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# Can Social Learning Promote Farmers' Green Breeding Behavior? Regulatory Effect Based on Environmental Regulation

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**Abstract:** Farmers' green breeding behavior is significant to environmental protection and sustainable development. Based on the micro-survey data of 1248 beef cattle farmers in Inner Mongolia Autonomous Region and Jilin Province, the OLS model and regulatory effect tests are used to analyze the influence of social learning on farmers' green breeding behavior and to verify the mechanism of environmental regulation. Key findings include the following: (1) Social learning has a significant positive impact on farmers' green breeding behavior. (2) Social learning has a significant positive impact on farmers' willingness to undertake green breeding, farmers' specific behavior of green breeding, and farmers' continuous green breeding, among which the effect on specific behavior of green breeding is the most positive. (3) Environmental regulation plays a moderating role in the relationship between social learning and farmers' green breeding behavior, among which all sub-dimensions of environmental regulation (incentive-based environmental regulation, binding environmental regulation and guided environmental regulation) have positive reinforcing effects, especially the most significant reinforcement effect of binding environmental regulation. Based on the research conclusions, this study proposes policy suggestions such as strengthening the training of farmers, strengthening the learning and communication among farmers' neighbors, increasing the frequency of farmers' use of mass media, improving the environmental regulation policy system, and promoting the coordinated development of environmental, economic, and social benefits.

**Keywords:** social learning; green breeding behavior; environmental regulations; beef cattle farmers; regulating effect

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## 1. Introduction

In the present century, environmental challenges such as the degradation of natural resources, climate change, desertifcation, air pollution, water scarcity, the destruction of large ecosystems, and the destruction of environmental diversity have become major concerns in many countries [1]. "Prosperous industry, ecologically livable, civilized village style, effective governance, and prosperous life" are the overall requirements of the national rural revitalization strategy, in which ecologically livable is the basis of rural revitalization and the guarantee of improving the ecological well-being of rural residents. In this context, solving agricultural and environmental pollution has become an important research topic in agriculture in rural areas. In animal husbandry, green development is also the general direction of the development of China's animal husbandry industry, and promoting the green and high-quality development of the livestock and poultry industry is an essential cornerstone for ensuring national food security and promoting rural ecological revitalization [2]. In recent years, the scale of livestock and poultry breeding in China has continued to expand. The supply of animals and meat is sufficient, which promotes the breeding efficiency of farmers but also aggravates the environmental pollution caused by livestock and poultry manure, making China face severe challenges in achieving economic development and protecting an exemplary environment [3]. In China, the beef cattle industry is one of the leading industries in animal husbandry, and the output value of beef in China reached CNY 530 billion in 2019; thus, it has become the third largest beef producer after the United States and Brazil. According to the report "Livestock's Big Shadow: Environmental Issues and Choices" released by the Food and Agriculture Organization of the United Nations, the global livestock industry emits about 7.1 billion tons of carbon dioxide equivalent every year, accounting for about 14.5% of the total greenhouse gas emissions from human activities, and the emissions of the transportation industry. As a sizeable multi-stomach ruminant, beef cattle will release a large number of greenhouse gases such as nitrous oxide ($N_2O$) and methane ($CH_4$) through intestinal fermentation and fecal discharge, far exceeding pigs, poultry, buffalo, and small ruminants, causing severe environmental pollution [4].

The root of environmental problems is human behavior. Farmers are the source of environmental protection in animal husbandry and the direct beneficiaries of environmental protection in animal husbandry. This dual attribute determines that their behavior directly affects the ecological environment. As the decision-makers and operators of agricultural production, when farmers adopt environmentally friendly agricultural production means and implement environmentally friendly green agricultural production behaviors, the negative impact on the agricultural environment will be reduced at the source. For beef cattle farmers, implementing green breeding behavior is both an economic and social responsibility. The three aspects of beef cattle production activities before, during and after production will cause pollution problems such as waste, feces, and sewage. Therefore, promoting the implementation of environmentally friendly behaviors by farmers has become the key to improving the current agricultural environmental quality [5]. As a "social person", farmers' production decisions are not only affected by their internal factors but also by the acquiring of knowledge and improvement of their experiences through mutual communication and learning in the social environment they live in, thus resulting in consistent behaviors [6]. From this point of view, social learning is a crucial factor affecting farmers' green production behavior. Social learning is the independent learning of farmers guided by social behavior, and it is an important external force that affects farmers' behavior. Through communication with relatives and neighbors, participation in training, use of mass media and other ways of learning, farmers may improve their knowledge and skills, not only increasing their understanding of green behavior, but also improving their professional skills to implement green behavior, thus encouraging farmers to implement green behaviors.

