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Analysis of the differences in green farming behavior of operating agents in grassland pastoral areas

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Green farming is the inevitable path to solving the problem of pasture ecological protection and a fundamental guarantee to realize the high-quality development of grassland animal husbandry. This study explores the differences in green farming behaviors of different operating agents in grassland pastoral areas. The mechanism of the formation of the differences is based on 274 working agents' survey data from Xilin Gol league pastoral areas in Inner Mongolia, China, by constructing the Logit model and Fairlie decomposition method. The results show that family ranch is the primary operating agent of green farming in China's grassland pastoral areas. The green farming behavior is 2.115 times more extreme than that of traditional pastoralists. Differences in the intensity of green farming behavior of the operating agents were significantly and positively correlated with differences in their ecological consciousness and differences in resource endowment. Differences in ecological consciousness and participation in training were the key factors contributing to the differences in the intensity of green farming behavior among the operators, with ecological consciousness contributing 51.34% and participation in training contributing 46.65% to the differences in the intensity of green farming behaviors. Therefore, to enhance the effective transformation of traditional pastoralists' green farming behavior, we should guide them to raise ecological consciousness, focus on the role of resource endowment, and gradually form a new grassland animal husbandry development where green farming behavior fully landed.

KEYWORDS

green farming, behavioral differences, ecological consciousness, resource endowment, Logit model, Fairlie decomposition method

1 Introduction

China's grasslands account for approximately 12% of the global grassland area, ranking first in the world (Forestry and Grassland Administration, 2018). Grassland pasture is the overlapping area of livestock production and grassland ecological civilization construction. It is an integral part of China's grassland, whose healthy development is related to national food, ecological security, and global sustainable development. However, with increasing population pressure and changes in production methods, Chinese grassland pastoral areas face many problems regarding production methods, ecological conditions, and lifestyles. On the one hand, a series of ecological issues, such as overgrazing (Xiong et al., 2017), increasing degradation of pastures (Zhu and Hao, 2018), and sanding (Qu, 2006), are frequent. On the other hand, the introduction of modern farming modes has also led to the gradual decline of the nomadic way formed over thousands of years, with herders settling down and grazing and living low standards (Jiang and Jing, 2013). Therefore, we urgently need to find a suitable development path to achieve the goal of "ecology, production, and life win-win" in pastoral areas.

Green farming refers to the behavior of individuals to actively reduce the negative impact of their farming decisions on the ecology (Stern, 2000), which is one of the primary measures to realize the sustainable development of the environment, society, and economy in grassland pastoral areas (Ke et al., 2019). Current research on green farming behavior and its influencing factors mainly focuses on livestock and poultry farming behavior in agricultural areas (Krishna et al., 2008; Guang et al., 2012; Jeon et al., 2015; Li et al., 2016; Pan, 2016; Hua et al., 2019; Xue et al., 2019; Li et al., 2020). There are few pieces of research on green farming behavior in grassland pasture areas. Notably, the differentiation of animal husbandry operators in agricultural areas significantly impacts green farming behavior (Qiu et al., 2019). At the same time, the effect of ecological consciousness and resource endowment on green farming behavior varies by the type of operating agents (Dan and Bin, 2015; Chang et al., 2021). However, grassland pastoral areas are special eco-economic and cultural regions with grassland animal husbandry as the primary industry. They differ significantly from agricultural areas regarding livestock breeding methods and business management modes (Sethu et al., 2011). It is debatable whether the rules of agricultural areas suit the reality of pastoral areas. In China, family ranches and traditional pastoralists are the leading operators of animal husbandry in grassland pastoral areas, and their ecology is significant for improving environmental problems and solving the challenges of green development of animal husbandry (Akintunde, 2017; Bleys et al., 2017; Dornhoff et al., 2019). Therefore, we urgently need to analyze the subject of implementing green farming behavior, the differences in green farming behavior, and the determinants factors in grassland pastoral areas.

