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The Grassland Ecological Compensation Policy Drives the Differentiation of Herders' Livelihoods in Inner Mongolian Desert Grassland

Hong Chang [1,2], Xinchao Liu [2], Yu Xie [2], Yahong Liu [2], Wu Yang [3] and Jianming Niu [1,4,5,*]

1 School of Ecology and Environment, Inner Mongolia University, Hohhot 010021, China
2 Inner Mongolia Academy of Agricultural & Animal Husbandry Sciences, Hohhot 010031, China
3 College of Environmental and Resource Sciences, Zhejiang University, Hangzhou 310058, China
4 Ministry of Education Key Laboratory of Ecology and Resource Use of the Mongolian Plateau, Hohhot 010021, China
5 Inner Mongolia Key Laboratory of Grassland Ecology and the Candidate State Key Laboratory of Ministry of Science and Technology, Hohhot 010021, China
* Correspondence: 111964401@imu.edu.cn

Abstract: Herders' livelihood strategies are functions of the capitals at their disposal. Although this thesis has been proved, it has not been applied to livelihood research in the context of conservation initiatives. The Chinese government implemented the Grassland Ecological Compensation Policy (GECP) in 2011. However, the impact of the policy on herders' livelihoods is still unclear. This study measured the variation in herders' livelihood strategies in the desert grassland of Inner Mongolia, China, after the implementation of the GECP. This study also analyzed the impacts of livelihood capitals on the livelihood strategies, revealing the shortages of different livelihood strategies. The results showed the following: After the GECP, (1) herders' livelihood strategies could be grouped into five types based on livelihood capitals. The livelihood capitals of herders varied greatly, resulting in large economical gaps among households with different livelihood strategies. (2) The herders' livelihood strategies were affected by factors including the education, age, social communication, amount of livestock, income, and subsidy of the herders. (3) The main income sources of different livelihood strategies were both subsidy and livestock husbandry. In general, the GECP drives the differentiation of herders' livelihoods remarkably. Future conservation initiatives should take the shortages of different livelihood strategies into account.

Keywords: livelihood capitals; livelihood strategies; herders; conservation policy; desert grassland

Citation: Chang, H.; Liu, X.; Xie, Y.; Liu, Y.; Yang, W.; Niu, J. The Grassland Ecological Compensation Policy Drives the Differentiation of Herders' Livelihoods in Inner Mongolian Desert Grassland. *Agriculture* **2022**, *12*, 1325. https://doi.org/10.3390/agriculture12091325

Academic Editor: Giorgio Testa

Received: 8 July 2022
Accepted: 25 August 2022
Published: 27 August 2022

1. Introduction

Livelihood is a way of making a living. It is a means to maintain life based on the ability and capital of farmers and herders [1–3]. Livelihood strategy and livelihood capital are two important concepts of livelihood. Livelihood capital is the basic means or main way for people to maintain their lives and engage in production, which mainly includes assets, actions, and the right to acquire assets [4]. Livelihood strategy refers to people's choices of production and operation activities using the existing livelihood capital allocation to improve their own living conditions and pursue livelihood output that can bring benefits [5]. The status of farmers' livelihood capital is the basis for their choices of livelihood strategies. Farmers adopt livelihood strategies depending on the composition and overall status of their livelihood capital [6]. The theory of livelihood has become a key entry point for the research of people's livelihood issues [7] and a means to connect socio-economic and environmental issues [8–11], which provides an important perspective for complex, rural, sustainable development from the perspective of farmers.

At present, the attentions of researchers have mainly focused on the interactions between livelihood capital and livelihood strategies to understand how the structure and

stock of livelihood capital affect livelihood strategies and to provide a basis for formulating policies to reduce poverty and environmental pressure. A relevant research study divided livelihood strategies into different types according to certain standards and analyzed the impact of livelihood capital on livelihood strategies [12]. As the livelihood strategies in different regions show different forms, there is no unified and available method for the division of livelihood strategies. The bases for dividing livelihood strategies in existing studies have included family income structure and occupation [13–16], geographical location [17], access to capital [18], capital abundance [19,20], etc. It was found that livelihood capitals affect livelihood strategies [21]. Generally speaking, people with more livelihood assets have more choices, a better ability to resist risks and cope with vulnerabilities, and can better switch between various livelihood strategies [14]. Therefore, farmers adopt different livelihood strategies according to the functions of available capital to achieve their livelihood goals. However, there are few relevant studies that divide livelihood strategies based on livelihood capital combinations and analyze the impact of livelihood capital on livelihood strategies up to now.

Herders are the main operators of pastoral areas and livestock husbandry. Paying attention to the livelihoods of herders is of great significance to the development of pastoral areas and livestock husbandry. With grassland and livestock as the main capital, the economy of pastoral areas is backward. In addition, the instability of the market and the impacts of natural disasters make the livelihoods of herders very fragile [22]. The livelihood capital of herders plays a decisive role in their livelihood strategies. The livelihood capital and livelihood strategies of herders are different among grassland types [23]. Except for a few studies on livelihood capital and livelihood strategies mainly focusing on overall pastoral areas [12,22,23], there are few reports on specific grassland types. Desert grassland is a type of grassland with poor productivity of which the contradiction between man and land is prominent. Therefore, the relationship between the livelihood capital and livelihood strategies of herders in desert grassland is not consistent with the research conclusions of other environments, and further research about desert grassland is needed. To establish an index system in line with the livelihood capital of herders in desert grassland and to clarify the impact of livelihood capital on livelihood strategies in this region can provide some enlightenment for future studies of this environment.