Environmental regulation is a series of measures taken by the government to restrict and guide the behavior of enterprises and individuals through legislation, administrative orders or other means to protect environmental quality, to coordinate the relationship between human activities and the natural environment to achieve sustainable development. To promote the green farming behavior of farmers, the government adopts a variety of policy means to regulate the behavior of farmers, and environmental regulation is the primary means [7] and plays an important role in rural environmental remediation. Therefore, it is of great significance to study the impact of environmental regulation on farmers' green breeding behavior.

Many scholars have studied the relationship between social learning, environmental regulation, and farmers' pro-environmental behavior. In terms of the relationship between social learning and farmers' pro-environmental behaviors, Ding found through research that social learning has a direct negative impact on farmers' pro-environmental behaviors [8]; however, some scholars found that farmers' social learning has a significant positive impact on green behaviors [9,10]. Regarding the effects and influencing factors of farmers' green behaviors, studies have pointed out that pro-environmental behaviors can significantly improve environmental quality [11] and enable the actors to obtain higher happiness and life satisfaction [12]. When Khataza et al. studied the influencing factors of rice farmers, it was found that individual ability differences of farmers will affect their implementation of pro-environmental behaviors [13]. Ahmad et al. concluded that farmers' awareness of the degree of use of livestock and poultry manure would affect their implementation of pro-environment behaviors [14]. In addition, many scholars have studied the resource utilization behavior of farmers' livestock and poultry waste [15–17]. In terms of the relationship between environmental regulation and farmers' pro-environment behaviors, Wang and Li argued that incentive-type environmental regulation promotes the implementation of pro-environment behaviors of dairy farmers more significantly than restrictive ecological regulation, and the impact of environmental regulation is non-linear [18]. Zhang et al. found through research that incentive and guidance regulations positively impacted farmers' waste resource utilization behaviors. Still, constraint regulation did not significantly affect waste resource utilization behaviors [19]. Other studies have shown that farmers' perception of environmental regulation can significantly promote farmers' adoption of agricultural green production technologies [20].

Our study is based on the existing literature and actual survey perceptions. It attempts to answer the following research questions:

(1) What factors influence farmers' green breeding behavior?
(2) What is the mechanism that influences government environmental regulation on farmers' social learning and green breeding behavior?

The results showed that in the baseline regression, the frequency of communication between farmers, participation in training, and use of mass media for learning were important factors influencing whether farmers engage in green breeding behavior. Secondly, the impact of the above three factors on the willingness of farmers to engage in green farming, the number of green farming behaviors adopted by farmers, and the sustained green breeding behaviors of farmers were studied. The research results also found a positive impact. Finally, we analyzed the mechanism of government environmental regulations in the relationship between rural social learning and green breeding behavior. We found that environmental regulations play a positive regulatory role, with the most significant strengthening effect of restrictive environmental regulations.

This study aims to fill a vital research knowledge gap. First, it is an addition to the literature on green production behavior. Although there is much literature about farmers' green production behavior at home and abroad, most of it is about farmers. Our study takes beef cattle farmers as the research object and analyzes the key factors that affect the green breeding behavior of beef cattle farmers. Secondly, the current research on farmers' green behavior mainly focuses on some specific behavior. The breeding behavior of beef cattle farmers in this study is diverse, and a total of seven behaviors are studied from three perspectives: prenatal, postpartum, and postpartum. Finally, based on the theory of sustainable development, this paper further analyzes the factors that affect the continuous adoption of green breeding behavior by beef cattle farmers, so that this study has continuity and dynamics to a certain extent. The findings help understand the breeding behavior of beef cattle farmers, predict the future breeding trend of beef cattle breeding industry, and guide government policy formulation.

The remainder of this article is structured as follows: Section 2 reviews the related literature and analyzes the mechanism of social learning affecting farmers' green breeding behavior. Based on relevant theories, we present the research hypothesis. Section 3 describes the data methodology and nature. Empirical results are presented and analyzed in Section 4, and Section 5 concludes the article.