Xilin Gol League of Inner Mongolia is a typical grassland pastoral area in northwest China, with various grassland types, including family ranches, traditional pastoralists, and other forms of operation. Accordingly, this study takes Xilin Gol League as an example. It uses the ordered Logit model and Fairlie decomposition method to build a regression model of the intensity of green farming behavior, ecological consciousness, and resource endowment of different operating agents. This study tries to answer the following questions: 1) Who are the green farming subjects in grassland pastoral areas? 2) What factors drive herders to choose green farming mode?

2 Research methodology

2.1 Data collection and sample descriptive statistics

Data were obtained from a field-based household survey conducted in September–November 2020 in Dongwu Banner (116°97′E, 45°52′N), Sonid Left Banner (113°63′E, 43°85′N), and Zhenglan Banner (115°99′E, 42°24′N), Xilin Gol League, Inner Mongolia, China. According to the purpose of the study and the national situation of China, this study divides the research subjects into two groups: family ranches and traditional pastoralists. According to the Inner Mongolia Autonomous Region Family Farming Opinions, the family ranch refers to the basic organizational unit of the herding family, where the family

TABLE 1 Basic characteristics of research samples.

Item	Group	Family ranch		Traditional pastoralist	
		N	%	N	%
Age of the householder	20–30 years old	2	1.418	2	1.504
	30–40 years old	41	29.078	33	24.812
	40–50 years old	67	47.518	51	38.346
	50–60 years old	29	20.568	39	29.323
	60–70 years old	2	1.418	8	6.015
Education level	0–5 years	17	12.057	45	33.835
	6–9 years	68	48.227	62	46.616
	10 years and above	56	39.716	26	19.549
Number of laborers engaged in pastoralism	1 person	3	2.128	6	4.511
	2 people	100	70.922	103	77.444
	3–5 people	38	26.950	24	18.045
Grassland operating area	0–4,000 mu	74	52.482	46	34.587
	4,000–8,000 mu	27	19.149	32	24.060
	8,000–12,000 mu	9	6.383	24	18.045
	12,000–16,000 mu	8	5.674	16	12.030
	16,000 mu and above	23	16.312	15	11.278

Note: 0–5 indicate that their educational background is between 0–5 year, while 6–9 indicate that they have been studies between 6–9 years.

TABLE 2 Detailed definition and assignment of the selected variables.

Variable name		Definition	Meaning
Green farming behavior intensity		Strength of green farming behavior of family ranches and traditional pastoralists	For either behavior, a value of 1 is assigned when it is adopted, and a value of 0 is assigned when it is not adopted. Sample green farming behavior is "0," "1," and "2," respectively
			1 means that the sample has either grass-livestock balance or manure resource utilization
			2 means that the sample engages in grass-livestock balance and manure resource utilization
Ecological consciousness	Ecological awareness level	Ecosystem degradation or damage can directly threaten human wellbeing	Completely disagree = 1, not quite agree = 2, generally = 3, more agree = 4, completely agree = 5
	Eco-practice concept	Green farming methods require much effort	Completely disagree = 1, not quite agree = 2, generally = 3, more agree = 4, completely agree = 5
	Ecological value perception	Comprehensive cost benefits and long-term development, green farming methods are good for your family to increase income	Completely disagree = 1, not quite agree = 2, generally = 3, more agree = 4, completely agree = 5
Natural capital	Grassland contracted area	Family contracted pasture area (mu)	Specific figures
	Grassland flowing area	Grassland area transferred by families (mu)	Specific figures
Social capital	Participation in training	Have participated in green farming content-related training	Participation in relevant training programs = 1, no participation = 0
	Frequency of communication	Do you often communicate and discuss with people within the gacha?	Never/rarely = 1, occasionally/less often = 2, generally = 3, often/more often = 4, frequently/lots = 5
Financial capital	Household business income in the previous year	Household business income in the previous year (yuan)	Specific figures
	Pasture subsidies	Grass-livestock balance, grazing ban, and grazing rest subsidies received (yuan)	Specific figures