Under the stress of climate change and overgrazing, the natural grassland in China has been seriously degraded, which makes the national ecological security face severe challenges. Depended on grazing as their main source of livelihood, herders have increased livestock and the utilization of grassland in order to raise their living standards, which has aggravated the degradation of the grassland. In order to protect the ecology of the grassland and improve the livelihoods of herders, the Chinese government implemented the Grassland Ecological Compensation Policy (GECP) in 2011. The conservation initiatives taken by the policy include preventing the grazing of animals, keeping livestock under the condition of a grassland–livestock balance, granting grassland subsidies to herders, and implementing pension subsidies and medical insurance. The policy also supported the transfer of herders' employment strongly. The objectives of the GECP were to protect the grassland ecology, improve the livelihoods of herders, broaden the sources of nonpastoral income, and reduce the dependence on livestock husbandry [24]. After the implementation of the GECP, while grassland ecology was protected, the livelihoods of herders depending on the utilization of grass for grazing was restricted due to the reduction in livestock. Therefore, when herders were faced with policies such as receiving grassland subsidies, reducing livestock, and banning grazing, what their livelihoods looked like was an urgent issue to be clarified.

In view of this, we conducted this research trying to answer the following three key questions: What are the livelihoods of herders like after the implementation of the GECP? What are the influencing factors of livelihood capital on livelihood strategies? How can the implementation of the GECP improve herders' livelihoods and reduce their dependence on grasslands for grazing? Therefore, we obtain the basic characteristics and socio-economic

information of herders in Damao Banner through investigation and interviews. Then, we group the types of livelihood strategies based on livelihood capital, analyze the differences between the types of livelihood strategies, and construct a multinomial logistic regression model to analyze the influencing factors of livelihood capital on livelihood strategies and the shortages of each livelihood strategy. Finally, we discuss policies and measures to improve the herders' livelihoods in order to provide scientific support for the formulation and implementation of conservation policies.

2. Materials and Methods

2.1. Study Area

Located in the midwestern Inner Mongolia Autonomous Region of China (Figure 1), Darhan Mumingan Joint Banner belongs to the middle part of the northern China steppe region, with a total area of approximately 18,177 square kilometers and an elevation of 1367 m. The area has a continental temperate semi-arid climate, with the annual rainfall ranging from 142.6 mm to 425.2 mm. Grassland is the dominant land use in the area, accounting for approximately 85.80% of its total land area. Desert grasslands are the major grassland type, which have a low productivity. The area has sharp conflicts between population and land. The rural residents live mainly by grazing their animals in grasslands and by livestock rearing. At the end of 2017, the area had a population of 111.6 thousand, with a population density of 6 people·km^{-2}, only one-twentieth of the national average. The per capita net income of the rural residents was CNY 12,691 (USD 2005), 5.52% lower than the national average of the rural population. The Grassland Ecological Compensation Policy (GECP) was implemented in 2011 in the whole area. According to the GECP, households could receive CNY 90·hm^{-2}·a^{-1} (USD 14·hm^{-2}·a^{-1}). Each household could receive an additional CNY 500·a^{-1} (78 USD·a^{-1}) comprehensive subsidy for means of production.

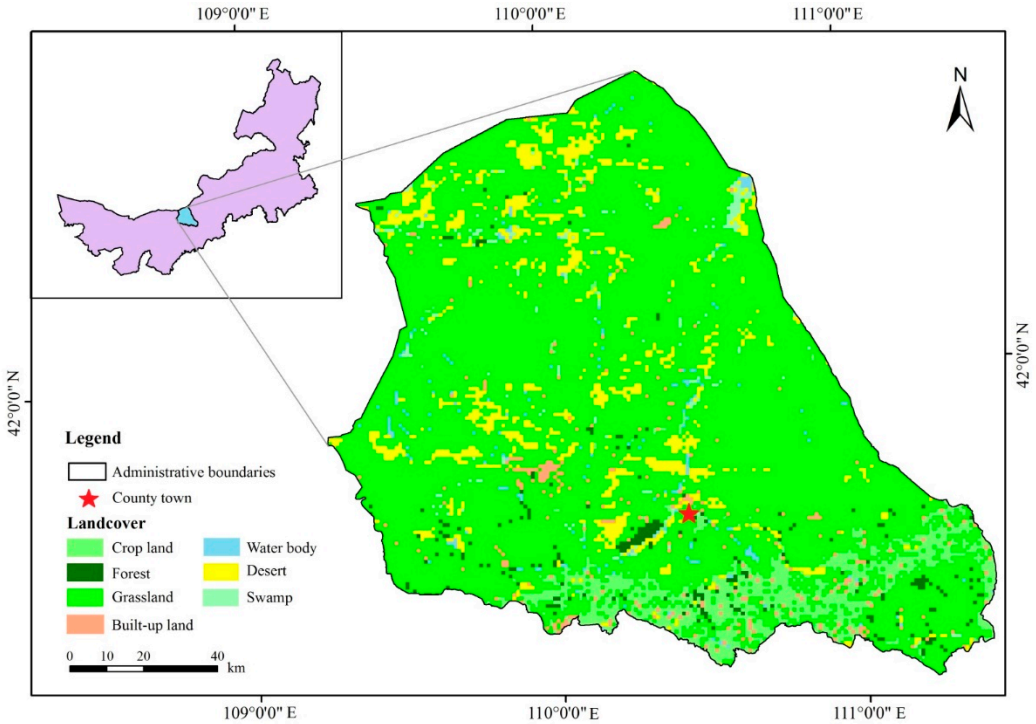

Figure 1. Map of the land use types in the research area.

2.2. Household Surveys

The data used in this study were derived from face-to-face household surveys [25] based on a stratified random sampling strategy [26]. Households were randomly selected in proportion to the total household numbers of the towns. The surveys were conducted in 2017. For respondents who did not speak Mandarin Chinese, we used a local interpreter to

help us communicate clearly. A pilot survey was conducted to improve the questionnaire before the formal survey began. For each household, we asked the head of the household who was familiar with the household's characteristics to answer the questions [27]. In this way, we were able to collect a first-hand data panel covering the implementation of the GECP. We interviewed a total of 270 households and obtained 251 validated questionnaires. The efficiency of the questionnaire was 92.96%.