## 2. Theoretical Basis and Research Hypothesis

### *2.1. Direct Impact: The Impact of Social Learning on Farmers' Breeding Behavior*

Social learning theory is mainly used to analyze the role of observational learning and self-regulation in human behavior. This theory was proposed by American psychologist Albert Bandura in 1971. It focuses on the interaction between human behavior and the surrounding environment and focuses on human observation learning or imitation learning [21]. The formation of individual behavior mainly includes direct experience learning and indirect experience learning. Direct experience learning refers to teaching individuals through the results of reactions, while indirect experience learning refers to teaching individuals through observing demonstrators' behavior. The main ways of learning include communication with friends and neighbors and training in agricultural production, mass media, and other ways of learning [22]. Farmers carry out social learning through the communication between their relatives and neighbors, which causes them to show a noticeable "herding effect" in their agricultural production behaviors, that is, farmers' behavior choices are easily influenced by their relatives and neighbors, and farmers will intentionally or unintentionally imitate the behaviors of their relatives and neighbors. If influential farmers around them choose to implement green behaviors or not, other farmers may also decide to imitate their behavior, but there is uncertainty. Through government agricultural production training or social learning through network media, farmers can improve their knowledge and skills, increasing their understanding of green behavior and improving their professional skills in implementing green behavior to promote green behavior among other farmers. Social learning has a two-sided character, and it impacts farmers' green behavior, but the direction of the effect remains to be verified.

Sustainable development theory. The idea of sustainable development began in 1789 in the book "Principle of Population", in which Malthus comprehensively elaborated on the huge problem faced by human society, that is, how to solve the contradiction between the rapidly growing population and limited resources. Malthus believed that only coordinated and sustainable development between the two could bring about social progress. In 1987, the concept of sustainable development was formally proposed by the United Nations for the first time, and its principles are "fairness", "sustainability", and "commonality". The primary purpose of development is to achieve sustainable development in the trinity of economy, society, and ecology, which means that existing resources can be used to fully meet the current generation's economic and social development needs without affecting future generations' development.

Intention is the premise of behavior and can promote the realization of behavior. Through communication with neighbors or people around them and participation in various forms of training, farmers will have a particular impact on their perception and then affect their behavioral intentions. Many scholars have studied the relationship between social network, social learning, and farmers' behavior. Some scholars believe that social networks' information channels and learning functions play a crucial role in farmers' technology adoption process [23,24]. In terms of participation in training, Liu and Xiao found that participation in environmentally friendly technology training can significantly improve farmers' green productivity [25]; Luo et al. found that with each additional agricultural technology training, the probability of farmers adopting five green production technologies such as organic fertilizer application increases by 3.1% [26]. Cui et al. found that participation in training had a significant positive impact on farmers' decision-making and adoption degree of eco-agriculture technology [27], and Chen et al. pointed out that effective external information transmission, such as agricultural technology training, could reduce pesticide application [28]. Cao et al. posited that the more technical training farmers receive, the more inclined they are to adopt modern breeding methods for beef cattle breeding [29]. In addition, in a social network, peer effects can play a role at different levels, such as nodes (individuals), clusters (subnetworks), or a whole network. Three types of social interactions, i.e., information transfer, experience sharing, and externalities, play an important role in farmers' innovation adoption. Individuals' choice of new things is an economic behavior of rational decision-making. It is also a social behavior embedded in interpersonal relationships [30]. Many studies have also found that peer effects is an important determinant of individual behavior decision-making [31,32].

Based on this, this paper proposes the following hypothesis:

**H1.** *Social learning has a significant positive impact on farmers' green breeding behavior*.

**H1a.** *Social learning has a significant positive impact on farmers' willingness to engage in green breeding*.

**H1b.** *Social learning has a significant positive impact on the specific behaviors of farmers in green breeding*.

**H1c.** *Social learning has a significant positive impact on farmers' sustainable green breeding behavior*.

*2.2. Regulatory Effect: The Impact of Environmental Regulation on the Relationship between Social Learning and Farmers' Green Breeding Behavior*