members are the primary labor force. In addition, ranch families also fulfill some other requirements, such as the moderate scale of animal husbandry with efficient labor, usage of modern technology as the production factor, and engagement in specialization and intensive livestock production. Furthermore, livestock income would be the primary source of income, and the implementation of self-operation, self-accumulation, self-development, self-financing, and self-management would be the primary goal. If the above requirements are met, the relevant departments will give the family ranch issued "Inner Mongolia Autonomous Region Family Ranch Certificate of Recognition." The remaining sample of herding households based on natural, rough traditional livestock farming was defined as traditional pastoralists. Sample selection combines stratified and random sampling in the study area based on careful consideration of livestock production, economy, topography, and grassland types. In the first stage, a typical sampling method was used to select 13 sumus. In the second stage, two more gachas were randomly chosen in each sumu. Finally, some family ranches and traditional pastoralists were randomly selected among the identified gachas. Three hundred questionnaires were distributed in this survey, and 274 valid questionnaires were obtained. Among them, there are 141 family ranches and 133 traditional pastoralists.

The details of the sample characteristics are shown in Table 1. Overall, the characteristics of family ranches and traditional pastoralists align with the reality of the Inner Mongolia grassland pastoral area, which is representative.

2.2 Analysis of the differences and causes of green farming behavior among different operators

2.2.1 Modeling strategy

Based on the study of Jie and Qi (2022) and the actual investigation and data quality, this study selects the ordered Logit regression model to systematically discuss the influence mechanism of ecological consciousness and resource endowment on green farming behavior intensity. According to the regression modeling principle of the model, the corresponding model function takes the following form:

$$ln\left[\frac{P(Y=k|X)}{P(Y=K|X)}\right]=\alpha_k+\sum_{i=1}^{I}\beta_{ki}x_i+\mu, \quad (1)$$

where Y is the set of dependent variables (the intensity of green farming behavior of the operating agent); X denotes the set of independent variables (ecological awareness and resource endowment); X_i is the i-th independent variable, $i = 1, 2, \ldots, I$; β_{ki} is the regression coefficient of the i-th independent variable of the k-th scheme, $k = 1, 2, \ldots, K$; $P(Y = k|X)$ is the probability of the k-th scheme and $\sum_{k=1}^{K}P(Y=k|X)=1$; α_k is the intercept of the k-th scheme; and μ is the random error term.

To further investigate the mechanism of the influence of ecological awareness and resource endowment differences on the difference in intensity of green farming behavior between family farms and traditional herders, the study chose the Fairlie decomposition method, denoted as

$$\bar{Y}^R - \bar{Y}^P = \left[\sum_{j=1}^{N^R} \frac{F\left(X_{ij}^R \hat{\beta}_{ij}^P\right)}{N^R} - \sum_{j=1}^{N^P} \frac{F\left(X_{ij}^P \hat{\beta}_{ij}^P\right)}{N^P}\right] + \left[\sum_{j=1}^{N^R} \frac{F\left(X_{ij}^R \hat{\beta}_{ij}^R\right)}{N^R} - \sum_{j=1}^{N^R} \frac{F\left(X_{ij}^R \hat{\beta}_{ij}^P\right)}{N^R}\right] \quad (2)$$

$\bar{Y}^R - \bar{Y}^P$ indicates the difference in intensity of green farming behavior between family ranches and traditional pastoralists; X_{ij}^R and X_{ij}^P corresponding to the j-th sample of the i-th independent variable for family ranches *versus* traditional pastoralists, respectively; N^R and N^P represent the sample sizes of family ranches and traditional pastoralists, respectively; $\hat{\beta}_i^R$ and $\hat{\beta}_i^P$ are the coefficients to be estimated for the i-th independent variable for family ranching and traditional pastoralists, respectively. Eq. 2 decomposes the sources of differences in the intensity of green farming behavior between family ranches and traditional pastoralists into an explainable component (i.e., differences in ecological awareness and differences in resource endowment in this study) and an unexplainable component, which often originates from variables that are not measurable or observable.