The interviewees were asked to provide: (1) the socio-demographic backgrounds of themselves and their households; (2) grassland information, such as contracted area, grazing area, and the details of transferred grassland (the area and its use); (3) livestock conditions, including the type, number, and sale details of the livestock; and (4) household income and expenditure details, with the household income consisting of the livestock income and off-farm income (labor payment, wage employment, selling of planted crops, subsidies from the GECP, and other income, which referred to other welfare transfers from the government). Household expenditure included livestock production (the costs of purchasing forage, machines, and vehicles) and living expenditures (medicine, education, and the costs of social relations, fuel, and residence).

2.3. Data Analysis

2.3.1. Income Sources and Calculation

According to the actual situation of the study area, the herders' income mainly came from three sources: net livestock income, transfer income, and other income. Each of the three income items was estimated as follows.

The net livestock income referred to the annual gross income from three main subcomponents—livestock sales, livestock products, and services—while deducting the total annual cost of items such as purchased fodder or straw, veterinary services, and hired labor from the gross livestock income.

Transfer income referred to the sum of state policy subsidies, such as subsidies of the GECP, grain supplement subsidies, seed subsidies, propagation-sowing subsidies, low-income household subsidies, endowment subsidies, and so on.

Other income comprised the net crop income (value of crop products over the year, deducting the values of crop inputs such as fertilizers, ploughing services, seeds, and any payment to hired labor), wage employment, trade, nonfarm market production, and other cash-generating business activities, deducting any costs incurred related to a person's engagement in an activity. In addition to the major income components described above, some households also earned income from other sources, such as monetary gifts from friends and relatives, pasture rent, land rental fees, and compensation for land acquisition.

2.3.2. Livelihood Capital Calculation

According to the SLA (Sustainable Livelihoods Analysis) framework [5], the kinds of capital that herders depend on for their livelihoods can be roughly classified into five types: human capital, natural capital, physical capital, social capital, and financial capital [5,28]. The more capital the farmers possess, the more flexible their livelihood strategies [14,29].

We selected indicators of livelihood capital after a comprehensive consideration of the definition of livelihood capital, the relevant literature [30,31], regional characteristics, and available data. Additionally, in order to avoid collinearity problems in the analysis, we chose predictor variables, used them as explanatory variables, and then carried out a collinearity test [32]. Finally, the asset-based explanatory variables we used here mitigated the problem of collinearity. The names and descriptions of the indicators are shown in Table 1.

In the study, the entropy method was used to calculate the weight of each index of livelihood capital, and then the original value of each index was standardized and weighted to calculate the total value of the livelihood capitals. The entropy method determines the weight of indicators according to the repeated information between indicators. The greater the weight, the greater the relative change degree of the index [33,34]. Using the entropy

method to determine the evaluation index weight can not only eliminate the subjectivity of artificially determining the index weight, but also can effectively overcome the information overlap between the indices, so that the given index weight value has high reliability. The entropy method provides a basis for multi-index comprehensive evaluation and is widely used in research on various social and economic problems [35]. The calculation is as follows [36–39].

Table 1. The valuation method of the livelihood capital index.

Evaluation Indices	Unit	Weight	Definition
Human capital			
Household size	capita	0.0283	H1 = total size of the household
Adult male labor	capita	0.0253	H2 = number of adult male labors
Education of the household head	dummy variable	0.0419	H3 = junior college and above × 1 + senior high school × 0.75 + junior high school × 0.5 + primary school × 0.25 + illiteracy × 0
Age of household head	year	0.0129	H4 = age of the household head in years
Dependency ratio	%	0.2120	H5 = (household size − household laborers)/household laborers
Natural capital			
Area of pasture contracted	1×10^3 mu	0.0538	N1 = area of contracted grassland
Area of pasture used	1×10^3 mu	0.0567	N2 = area of contracted grassland ± area of rented grassland
Physical capital			
Livestock number	sheep unit	0.0372	P1 = camel × 7 + horse × 5 + cattle × 5 + sheep × 1 + goat × 0.9
Fixed assets	number	0.0453	P2 = the number of fixed assets owned by the household
Distance to the nearest county	km	0.0358	P3 = distance from household to the nearest county center
Housing condition	m^2	0.0353	P4 = the actual living space of the household
Social capital			
Gift expenditure	1×10^4 CNY	0.0459	S1 = total expenses for interpersonal communication in the survey year
Wage earners in the household	capita	0.2547	S2 = the number of people with a steady wage in the household
Financial capital			
Per capita income	1×10^4 CNY	0.0614	F1 = total household income in the survey year/household size
Per capita subsidy	1×10^4 CNY	0.0535	F2 = total household subsidy in the survey year/household size

Note: CNY 1 = USD 0.156 (at the time of the study); 1 mu ≈ 667 m^2 or 0.0667 hm^2.

First, the data are standardized using the forward range standardization method:

$$X'_{ij} = \left(X_{ij} - X_{min}\right) / \left(X_{max} - X_{min}\right), \quad (1)$$

where X_{ij} is the actual value of the ith sample of index j; X'_{ij} is the standardized value of the ith sample of index j; and X_{max} and X_{min} represent the maximum and minimum values of index j, respectively. $0 < i < n$, $0 < j \leq m$.

Second, the contribution of the sample to the index is calculated:

$$P_{ij} = \frac{X'_{ij}}{\sum_{i=1}^{n} X'_{ij}} \quad (2)$$

Third, the entropy value of index j is calculated:

$$e_j = \left(-\frac{1}{\ln n}\right) \sum_{i=1}^{n} P_{ij} \ln P_{ij} \quad (3)$$

e_j is the information entropy of the jth index, $e_j \in [0, 1]$.