In recent years, with the strengthening of environmental supervision by the government, scholars have begun to pay attention to the role of environmental regulation on the behavior of farmers. Environmental regulation moderates the relationship between risk perception and environmentally friendly behavior [33], and situational variables are considered important moderating variables for implementing environmental behaviors. Zhang demonstrated through empirical analysis that different environmental regulations have a positive regulating effect on the relationship between environmental risk perception and the environmental behavior of pig farmers [34]. Some scholars believe that environmental regulations directly affect the environmentally friendly behavior of farmers [35]. The research results of Tomoya et al. showed a close relationship between environmental regulation and farmers' adoption behavior of green farming technology. Environmental regulation is the government's guidance and arrangement in a particular field, which can affect the occurrence of economic activities and even the formulation and implementation of farmers' adoption behavior of green farming technology [36]. Xia et al. believe that environmental regulations significantly impact the intention of resource utilization of large-scale pig farmers [37]. Still, different environmental regulations have different degrees of impact on the environmentally friendly behaviors of farmers [38] in which incentive regulations positively affect the green breeding behavior of livestock and poultry. In contrast, restraint regulations have no significant impact on the green breeding behavior of livestock and poultry [39]. Zhao et al. found through their research that environmental regulation can promote farmers' resource-based waste treatment behavior, and the command, incentive, and guiding regulations in environmental regulation can promote farmers' resource-based waste treatment behavior [40]. According to the externality theory, environmental regulation refers to the regulatory measures taken by the government to intervene and manage micro-entities, internalize environmental costs by influencing the allocation of market resources and the decision-making behaviors of economic activities participants, and ultimately achieve the purpose of improving social welfare [41]. Because of the negative externalities of environmental pollution caused by farmers' farming behavior and the positive externalities of farmers' green farming behavior, the influence of government intervention on farmers' green farming behavior is particularly important. The purpose of environmental regulation is to overcome the external diseconomy of environmental problems. The government internalizes environmental costs through the optimal allocation of market resources and the regulation of economic activities to achieve the coordinated development of the ecological environment and economic benefits [42], which mainly includes binding, incentive, and guiding types [38,43,44]. Among them, the binding regulation is that the government restricts farmers' green breeding behavior through mandatory orders. Incentive-based regulation means that the government reduces the cost of farmers' green breeding behavior using economic compensation. Guided regulation means that the government enhances the probability of farmers' green breeding behavior through environmental protection publicity and training activities.

Green farming behavior constitutes a public good and farmers' behavior can result in adverse selection and moral hazards, so they cannot exist independently from government environmental regulations [45]. Based on this, this paper proposes the following hypothesis:

**H2:** *Environmental regulation plays a positive regulating role in the relationship between social learning and farmers' green breeding behavior*.

**H2a:** *Incentive-based environmental regulation positively regulates the relationship between social learning and farmers' green breeding behavior*.

**H2b:** *Binding environmental regulation positively regulates the relationship between social learning and farmers' green breeding behavior*.

**H2c:** *Guided environmental regulation positively regulates the relationship between social learning and farmers' green breeding behavior*.

### *2.3. Research Framework*

The research framework of this paper is shown in Figure 1.