Decomposition was calculated again to obtain the contribution of each variable to identify the differences in the intensity of green farming behavior. The independent contribution of X_i to the difference in intensity of green farming behavior between family ranches and traditional pastoralists in the explainable component (i.e., E_i) can be expressed as

$$\mathbf{E_1} = \frac{\mathbf{1}}{\boldsymbol{N^P}} \sum_{j=1}^{N^P} \left[\mathbf{F}\left(\hat{\boldsymbol{\alpha}}^* + \mathbf{X^R}_{1j}\hat{\boldsymbol{\beta}}_1^* + \mathbf{X^R}_{(i-1)j}\hat{\boldsymbol{\beta}}_{i-1}^*\right) - \mathbf{F}\left(\hat{\boldsymbol{\alpha}}^* + \mathbf{X^P}_{1j}\hat{\boldsymbol{\beta}}_1^* + \mathbf{X^R}_{(i-1)j}\hat{\boldsymbol{\beta}}_{i-1}^*\right)\right]. \quad (3)$$

E_1 indicates that the contribution of variable 1 to the green farming behavior differences is equal to the change in average predicted probability from replacing the family ranch distribution with the traditional pastoralist distribution of that variable while holding the distribution of other variables constant. The method requires consistent sample sizes for both subjects, therefore N^P. $\hat{\alpha}^*$ denotes the full-sample estimated coefficient of the constant term.

2.2.2 Variable selection

This study selects grass-livestock balance behavior and livestock manure resource utilization behavior to indicate green farming behavior. The grass-livestock balance behavior of the operating agents draws on the "Guidance on the Approval of Suitable Livestock Carrying Capacity of Xilinguole League Grassland." We compared the livestock carrying capacity accommodated in the operating area of the operating agent's grassland with the standard livestock carrying capacity mentioned in the above document. The observation method obtains data on livestock farming manure disposal behavior, whereas ordered variables measure the intensity of green farming behavior.

Ecological consciousness is characterized using ecological awareness level, ecological practice concept, and ecological value perception (Donmez-Turan and Kılıçlar, 2020). Each variable was measured on a five-point Likert scale (see Table 2 for variable selection).

Resource endowment is measured through natural, social, and financial capital (Ellis, 2000). Natural capital was expressed using the contracted area of pasture and the area of pasture flow (Man et al., 2019). Social capital was defined by participation in training and the degree of communication (Jing and Chu, 2019), and financial capital was expressed by the previous year's household business income and pasture subsidies (Jian et al., 2022).

Based on the literature, the age of the household head, education level, and the number of laborers engaged in pastoralism were selected as control variables in this study (Van Liere and Dunlap, 1980; Gifford and Nilsson, 2014).

This study selects "availability of local agricultural training" as the instrumental variable due to the endogeneity Problem. This variable affects whether family ranches and traditional pastoralists participate in training but does not directly affect their green farming behavior, which is consistent with the requirements of the instrumental variable (Han et al., 2022).

2.3 Empirical analysis

The study adopted SPSS 22.0 software to conduct the Mann–Whitney U test on the variability of green farming behavior intensity, ecological consciousness variability, and resource endowment between family ranches and traditional pastoralists. This study uses Stata 12.0 software to analyze the influence of ecological awareness and resource endowment of operating agents on the intensity of green farming behavior using the ordered Logit model. To exclude possible covariance problems among the explanatory variables, we conducted the variance inflation factor test of Stata 12.0 software, and the results showed that the variance inflation coefficients of all variables were less than 5, and there was no significant covariance problem (Supplementary Table S7). To obtain the best appropriate model, we used the instrumental variable test of SPSS 22.0 software to address the possible inverse causality between family ranches and traditional pastoralists' participation in training variables and the intensity of green farming behavior. The results (Supplementary Table S8) show no endogeneity problem.