Fourth, the weight of index j is defined as w_j:

$$w_j = \left(1 - e_j\right) / \sum_{j=1}^{m} \left(1 - e_j\right) \quad (4)$$

Fifth, the livelihood capital W is calculated:

$$W = \sum_{j=1}^{m} w_j X'_{ij} \quad (5)$$

According to the above steps, the weight of each index can be determined by the entropy method (Table 1).

2.4. Statistic Analysis

2.4.1. Clustering Sample Households

We used a hierarchical cluster analysis and chose the Ward's minimum variance method to group sample households into mutually exclusive groups of household livelihood strategy types according to livelihood capital indicators [40,41]. The data were analyzed with SPSS version 26.

2.4.2. Variance Analysis

We conducted a descriptive analysis to report household livelihood assets and information. One-way ANOVA and least significance difference tests were used to compare the differences in livelihood capital and family income structures of the livelihood strategies. The data were analyzed with SPSS version 26, IBM (New York, NY, USA), https://www.ibm.com/support/pages/downloading-ibm-spss-statistics-26.

2.4.3. Model Construction

We constructed a multinomial logistic regression model to identify the key livelihood capital types affecting the herders' livelihood strategies [42,43]. A multinomial logistic regression model is one of the logit models and the most widely used model at present. There are multiple independent variables in a multinomial logit model. When the response variable is a multiclassification variable, the corresponding logit model becomes a multinomial logistic model. The dependent variables we set were category LS1, LS2, LS3, LS4, and LS5, which were assigned as 1, 2, 3, 4, and 5 respectively. Each category was taken as the reference category in turn. Therefore, the reference categories (p_{yj}) were 1, 2, 3, 4, and 5, successively. The calculation formula was as follows:

$$\ln(p_{y1}/p_{yj}) = b_{210} + b_{211}x_1 + , \ldots, + b_{21m}x_i \quad (6)$$

$$\ln(p_{y2}/p_{yj}) = b_{210} + b_{211}x_1 + , \ldots, + b_{21m}x_i \quad (7)$$

$$\ln(p_{y3}/p_{yj}) = b_{310} + b_{311}x_1 + , \ldots, + b_{31m}x_i \quad (8)$$

$$\ln(p_{y4}/p_{yj}) = b_{410} + b_{411}x_1 + , \ldots, + b_{41m}x_i \quad (9)$$

$$\ln(p_{y5}/p_{yj}) = b_{510} + b_{511}x_1 + , \ldots, + b_{51m}x_i \quad (10)$$

where p_{y1}, p_{y2}, p_{y3}, p_{y4}, and p_{y5} are 1, 2, 3, 4, and 5, respectively; j = 1, 2, 3, 4, and 5, respectively; x_1, x_2, . . . , and x_i are the explanatory variables, that is, livelihood capital or specific livelihood capital indicators, and their names and descriptions are given in Table 1; and b_{210}, b_{211} . . . , b_{21m}, b_{310}, b_{311} . . . , b_{31m}, b_{411} . . . , b_{41m}, and b_{511} . . . , b_{51m} are the coefficients to be estimated, which are used to explain the change in the dependent variable caused by the change of one unit of the corresponding independent variable. If the coefficient to be estimated was greater than 0, it meant that the incidence increased with the increase in the corresponding independent variable under the condition that other variables remained unchanged; the opposite was also true.

3. Results

3.1. Categories of Herders' Livelihood Strategies and Descriptions

Using a cluster analysis according to livelihood capital indicators, the 251 sample households were grouped into five types (see Figure 2, Appendix A). In this way, we

obtained the mutually exclusive five livelihood strategies of herders and analyzed the differences in livelihood capital stock among the five types of livelihood strategies.

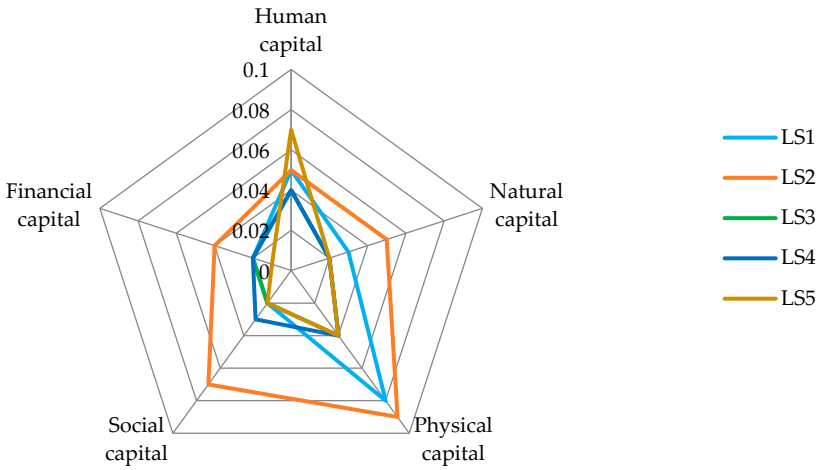

Figure 2. The differences in livelihood capital stock among the five categories of livelihood strategies (the data related to Figure 2 are in Appendix A).

The numbers of households of the five livelihood strategies were, respectively, 77, 56, 10, 65, and 43, accounting for 30.68%, 22.31%, 3.98%, 25.90%, and 17.13% of the total sample households, respectively. Households following different categories of livelihood strategies had significantly different characteristics in livelihood capital. In terms of livelihood capital levels, compared with other categories, LS2 households had significantly higher natural capital, as well as physical capital, social capital, financial capital, and total capital per household. They were followed by LS1 households, whose human capital, natural capital, physical capital, financial capital, and total capital per household were higher than the remaining categories. LS4 households had the significantly lowest human capital, physical capital, social capital, and total capital per household, but their natural capital was higher than LS3 and LS5, and their financial capital was higher than LS5. Unlike LS2, LS3 households had the lowest livelihood capital and total capital per household, except financial capital, which was higher than LS5. Although LS5 households had the significantly highest human capital, their natural capital, as well as their physical capital, financial capital, and total capital per household, were significantly lower than other categories.