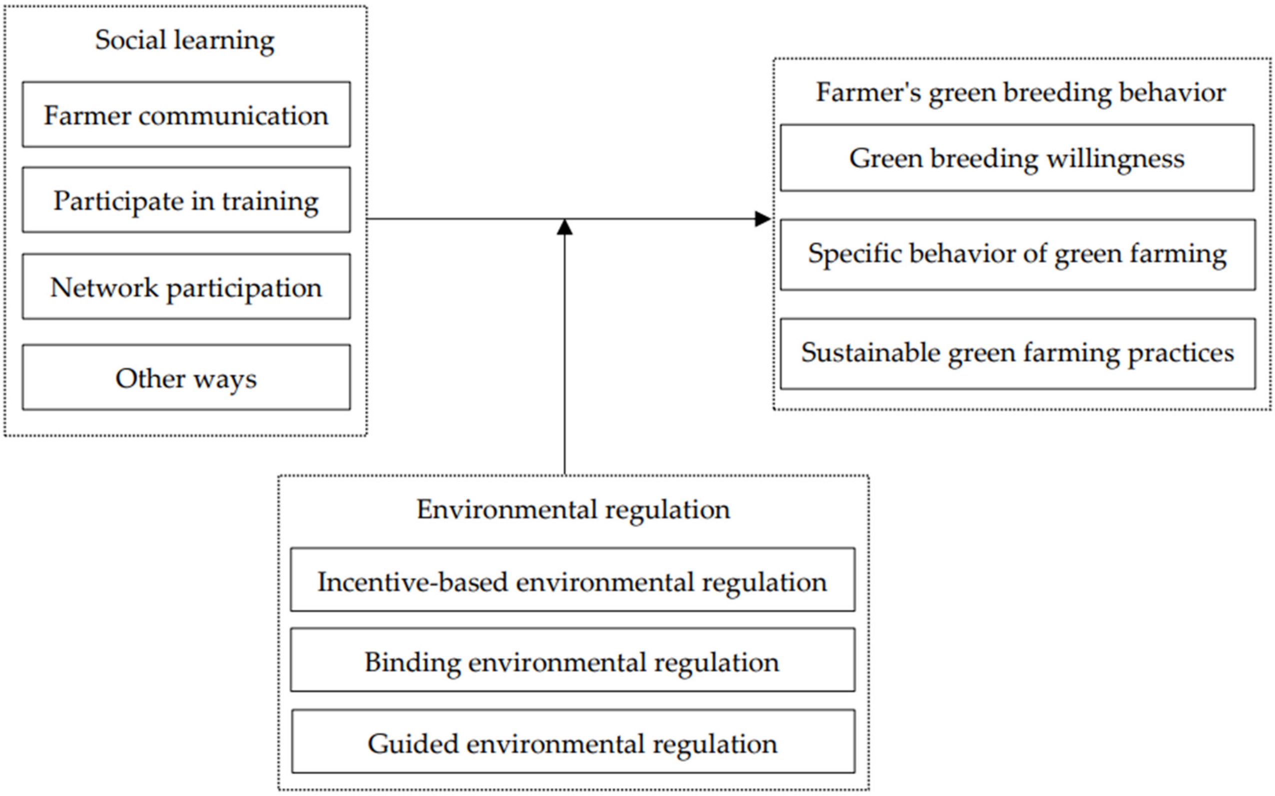


**Figure 1.** The research framework of social learning on farmers' green breeding behavior.

## 3. Research Design

### *3.1. Variable Selection and Description*

#### 3.1.1. Dependent Variable

According to Stern, green behavior refers to those behaviors that have a positive significance to the environment, and individuals make behaviors that help the environment to protect the environment or prevent further deterioration of the environment [46]. In the spirit of the "Opinions" of the State Office of the People's Republic of China and the expression of relevant literature, the green development of agriculture is defined as the harmonious coexistence of man and nature, the construction of a new production system, ecological system and living system, and the transformation of the development mode. We will promote the formation of a new pattern of high-quality sustainable development in agriculture and rural areas featuring resource conservation, ecological and environmental safety, supply of green products, and a rich and beautiful life [47]. Farmers' green behavior is pro-environment behavior in aquaculture.

Based on the above analysis, this study defines the green farming behavior of farmers as follows: in the process of farming, farmers adopt green technologies and measures to reduce the damage and impact of farming behavior on the environment, maintain and balance the adequate supply of agricultural ecosystem services and functions of the present and future generations, and thus ensure the sustainable development of animal husbandry. In this paper, the relevant indicators of the green breeding behavior of beef cattle farmers were set up in the three environments of prenatal, puerperal, and postnatal, and farmers' green breeding intention, farmers' specific green breeding behavior, and farmers' continuous green breeding behavior were collectively called farmers' green breeding behavior.

#### 3.1.2. Explanatory Variable

Social learning first appeared in the 1940s; foreign scholars were interested in it, and related research was relatively rich. However, it is a new field in China that has attracted attention in recent years. Fernandez et al. define social learning as "the process of collective reflection through interaction and dialogue between different participants (stakeholders)" [48]. Wang et al. believe that the concept of social learning comes from "learning by use" and "learning by interaction", which is to abandon and upgrade the narrow instrumental theory of "learning by use" and expand the scope of application of "learning by interaction" [49]. This study synthesizes existing studies and defines social learning as the process in which farmers living in social situations acquire knowledge and skills through interaction with others. Therefore, this paper's measurement indicators are neighborhood communication learning, agricultural training learning, mass media learning, and other ways of learning.

#### 3.1.3. Control Variables

The main control variables include individual characteristics and breeding characteristics that have been proven to have a significant impact on farmer behavior: gender, age, education background, physical health status, whether to join a cooperative, beef cattle breeding scale, and the proportion of breeding income [19,50].

#### 3.1.4. Mechanism Variable

Environmental regulation. According to the externality theory, environmental regulation refers to the regulatory measures taken by the government to intervene and manage micro-entities, internalize environmental costs by influencing the allocation of market resources and the decision-making behaviors of economic activities participants, and ultimately achieve the purpose of improving social welfare [41]. Environmental regulation mainly focuses on promoting environmental regulation, the main body of which is government. It is the sum of all guiding or mandatory, direct or indirect measures, policies, laws, regulations, clauses, and documents formulated and implemented by the government that are conducive to reducing pollutant discharge to restrict individual or organizational behaviors. The implementation means of environmental regulation include mandatory laws and regulations and relevant measures such as market mechanisms, which aim to limit subjects' behavior, reduce environmental pollution, and promote the coordinated development of economy and environment [51]. The government usually forces or guides the means of internalizing externalities to realize environmental protection in the breeding process [3]. Based on this, this study divides environmental regulation into incentivized, binding, and guided environmental regulation.

It should be noted that the first-level indicators of explained variables, explanatory variables, and regulating variables in this study are weighted by the entropy weight method, and the specific descriptions of each variable are shown in Table 1.