Based on the Logit model estimation results, we used the Fairlie decomposition of Stata 12.0 software to identify the extent to which differences in ecological awareness and resource endowment affect differences in green farming behavior intensity and the contribution of each variable to differences in behavioral intensity (Fairlie, 2005). During the analysis, we replicated the sampling 100 times at the comparison stage to avoid overdependence of the analysis results on a single subsample. Since the individual contributions of independent variables or groups of independent variables may be sensitive to variable ranking, we adopted a specific procedure reproduction ratio (RO) option that randomizes the ranking of variables and finally obtained an approximate average result.

3 Results

3.1 Main implementation agents of green farming behavior

The intensity of green farming behavior between family ranches and traditional pastoralists was significantly different at the 1% statistical level (Table 3). According to the implementation of green farming behavior, the proportion of family ranches implementing two green farming practices was 39.007%. In contrast, only three traditional pastoralists implemented two green farming practices. Fewer family ranches (8.511%) did not implement green farming practices than

TABLE 3 Implementation of green farming behaviors and results of the Mann–Whitney *U* test for differences in behavior between family ranches and traditional pastoralists.

Green farming behavior intensity	Family ranch		Traditional pastoralists		Family ranch-traditional pastoralists
	Number of pieces	Percentage (%)	Number of pieces	Percentage (%)	
0	12	8.511	54	40.601	—
1	74	52.482	76	57.143	—
2	55	39.007	3	2.256	—
Mean value of the intensity of green farming behavior in the sample	1.305	—	0.617	—	0.688***

Note: *, **, and *** represent 10%, 5%, and 1% significant levels in that order.

TABLE 4 Mean value of each variable and results of the Mann–Whitney *U* test for differences in the means of variables between family ranches and traditional pastoralists.

Variables		Family ranch	Traditional pastoralists	Family ranch-traditional pastoralists
Ecological consciousness	Ecological awareness level	2.844	2.662	0.182*
	Eco-practice concept	2.383	2.218	0.165
	Ecological value perception	2.787	1.564	1.223***
Natural	Grassland contracted area	5010.709	6074.256	−1063.547**
Capital	Grassland flowing area	2710.996	2024.436	686.56***
Social	Participation in training	0.879	0.459	0.42***
Capital	Frequency of communication	2.723	2.677	0.046
Financial Capital	Household business income in the previous year	272,001.933	163,964.044	108,037.889***
	Pasture subsidies	17,925.323	11,559.835	6,365.488***

Note: *, **, and *** represent 10%, 5%, and 1% significant levels in that order.

traditional pastoralists (40.601%). Accordingly, from the perspective of "whether to implement green farming practices" and "intensity of green farming practices," family ranches are the leading implementers of green farming practices in grassland pasture areas.

3.2 Equations effects of differences in ecological consciousness and resource endowment on differences in green farming behavior

3.2.1 Difference between ecological consciousness and resource endowment

As shown in Table 4, ecological awareness level ($p < 0.1$) and ecological value perception ($p < 0.01$) were significantly different between family ranches and traditional pastoralists, and there was no difference in the ecological practice concept. In terms of resource endowment, the variables of contracted pasture area ($p < 0.05$), pasture area transferred ($p < 0.01$), participation in training ($p < 0.01$), previous year's household business income ($p < 0.01$), and pasture subsidy ($p < 0.01$) were significantly different between family ranches and traditional pastoralists. The differences in the variables of frequency of communication between family ranches and traditional pastoralists were insignificant.

3.2.2 The influence of ecological consciousness and resource endowment on the intensity of green farming behavior

Ecological consciousness has a significant effect on the intensity of green farming behavior. The adjusted R-squared was 0.1681 and 0.4637, respectively, and the model fitted well. According to the results in Table 5, ecological awareness level and ecological value perception of family ranches positively affected the intensity of their implementation of green farming behavior at the significance level of 5% and 1%, respectively. The effects of ecological awareness level and ecological value perception of traditional pastoralists on the intensity of their green farming behavior passed the significance at 1%.