3.2. Summary Statistics of Information on Livelihood Strategies

Table 2 shows the means and standard deviations of the summary statistics of herder information under the five categories of livelihood strategies. Compared with other categories of livelihood strategies, LS1 households had the largest household size (3.66), fixed assets (5.91), and house area (124.45 m^2) of all the categories of livelihood strategy households. Their adult male workforce (1.47), household contracted grassland area (3.75×10^3 mu), livestock size (275.65), gift expenditure (1.15×10^4 CNY), per capita income (2.20×10^4 CNY), and per capita subsidies (0.85×10^4 CNY) were higher compared to the other categories of livelihood strategy households. However, their amount of wage earners in the household (0.12) was the lowest.

LS2 households were relatively affluent herders, with the highest per capita income (4.78×10^4 CNY). The heads of households in this category were the youngest. Additionally, they had the largest household contracted grassland area (5.83×10^3 mu), used grassland area (8.36×10^3 mu), and per capita subsidies (1.57×10^4 CNY). In addition, their livestock size (469.29), fixed assets (5.68), house area (107.96 m^2), gift expenditure (1.73×10^4 CNY), and wage earners in the household (0.57) were higher compared to the other categories of livelihood strategy herders. However, their household size (2.96) and adult male workforce (1.23) were below average.

Table 2. Summary statistics of information on livelihood strategies.

Livelihood Capital Indicators		Overall Samples	LS1 (n = 77)	LS2 (n = 56)	LS3 (n = 10)	LS4 (n = 65)	LS5 (n = 43)
Human capital	H1	3.25 ± 1.22	3.66 a ± 1.43	2.96 b ± 0.87	2.10 c ± 0.32	3.09 b ± 1.23	3.40 ab ± 1.03
	H2	1.34 ± 0.67	1.47 ab ± 0.65	1.23 b ± 0.49	0.35 c ± 0.47	1.22 b ± 0.54	1.66 a ± 0.84
	H3	2.59 ± 0.95	2.56 c ± 0.85	2.93 b ± 1.04	2.10 cd ± 0.57	1.89 d ± 0.66	3.37 a ± 0.58
	H4	50.69 ± 10.35	50.04 b ± 9.76	45.71 c ± 9.73	67.80 a ± 1.99	53.11 b ± 10.03	50.70 b ± 8.65
	H5	0.21 ± 0.40	0.12 c ± 0.19	0.30 b ± 0.46	1.50 a ± 0.53	0.15 c ± 0.26	0.06 c ± 0.13
Natural capital	N1	3.67 ± 2.86	3.75 b ± 2.14	5.83 a ± 3.84	2.14 bc ± 1.39	2.97 bc ± 2.13	2.12 c ± 1.94
	N2	4.89 ± 4.00	4.32 b ± 2.62	8.36 a ± 5.02	2.34 b ± 1.36	3.72 b ± 2.50	3.77 b ± 4.28
Physical capital	P1	294.68 ± 178.76	275.65 b ± 140.89	469.29 a ± 187.39	72.00 d ± 71.31	255.08 bc ± 139.45	213.00 c ± 123.34
	P2	4.09 ± 1.97	5.91 a ± 0.40	5.68 a ± 1.06	3.20 b ± 1.69	2.06 c ± 0.46	2.02 c ± 0.15
	P3	42.98 ± 21.34	41.24 a ± 24.52	43.37 a ± 17.47	38.56 a ± 24.95	44.22 a ± 19.07	44.72 a ± 22.80
	P4	99.68 ± 63.49	124.45 a ± 77.28	107.96 a ± 60.83	65.70 b ± 39.50	84.17 b ± 48.78	75.88 b ± 44.05
Social capital	S1	1.14 ± 0.82	1.15 b ± 0.77	1.73 a ± 0.96	0.38 c ± 0.29	0.92 b ± 0.64	0.86 bc ± 0.59
	S2	0.25 ± 0.58	0.12 b ± 0.32	0.57 a ± 0.89	0.20 b ± 0.42	0.23 b ± 0.55	0.12 b ± 0.32
Financial capital	F1	2.54 ± 2.38	2.20 b ± 1.15	4.78 a ± 3.06	1.38 bc ± 0.76	1.99 bc ± 2.41	1.31 c ± 0.85
	F2	0.94 ± 0.79	0.85 b ± 0.48	1.57 a ± 1.18	1.21 ab ± 0.65	0.75 bc ± 0.50	0.51 c ± 0.42

Note: Different letters indicate significant difference ($p < 0.05$); data in the table are means ± SD. Refer to Table 1 for the names and explanations of variables.

LS3 households were the kind of household with the oldest heads of households, whose average age was 67.80 years old; similarly, this kind of household had the highest dependency ratio (1.50) and the lowest adult male workforce (0.35). Additionally, they had the smallest livestock size (72), house area (65.70 m^2), and gift expenditure (0.38 × 10^4 CNY). Their household contracted grassland area (2.14 × 10^3 mu) and per capita income (1.38 × 10^4 CNY) were low, but per capita subsidies (1.21 × 10^4 CNY) were higher than the types of LS1, LS4, and LS5.

LS4 households had higher household size (3.09), adult male workforce (1.22), livestock size (255.08), and gift expenditure (0.92 × 10^4 CNY) than LS3 households. However, the education of their household heads (1.89), dependency ratio (0.15), household contracted grassland area (2.97 × 10^3 mu), fixed assets (2.06), house area (84.17 m^2), wage earners in the household (0.23), per capita income (1.99), and per capita subsidy (0.75) were low.