**Table 1.** Variable design table.

| | Primary Index | Secondary Index | Pointer Name | Weight |
|---|---|---|---|---|
| Dependent variable | Farmer's green breeding behavior | | c | |
| | | Willingness to engage in green breeding | c1 | 0.3876 |
| | | The specific behavior of green breeding | c2 | 0.3897 |
| | | Sustainable green breeding practices | c3 | 0.2227 |
| Explanatory variable | Social learning | | a | |
| | | Farmer communication | a1 | 0.2441 |
| | | Participate in training | a2 | 0.2571 |
| | | Network participation | a3 | 0.2519 |
| | | Other ways | a4 | 0.2469 |
| Mechanism variable | Environmental regulation | | t | |
| | | Incentive-based environmental regulation | t1 | 0.2406 |
| | | Binding environmental regulation | t2 | 0.3843 |
| | | Guided environmental regulation | t3 | 0.3751 |
| Control variables | Sex | | sex | |
| | Age | | age | |
| | Educational background | | edu | |
| | Whether to join a cooperative | | zuzhi | |
| | Beef cattle breeding scale | | guimo | |
| | The proportion of aquaculture income | | shouru | |
| | Physical health | | health | |

Table 2 shows the definition and description of the variables. It should be noted that the specific green breeding behavior indicators include seven behaviors: standard site selection, the establishment of biogas digesters, veterinary drug reduction and use behavior, health and epidemic prevention, waste treatment, the treatment of sick and dead cattle, and sewage treatment. The assignment is consistent with the number of behaviors adopted by respondents.

**Table 2.** Definition of variable.

| Categories | Variables | Variable Meaning and Assignment |
|---|---|---|
| Dependent variable | Willingness to engage in green breeding (c1) | Are you willing to practice green farming? Strongly unwilling = 1; Strongly willing = 5 |
| | Specific behavior of green breeding (c2) | The number of green farming practices adopted (quantities). |
| | Sustainable green breeding practices (c3) | Will you practice green farming in the long-term? Strongly disagree = 1; Strongly agree = 5 |
| Explanatory variable | Farmer communication (a1) | The number of times per month that I learned related knowledge of green farming through exchanges between farmers (times). |
| | Participate in training (a2) | The number of times per year that I learned the relevant knowledge of green farming through participating in training (times). |
| | Network participation (a3) | The number of times per month that I learned about green farming through online media (times). |
| | Other ways (a4) | The number of times per month that I learned green farming knowledge through other ways (times). |

**Table 2.** *Cont.*

| Categories | Variables | Variable Meaning and Assignment |
| --- | --- | --- |
| Mechanism variable | Incentive-based environmental regulation (t1) | Government environmental subsidies: Very little = 1; Very Strong = 5 |
| | Binding environmental regulation (t2) | The government's supervision and restraint on green farming: Very little = 1; Very Strong = 5 |
| | Guided environmental regulation (t3) | The government's publicity and education on environmental protection: Very little = 1; Very Strong = 5 |
| Control variables | sex (sex) | What is the sex of the respondents? Male = 1; Female = 2 |
| | age (age) | Age of the respondents (years) |
| | Educational background (edu) | Respondent's education background: junior high school and below = 1; high school/technical secondary school = 2; junior college = 3; undergraduate = 4; postgraduate and above = 5 |
| | Whether to join a cooperative (zuzhi) | Whether respondents joined a a cooperative? Yes = 1; No = 0 |
| | Beef cattle breeding scale (guimo) | Respondents' beef cattle farming scale (heads): under 50 = 1; 51–100 = 2; 101–300 = 3; 300 and above = 4 |
| | The proportion of aquaculture income (shouru) | The proportion of respondents' farming income in total household income (ratio) |
| | Physical health (health) | The health status of the respondents: Very poor = 1; Very good = 4 |

### *3.2. Model Setting*

In studying the relationship between social learning and farmers' green breeding behavior, the dependent variable farmers' green breeding behavior is obtained by weighted summation of the entropy weight method, which is discrete ordered data. Therefore, the OLS model, an econometric model suitable for discrete ordered dependent variables, is selected. Its expression is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 Z + \varepsilon \quad (1)$$

In Equation (1), $Y$ is the dependent variable, that is, the green farming behavior of farmers; $X_1$ is whether to participate in social learning; $Z$ is other control variables; $\beta_0$ is a constant term; $\beta_1$ and $\beta_2$ are regression parameters; and $\varepsilon$ is the random disturbance term.