Specifically for resource endowment, social capital positively contributed to the intensity of green farming behavior in family ranches. The participation in the training variable is significant at 1%, affecting the intensity of green farming behavior in family ranches. The effect of the degree of communication with friends and relatives' variable on the intensity of green farming behavior in family ranches is significant at 10%. For traditional pastoralists, social and financial capital substantially impacts the intensity of their green farming behavior. The participation in the training variable affected the intensity of green farming behavior of traditional pastoralists at the 5% level. The previous year's

TABLE 5 Results of ordered Logit-based estimation of the intensity of green farming behavior of family ranches and traditional pastoralists.

Variables		Family ranch		Traditional pastoralists	
		Coefficient	Standard error	Coefficient	Standard error
Ecological consciousness	Ecological awareness level	1.520**	0.607	2.489***	0.536
	Eco-practice concept	0.079	0.488	0.796	0.574
	Ecological value perception	1.082***	0.309	1.934***	0.620
Natural	Grassland contracted area	−0.348	0.700	−0.162	0.867
Capital	Grassland flowing area	−0.019	0.165	0.194	0.164
Social	Participation in training	2.056***	0.691	1.302**	0.558
Capital	Frequency of communication	1.063*	0.581	0.011	0.350
Financial	Household business income in the previous year	−0.243	0.386	−0.652***	0.237
Capital	Pasture subsidies	0.712	0.891	1.438	1.007
Control variables		Controlled		Controlled	
Adj R-squared		0.1681		0.4637	
Sample size		141		133	

Note: *, **, and *** represent 10%, 5%, and 1% significant levels in that order.

household business income variable was significant at 1%, indicating some effect on the intensity of green farming behavior of traditional pastoralists (Table 5).

3.2.3 Effect of differences in ecological consciousness and resource endowment on green farming behavior

Table 6 indicates the extent to which differences in ecological consciousness and resource endowment between family ranches and traditional pastoralists affect differences in the intensity of their green farming behavior. The results indicated that the extent to which ecological awareness and resource endowment differences explain the intensity of green farming behavior between family ranches and traditional pastoralists is 0.402. This study further decomposes the contribution of each variable by considering the sum of the coefficients of variation as 1, and the results showed that the contribution of ecological awareness differences and resource endowment differences to the difference in intensity of green farming behavior between family ranches and traditional pastoralists was 51.34% and 48.66%, respectively. Participation in training, ecological value perception, and ecological awareness level were the main influencing factors that widened the gap between the intensity of green farming behavior of family ranches and traditional pastoralists.

Further decomposition of ecological consciousness differences showed that the ecological value perception (37.96%) is positively significant at 5%, indicating that it is the leading cause of the difference in intensity of green farming behavior between family ranches and traditional pastoralists. In contrast, ecological awareness and the concept of ecological practices are positively significant and contribute only 12.58% and 0.80%, respectively.

At the level of resource endowment differences, the magnitude of the contribution of the differences in the variables to the differences in the intensity of green farming behavior between family ranches and traditional pastoralists was in the following order: participation in training (46.65%) > frequency of communication (2.82%) > pasture area transferred (2.26%) > pasture subsidy (0.24%) > previous year's family business income (−0.08%) > pasture contracted area (−3.23%), where the effect of the difference in participation in training on the difference in intensity of green farming behavior between family ranches and traditional pastoralists was statistically significant at 1% level.