LS5 households were relatively the poorest category because their average per capita income was lowest (1.31 × 10^4 CNY), and their household contracted grassland area (2.12 × 10^3 mu), fixed assets (2.02), wage earners in the household (0.12), and per capita subsidy (0.51) were also the lowest of all the categories of households, although they had good labor conditions with the largest adult male workforce (1.66), the highest education of the household head (3.37), and the lowest dependency ratio (0.06).

3.3. Livelihood Capitals That Affect Livelihood Strategies and Shortages in Livelihood Strategies

Using a multinomial logistic regression model, we analyzed the livelihood capitals that affected livelihood strategies, the shortages in different livelihood strategies, and the conditions for transformation between the categories of livelihood strategies. Five categories of livelihood strategies (LS1, LS2, LS3, LS4, and LS5) were taken as the reference category, respectively (Table 3). Concerning the overall significance of the model, the computed log likelihoods, the chi-squared value, and its corresponding probability showed that the overall model was significant and explained the observed behavior (see statistics below Table 3).

LS2 was a relatively affluent category of livelihood strategy with high livelihood capital. Therefore, it would show significance when analyzing the transformations from other categories to LS2. Although other categories of livelihood strategies had obvious characteristics, they did not show significant differences in the transformations between them.

Education and age of the household head, livestock number, gift expenditure, wage earners in the household, per capita income, and per capita subsidy were the main livelihood capital indicators affecting the livelihood strategies of herders.

Table 3. Multinomial logit regression results.

Influence Factor	Base Categories							
	LS1		LS3		LS4		LS5	
	B	*p*-Value	B	*p*-Value	B	*p*-Value	B	*p*-Value
H1	19.154	0.156	28.815	0.999	−24.300	0.999	−61.108	0.997
H2	−18.143	0.150	27.951	0.999	78.915	0.992	−49.918	0.995
H3	17.289	0.049	46.732	0.999	161.716	0.985	−124.139	0.992
H4	−17.143	0.074	−26.722	0.005	4.963	1.000	21.989	0.999
H5	23.689	0.068	−33.967	0.999	40.909	0.996	174.109	0.987
N1	−27.050	0.245	−141.521	0.999	93.279	0.994	−32.423	0.998
N2	28.666	0.053	154.221	0.999	−54.366	0.996	−50.061	0.997
P1	28.107	0.019	77.791	0.998	−32.021	0.998	72.073	0.996
P2	−7.339	0.469	70.110	0.997	202.345	0.980	183.407	0.982
P3	17.652	0.077	−13.746	1.000	−22.186	0.998	37.192	0.997
P4	−18.575	0.056	27.712	1.000	16.671	0.998	11.758	0.999
S1	32.715	0.037	37.730	0.999	30.579	0.997	138.683	0.988
S2	27.379	0.016	62.443	0.999	−33.741	0.997	−10.438	0.999
F1	33.701	0.024	75.873	0.999	104.794	0.993	1.485	1.000
F2	63.067	0.114	62.849	0.116	23.928	0.549	263.091	0.000
Intercept	−41.938	0.088	−104.630	0.997	−180.239	0.989	−84.657	0.995

Note: Livelihood strategy transformed from base categories to LS2; base categories are LS1, LS3, LS4, and LS5, respectively. Refer to Table 1 for variable names and definitions. Indicators of overall model significance: log likelihood = 23.989; LR chi^2 (18) = 717.818; prob > chi^2 = 0.000; pseudo R^2 = 0.943. B is the regression coefficient.

In livelihood strategies transformed from LS1 households to relatively affluent LS2 households, these five factors showing significance ($p < 0.05$) included education of the household head, livestock number, gift expenditure, wage earners in the household, and per capita income. The regression coefficients were 17.289, 28.107, 32.715, 27.379, and 33.701, respectively, indicating that increasing these factors had a significant positive impact on livelihood strategy transformation to an affluent livelihood strategy.

The age of the household head showed significance in livelihood strategy transformation from LS3 to LS2 ($p < 0.05$), and the regression coefficient was −26.722, indicating that the age of the household head had a significant negative impact on livelihood strategy transformation from LS3 to LS2, that is, the younger the age of the household head, the more they transformed to an affluent livelihood strategy.

The per capita subsidy showed significance in livelihood strategy transformation from LS5 to LS2 ($p < 0.05$), and the regression coefficient was 263.091, indicating that the per capita subsidy had a significant positive impact on livelihood strategy transformation from LS5 to LS2, that is, increasing the per capita subsidy benefitted LS5 transformation to an affluent livelihood strategy.

3.4. Income Structure of Five Livelihood Strategies

Table 4 indicates that, in the income compositions of local households, transfer income was the main source of income, accounting for 54.04% of the total income, followed by the net livestock income, which accounted for 34.82% of the total income. The least was other income, accounting for only 11.13%.

We compared the income structures of the five categories of livelihood strategies. LS5 households' net livestock income accounted for the highest proportion of total household income, which was 43.82%, and their transfer income proportion was the lowest (44.25%). LS3 households' transfer income accounted for the largest proportion (90.01%) of the total household income. Because the average age of these households' heads was the oldest, it was the eldest group who did not have enough labor to raise livestock and had the lowest livestock size, so they mainly relied on government subsidies as a source of livelihood. Because other income was the lowest and did not show significance, we focused on the analysis of the previous two incomes.

Table 4. Comparison of income structures of five livelihood strategies.

Livelihood Strategy Categories	Number of Households	Income Structure		
		Net Livestock Income Share (%)	Transfer Income Share (%)	Other Income Share (%)
LS1	77	33.05 b ± 22.43	53.66 bc ± 22.84	13.29 a ± 24.96
LS2	56	36.29 ab ± 29.30	50.64 bc ± 30.46	13.07 a ± 26.36
LS3	10	8.13 c ± 8.39	90.01 a ± 8.31	1.86 a ± 5.12
LS4	65	33.82 ab ± 26.40	58.37 b ± 27.63	7.81 a ± 17.30
LS5	43	43.82 a ± 29.20	44.25 c ± 29.16	11.93 a ± 21.89
Total	251	34.82 ± 26.65	54.04 ± 27.91	11.13 ± 22.56

Note: different letters indicate significant difference ($p < 0.05$).