This section aims to further study the moderating effects of environmental regulation and its sub-dimensions (incentive-based, binding, and guided) on social learning and farmers' green breeding behavior and construct a moderating effect model through the following equations:

$$Y = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_1 T + \alpha_3 Z + \varepsilon \quad (2)$$

$$Y = \delta_0 + \delta_1 X_1 + \delta_2 X_1 T_1 + \delta_3 Z + \varepsilon \quad (3)$$

$$Y = \rho_0 + \rho_1 X_1 + \rho_2 X_1 T_2 + \rho_3 Z + \varepsilon \quad (4)$$

$$Y = \varphi_0 + \varphi_1 X_1 + \varphi_2 X_1 T_3 + \varphi_3 Z + \varepsilon \quad (5)$$

In Formula (2), $T$ is the regulatory variable environmental regulation; in Formula (3), $T_1$ is the regulatory variable incentive-based environmental regulation; in Formula (4), $T_2$ is the regulatory variable binding environmental regulation; in Formula (5), $T_3$ is the regulatory variable guided environmental regulation.

### *3.3. Data Source*

We recruited 24 researchers in July to December 2023, consisting of doctoral and master's degree students. All of them were divided into six groups of four members each, with a PhD student as the leader of each group. The research teams conducted research in the eastern and western parts of the Inner Mongolia Autonomous Region and Jilin Province, including Songshan District, Bahrain Right Region, Arukolqin Region, and Keshketeng Region in the eastern part of the Inner Mongolia Autonomous Region; Ertok Region of Ordos City in the western part of the Inner Mongolia Autonomous Region; and Baicheng City, Jilin City, Liaoyuan City, Siping City and Changchun City in Jilin Province. According to the feasibility of the survey, six towns and townships were selected from the above-mentioned cities and regions, and 8 to 10 sample villages were randomly selected for each town, and 10 to 20 beef cattle farmers were randomly selected for each sample village. After strict data screening and the elimination of questionnaires that lacked answers to key questions, the final valid sample was 1248, with a valid questionnaire rate of 96.47%. The descriptive statistics of variables are shown in Table 3.

**Table 3.** Descriptive statistics.

| | N | Minimum Value | Maximum Value | Mean Value | Standard Deviation |
|---|---|---|---|---|---|
| a | 1248 | 0.00 | 1.00 | 0.4201 | 0.17812 |
| c1 | 1248 | 1.00 | 5.00 | 3.1442 | 1.15933 |
| c2 | 1248 | 0.00 | 9.00 | 3.7548 | 2.13178 |
| c3 | 1248 | 0.00 | 5.00 | 3.0417 | 1.32699 |
| c | 1248 | 0.09 | 1.00 | 0.5058 | 0.22673 |
| b1 | 1248 | 1.00 | 5.00 | 3.1042 | 1.08959 |
| b2 | 1248 | 1.00 | 5.00 | 2.9784 | 1.09618 |
| b3 | 1248 | 1.00 | 5.00 | 3.0954 | 1.06246 |
| b | 1248 | 0.00 | 1.00 | 0.5138 | 0.24806 |
| t1 | 1248 | 1.00 | 5.00 | 3.1691 | 1.17148 |
| t2 | 1248 | 1.00 | 5.00 | 3.4623 | 1.03206 |
| t3 | 1248 | 1.00 | 5.00 | 3.2444 | 1.19759 |
| t | 1248 | 0.00 | 1.00 | 0.5670 | 0.24261 |
| cz | 1248 | 0.00 | 10.00 | 5.2083 | 3.57213 |

## 4. Results and Discussion

### *4.1. Basic Regression Analysis*

Table 4 reports the results of the direct effect model of social learning on farmers' green breeding behavior. In general, Table 4 (1) shows that social learning has a significant positive impact on farmers' green breeding behavior at a 1% confidence level. Regarding sex, age, education, whether to join a cooperative, beef cattle breeding scale, and physical health status, for every 1 unit increase in social learning, farmers' green breeding behavior increases by 0.378 units on average.

**Table 4.** Direct effect test.

| | **(1)** | **(2)** | **(3)** | **(4)** |
|---|---|---|---|---|
| | **c** | **c1** | **c2** | **c3** |
| a | 0.378 *** | 1.120 *** | 5.228 *** | 0.878 *** |
| | (14.48) | (8.42) | (19.36) | (4.96) |
| gender | −0.038 *** | −0.273 *** | 0.175 * | −0.398 *** |
| | (−4.02) | (−5.56) | (1.75) | (−6.07) |
| age | −0.003 *** | −0.003 | −0.043 *** | −0.007 ** |
| | (−6.45) | (−1.31) | (−10.65) | (−2.51) |
| edu | −0.075 *** | −0.441 *** | −0.431 *** | −0.395 *** |
| | (−20.55) | (−23.68) | (−11.40) | (−15.93) |
| zuzhi | 0.026 *** | 0.172 *** | 0.154 * | 0.081 |
| | (3.09) | (3.90) | (1.72) | (1.37) |
| guimo | −0.023 *** | −0.156 *** | 0.024 | −0.156 *** |
| | (−5.44) | (−7.29) | (0.55) | (−5.46) |