4 Discussion

4.1 Main implementation subjects of green farming in grassland pastoral areas

The empirical results show that family ranches are more willing to carry out green farming than traditional pastoralists. This finding is consistent with the findings of Qiu et al. (2019). The implementation of green farming behavior requires operating agents to have a certain degree of economic strength, risk resistance, and a certain degree of ecological consciousness. Family ranches are the leading operating agents of animal husbandry in grassland pastoral areas (Sakyuzhina, 2017), with better economic resource endowments and higher levels of ecological consciousness. They are more inclined to implement green farming behavior. Traditional pastoralists are more concerned about their economic growth and income to escape poverty. Due to their weak capital accumulation and lack of capital strength to bear the failure cost, they are generally unwilling to adopt new technologies and knowledge. Although they recognize the importance of ecological conservation, they still rely on quantity to increase their income due to livelihood pressure (Shan and Tong, 2013), showing a contradiction between cognition and behavior.

TABLE 6 Contribution of each variable to the difference in intensity of green farming behavior between family ranches and traditional pastoralists based on the Fairlie decomposition method.

Variable		Family ranch-traditional pastoralists (*N* = 133)		
		Coefficient of variation	Contribution rate	Sort
Ecological consciousness	Ecological awareness level	0.051*	12.58%	3
	Eco-practice concept	0.003	0.80%	6
	Ecological value perception	0.153**	37.96%	2
Natural	Grassland contracted area	−0.013	−3.23%	9
Capital	Grassland flowing area	0.009	2.26%	5
Social	Participation in training	0.187***	46.65%	1
Capital	Frequency of communication	0.011	2.82%	4
Financial	Household business income in the previous year	−0.000	−0.08%	8
Capital	Pasture subsidies	0.001	0.24%	7
Total difference		0.402	100%	-

Note: *, **, and *** represent 10%, 5%, and 1% significant levels in that order.

4.2 Key factors affecting differences in green farming behavior

Differences in ecological value perception and participation training variables between family ranches and traditional pastoralists can largely explain differences in their green farming behavior. Consciousness is essential for behavior (Jing and Liang, 2013), and resource endowment provides the basic conditions for behavior implementation (Mills et al., 2017). The family ranches with higher ecological consciousness and better social capital contribute 2.115 times more intensely to green farming behavior than traditional pastoralists (Matteson, 2013). Our results indicated that family ranches were better than conventional pastoralists in implementing two green farming behaviors.

Ecological consciousness plays a crucial role in individual green farming behavior decisions. In other words, operators with a higher level of ecological consciousness are more likely to engage in green farming. This idea applies to family ranches and traditional pastoralists. This finding is consistent with Dunlap and ve Van Liere (1978) and Poortinga et al. (2004), among others, who emphasized that greater ecological consciousness is associated with more environmentally friendly behavior. Among them, the level of ecological awareness and the perception of ecological value are more influential on the green farming tendency of the operating agents. The higher the level of ecological awareness, the more likely livestock operators are to be aware of the environmental threats caused by irrational livestock economic behavior (Wang et al., 2017). At the same time, high ecological value perceptions lead livestock operators to weigh the relationship between environmental protection and long-term economic benefits more carefully, which is aligned with earlier studies (Grothmann and Patt, 2005; Dan and Bin, 2015; Li et al., 2022). The ecological practices of the operating agents did not significantly influence green farming behavior, possibly because green farming practices are more costly in terms of individual efforts and sacrifice (Steg et al., 2014). In addition, the sample statistics (Table 4) showed that the level of ecological consciousness among family ranches and traditional pastoralists was generally low, and there is room for improvement. Therefore, improving the ecological consciousness level of family ranches and traditional pastoralists is necessary.