To sum up, we can see that transfer income and net livestock income were still the main sources of income for local herders, and other income only played a supplementary role in the total household income.

4. Discussion

To clarify the variations in the livelihoods of herders after the implementation of the GECP is of great significance to improve the grassland conservation policy and promote grassland ecological protection. From the perspective of sustainable livelihood science, we analyzed the livelihood statuses of herders in desert grassland and explored the impact factors of livelihood capital on livelihood strategies, as well as the shortages in different livelihood strategies. Then, we analyzed the income structures of households with different types of livelihood strategies after the implementation of the GECP. Finally, we put forward policy suggestions to improve the livelihoods of herders.

4.1. Livelihood Strategies of Herders Were Grouped into Five Categories Based on Livelihood Capital

The division of livelihood strategies is the basis of sustainable livelihood research. Researchers have used a variety of methods to classify livelihood strategies so far. For example, livelihood strategies have been divided into two types (farm and nonfarm) [21] or three types (livestock type, diversified type, and farm type) [44]. Others have also considered the share of forestry and animal husbandry in household incomes. For example, household livelihood strategies can also be divided into low, moderate, high, and very high types of dependence on forest and livestock income [14,45]. Few studies have considered classifying household livelihood strategies with different combinations of livelihood capital. Combinations of livelihood capital can affect a family's livelihood strategy. A family's choice of livelihood mode directly depends on the availability of livelihood capital [46–48]. By clustering the livelihood capital types, we could identify the livelihood strategies based on different combinations of livelihood capital, which made it easy to identify the characteristics and shortages of livelihood strategies and to provide support for improving herders' livelihoods and follow-up research.

4.2. Livelihood Capital of Herders with Different Livelihood Strategies Varied Greatly and Resulted in Large Economical Gaps among Households with Different Livelihood Strategies

The livelihood capitals and income levels of herders with different livelihood strategies differed greatly, which reflected the large gap between the rich and the poor. As a natural capital, grassland is an important substance of production and plays a decisive role in production. A grassland subsidy is granted according to the area of a household's contracted grassland. The larger the contracted grassland area, the higher the grassland subsidy obtained. Similarly, herders with large grassland areas can raise more livestock to obtain more livestock husbandry income. This leads to a significant increase in the incomes of herders with large, contracted grassland areas. Yin et al. [24] also reported that herders with large, contracted grassland areas had higher income. The inequality of grassland can lead to a large economical gap among local herders. In this study, the contracted grassland area of LS2 herders was the largest, and their natural capital and other livelihood capital,

as well as their incomes, also were the largest, so LS2 was a kind of livelihood strategy for wealth. LS5 herders had the lowest per capita income, which indicated a poor livelihood strategy. Although they had high human capital with a large family population and labor force, they were still constrained by a small grassland area; in addition, their numbers of livestock and grassland subsidies were also low. Meanwhile, because of few employment channels and opportunities for local herders, the surplus labor force of LS5 households had few opportunities to engage in other occupations to increase their incomes. Therefore, the GECP drove the differentiation of local herders' livelihoods remarkably.

4.3. Multiple Factors of Livelihood Capital Affect the Herders' Livelihood Strategies

Several studies have explored the influencing factors on household livelihood strategies. The general conclusion was that access to and control over different types of livelihood capital mainly affected household livelihood strategies [28,49]. In this study, the education and age of the heads of households were the human capital factors that affected the herders' livelihood strategies, which is consistent with the research results of Meng et al. [50]. The higher the herders' education, the stronger the ability to obtain all kinds of information. The younger or middle-aged heads of households provided good labor conditions for livestock husbandry production. Although the number of livestock was an affecting factor of livelihood strategy, increasing the number of livestock was bound to cause pressure on the grassland. Gift expenditure and the number of people with a steady wage in a household were the social capital factors affecting the livelihood strategies of herders. This viewpoint is consistent with the research results of Ding et al. [16] and Meng et al. [38]. Social cooperation promotes information and the resources exchange, which is conducive to the development of production. The number of people with a steady wage in a household increased the sources of household income. The level of per capita income reflects the economic condition of a family. The per capita subsidy showed significance, which indicated that government subsidies played an important role in improving the livelihoods of herders.

In view of the herders' livelihood statuses, strong external intervention is needed to adjust the livelihood strategies of herders because of the weak livelihood and income inequality of the local households. The current ecological compensation policies generally have a "one size fits all" scheme, which does not take the socio-economic environment, the heterogeneity, and the shortages of herder households into account. Future policies should take the needs of different beneficiaries into account to allocate resources effectively and accurately. For category LS1, education of the heads of households, gift expenditure, number of people with a steady wage in a household, and per capita income were the factors restricting transformation to a richer livelihood strategy. The LS1 type was the largest type of herders among the local herders, accounting for 30.68% of the local herders. The government should actively organize vocational skills training to improve the employment competitiveness of herders, enhance cooperation among herders, and encourage herders to establish professional cooperatives. For category LS3, since the heads of the households were older and did not have the labor conditions to engage in livestock husbandry and other production, the main income source of this type of household was government subsidies. Therefore, for this type of herder, the government should increase subsidies to ensure their basic living needs. For category LS5, due to small areas of contracted grassland, large family populations, and lowest per capita subsidies, the subsidies granted by the GECP had not achieved the expected effect. Therefore, is it more reasonable to grant subsidies according to the population? Although herders of the LS2 type were relatively affluent, they still relied heavily on livestock husbandry with a large number of livestock and had few other sources of income. Meanwhile, the herders of other livelihood strategies also relied heavily on livestock husbandry. It is urgent to increase nonpastoral employment opportunities for herders; only in that way can we transfer the labor force of livestock husbandry, reduce the dependence on livestock husbandry, alleviate the pressure on the ecology, and reduce the vulnerability of single-source livelihoods.

4.4. Income Sources of Herders Were Mainly Government Subsidy and Livestock Husbandry, While Nonpastoral Income Only Played a Supplementary Role

The main objective of the GECP is to reduce the herders' dependence on grassland by increasing nonpastoral income and diversifying the livelihood modes of herders. In this study, the income sources of households were single, which were mainly transfer income and income from livestock husbandry. Government subsidies had become the most important source of family income. Herders were still highly dependent on livestock husbandry. They had not departed from the livelihood strategy of relying on livestock husbandry and government subsidies. This result is consistent with the research results in Inner Mongolia of Ding et al. [16] and Yin et al. [17]. We can see that, after the implementation of the GECP, the policy did not achieve the effect of reducing herders' dependence on livestock husbandry and increasing income sources. The original intention of the subsidy was to make up for the economic losses caused by livestock reduction. However, relevant studies have shown that most herders consider the standards of grassland subsidies as too low. The subsidies of the GECP were less than the economic losses caused by livestock reduction. Herders still had to continue to raise livestock to meet their living needs [23,24]. Ding et al. [16] showed that the proportion of livestock husbandry income in the total income of herders was greater than the transfer income, which is different from the results of this study, where the proportion of the transfer income in the total income was greater than the livestock husbandry income. This was due to the different grassland types of the study areas. The productivity of desert grassland is low, their stocking rate is small, and the herders' incomes of livestock husbandry are limited, so herders were more dependent on the transfer income.

4.5. Implications for Policy Making and Implementation in the Future

It is a complex process to protect grassland ecology and improve the livelihoods of herders through the implementation of conservation policies. Our results could provide some suggestions for the formulation and implementation of conservation policies in the future.

Firstly, increasing the income sources of herders by increasing the nonpastoral employment opportunities and nonpastoral income is necessary. The government should develop new industries according to local characteristics, such as processing industries and tourism, and develop tertiary industry to increase nonpastoral employment opportunities for herders. Nowadays, grassland tourism is developing rapidly due to the beautiful scenery. As a rising tertiary industry, tourism can drive the development of upstream and downstream industries related to it, such as the catering industry and the service industry, which can play a great role in driving the surrounding industries. At the same time, we should also pay attention to the implementation of supporting policies to improve the labor market in the surrounding towns of the pastoral area in order to speed up the urbanization construction of the pastoral area. Transferring the local labor force and increasing the total income of households by engagement in nonpastoral activities is not only a powerful way to help the herders increase their income, but also an effective means to encourage the herders to reduce the number of livestock and reduce the intensity of grazing.

Secondly, differentiated compensation policies should be implemented according to the shortages in herders' livelihood strategies. It is necessary to accurately identify specific types of herders and give preference in resource allocation. At present, the compensation standard of the policy is to grant subsidies according to the area of household contracted grassland. However, due to the large differences in the grassland areas contracted by herders, this leads to an economical gap between the herders, so it is more reasonable to grant subsidies according to the family population. We should pay attention to increasing subsidies [51], and subsidy funds should be reasonably compensated according to the economic losses caused by the livestock reduction of herders.

Finally, vocational skills training should be actively organized to improve the employment competitiveness of herders. Most herders are ethnic minorities. Due to limitations

of poor language, low education, and poor vocational skills, the herders participating in nonpastoral employment in pastoral areas are, generally, few. We should organize targeted vocational skills training for herders to break down the language and skill barriers to herders' employment [52] and help more livestock husbandry workers participate in nonpastoral employment.

Author Contributions: Conceptualization, H.C. and J.N.; methodology, H.C.; software, H.C. and X.L.; investigation, H.C., Y.X., Y.L. and X.L.; data curation, Y.X. and H.C.; writing—original draft preparation, H.C.; writing—review and editing, J.N.; visualization, X.L. and H.C.; designing—questionnaire, W.Y.; project administration, W.Y.; funding acquisition, J.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Ministry of Science and Technology of China (grant number 2016YFC0503404) and Major Projects of the Natural Science Foundation of the Inner Mongolia Autonomous Region, China (grant number 2018ZD03).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Written informed consent has been obtained from the patient(s) to publish this paper.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The differences in livelihood capital stock among the five types of livelihood strategies.

Livelihood Strategy Categories	Human Capital	Natural Capital	Physical Capital	Social Capital	Financial Capital	Total Capital per Household
(n = 77)	0.05 b ± 0.01	0.03 b ± 0.02	0.08 b ± 0.01	0.02 b ± 0.03	0.02 b ± 0.01	0.21 b ± 0.05
LS2 (n = 56)	0.05 b ± 0.02	0.05 a ± 0.03	0.09 a ± 0.02	0.07 a ± 0.08	0.04 a ± 0.02	0.31 a ± 0.08
LS3 (n = 10)	0.04 c ± 0.01	0.02 c ± 0.01	0.04 c ± 0.02	0.02 b ± 0.04	0.02 bc ± 0.01	0.14 c ± 0.05
LS4 (n = 65)	0.04 c ± 0.01	0.02 bc ± 0.02	0.04 c ± 0.01	0.03 b ± 0.05	0.02 bc ± 0.01	0.15 c ± 0.06
LS5 (n = 43)	0.07 a ± 0.01	0.02 c ± 0.02	0.04 c ± 0.01	0.02 b ± 0.03	0.01 c ± 0.01	0.16 c ± 0.05

Note: different letters indicate significant difference ($p < 0.05$).

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