Resource endowment significantly affects their green farming behavior, but there is some variation in the degree of effect. Social capital is the core element that substantially influences green farming behavior in family ranches. According to the empirical results, participation in training positively affects green farming behavior in family ranches, mainly because operators can fully understand the impact of the ecological environment on their livestock production, green farming knowledge, and methods through training. This result is supported by the findings of Pinzone et al. (2019) and Donmez-Turan and Kllar (2020). There is a gap between the actual production practices of operating agents and the best production practices, and training facilitates operating agents to bridge that gap by transferring information and knowledge (Jian et al., 2018; Han et al., 2022). The more frequently the family ranch interacts with family and friends, the more favorable the green farming behavior is. This finding is confirmed (Thoyre, A., 2011; Videras et al., 2012; Atshan et al., 2020). Social and financial capital impacts the intensity of green farming behavior of traditional pastoralists. Participation in training can somewhat promote the green farming behavior of traditional pastoralists. Prior year household business income negatively affects conventional pastoralists' green farming behavior, which is contrary to the study of Ponce et al. (2019). The possible reason is that traditional pastoralists have a low level of ecological consciousness at this stage, and their farming behavior is closely related to the goal of increasing income. Suppose traditional pastoralists believe their current business situation cannot maintain a balanced household income and expenditure or even achieve a surplus. In that case, it is challenging to reduce livestock to curb overload and resource utilization of manure (Shan and Tong, 2013). Therefore, implementing rationalized and differentiated incentives is

crucial to motivate family ranches and traditional pastoralists to green farming.

4.3 Innovations and limitation

Unlike the previous literature, the present study is innovative. First, the study incorporates the differences in operating agents into the research and analyzes the impact of the internal and external differences of the agents underlying such differences in green farming behavior. Second, it defines the ecological consciousness and resource endowment characteristics of the agent according to the characteristics of the operating agent. Thirdly, the theoretical mechanism of the role of ecological consciousness and resource endowment of operating agents in green farming decision-making is clarified. The degree of contribution of different factors is also distinguished, which reveals the difference between green farming behavior decision-making when subjects' ecological consciousness and resource endowment are heterogeneous. There are also some shortcomings in the study. First, we have explored the reasons behind differences in green farming behavior between different business entities. However, besides ecological awareness and resource endowment, other factors could influence green farming behavior. Second, the study did not further assess the mechanism of ecological consciousness and resource endowment differences in different green farming practices of different operators. Finally, the cross-sectional data failed to reflect the dynamic nature, and the study's sample size was limited. Whether the effect of intrinsic and extrinsic factors on the green farming behavior of operators becomes greater or smaller under a larger sample is unknown. These factors need to be further identified and verified by future studies.

5 Conclusion and insight

This study analyzed the differences and their cause in green farming behavior between family ranches and traditional pastoralists in the grassland pastoral areas of Xilin Gol league in Inner Mongolia by adopting the Logit model and Fairlie decomposition approach and obtained the following conclusions. First, there are significant differences between family ranches and traditional pastoralists in green farming behavior. Mainly, family ranches are implementing green farming behavior in China's grassland pastoral areas. Second, the heterogeneity of ecological consciousness and resource endowment is the critical factor that drives the difference in their behaviors. The influence of ecological consciousness is more significant than resource endowment in both.

Based on the conclusions, the following recommendations are made. First, the government should improve existing training methods and systems. In addition, combining the actual livestock production to determine the time and period of different training would help enrich the training content and meet the diverse needs of the main body. Furthermore, the government should moderately strengthen the guidance and training of the main body with weak resource endowment and boost the enthusiasm of traditional pastoralists to participate in training. Second, it should increase the "Green mountains, and clean water is equal to mountains of gold and silver [*sic*]" development concept of publicity and education. Guide the family ranches and traditional pastoralists to establish a correct ecological view, improve their awareness of ecological protection, and enhance their enthusiasm for green farming. Finally, we should achieve consistency between the traditional pastoralists' green farming and income generation. And we should pay attention to the critical role of resource endowment in their behavior, promotes the organization of agricultural production, and brings the leadership of family ranching demonstrations and cooperative organizations to drive traditional pastoralists to implement green farming actively.

Data availability statement

The datasets presented in this article are not readily available because the data are primary data obtained from research and unpublished information. Requests to access the datasets should be directed to FX, nanana.angel@163.com.

Author contributions

FX wrote the manuscript; BG and LW helped design the structure of the manuscript and revised it. GQ reviewed the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fenvs.2023.1109430/full#supplementary-material

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