**Table 4.** *Cont.*

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | **c** | **c1** | **c2** | **c3** |
| shouru | 0.009 | 0.195 *** | −0.370 *** | 0.093 |
| | (0.68) | (2.95) | (−2.75) | (1.06) |
| _cons | 0.783 *** | 4.633 *** | 4.744 *** | 5.067 *** |
| | (25.77) | (29.80) | (15.03) | (24.46) |
| *N* | 1248 | 1248 | 1248 | 1248 |
| adj. $R^2$ | 0.566 | 0.560 | 0.463 | 0.403 |
| *F* | 233.308 *** | 227.39 *** | 154.66 *** | 121.46 *** |

Note: *, **, ***: statistically significant at 10%, 5% and 1%, respectively; Standard error in parentheses.

Specifically, columns (2)–(4) in Table 4 examine the impact of social learning on the sub-dimensions of farmers' green breeding behavior (green farming intention, specific green farming behavior and sustainable green farming behavior). It can be seen that social learning has a significant positive impact on the sub-dimensions of farmers' green breeding behavior, especially the most important positive impact of social learning on the specific behavior of green farming. When the social learning changes by 1 unit, the particular behaviors of farmers in green farming can be improved by an average of 5.228 units. Specifically in the research samples, it can be found that farmers' social learning significantly affects the green breeding behaviors of beef cattle farmers before (standard site selection, biogas digester), during (farmers' behavior of reducing the use of veterinary drugs, health, and epidemic prevention), and after delivery (waste treatment methods, treatment methods of sick and dead cattle, and sewage treatment methods). Therefore, this study's Hypotheses 1, 1a, 1b and 1c are valid.

### *4.2. Endogeneity Problem and Robustness Test*

#### 4.2.1. Endogenous Problems

There may be endogenous problems between farmers' social learning and green farming behavior, for two reasons: first, there may be missing variables; second, there is a correlation between social learning and farmers' green breeding behavior, which leads to bias in the estimation results. Therefore, the influence of endogeneity is reduced by searching for instrumental variables. It should be noted that suitable instrumental variables must conform to the two principles of relevance and exclusivity.

As explained above, farmers' social learning is influenced by many aspects. Through field investigation, it was found that the government mainly leads farmers' training in social learning, and training places are mostly concentrated in town government buildings. Therefore, there is a direct correlation between the distance between farmers and town government buildings and whether farmers engage in social learning, which satisfies the principle of relevance. On the other hand, whether farmers implement green breeding is not directly related to their distance from the town government, which satisfies the principle of exclusivity. To sum up, the instrumental variable used in this paper is the distance to the town government buildings.

The estimation results of the first stage of the instrumental variable method are shown in Table 5. The coefficient of distance to the town government is 0.175, which is significant at a 1% level. This indicates that the closer the distance between farmers and the town government, the more likely social learning behaviors will occur. The F statistic of the first stage is 427.13, which is greater than the empirical threshold of 10, indicating that the possibility of weak instrumental variables is low. The results of the second-stage regression show that the coefficient of social learning is still significantly positive, which is consistent with the conclusion of the regression results in Table 4, excluding the resulting bias caused by reverse causality and missing variables.

**Table 5.** Endogeneity test.

| | First Stage | 2SLS |
|---|---|---|
| | **a** | **c** |
| a | | 0.370 *** |
| | | (11.54) |
| distance | 0.175 *** | |
| | (47.83) | |
| Z | Controlled | Controlled |
| _cons | 0.008 | 0.780 *** |
| | (0.38) | (23.58) |
| $N$ | 1248 | 1248 |
| adj. $R^2$ | 0.705 | 0.569 |
| $F$ | 427.13 *** | 1588.62 *** |

Note: *, **, ***: statistically significant at 10%, 5% and 1%, respectively; Standard error in parentheses.

#### 4.2.2. Robustness Test

To further ensure the robustness of the estimation results in this paper, three methods were used to test the robustness of the estimation results of the influence of social learning on farmers' green breeding behavior: replacing the explained variable, carrying out a 1% tail reduction for the core explanatory variable, and removing samples from the eastern region. The specific results are shown in Table 6. Specifically, columns (1)–(3) are the estimation results of replacing explained variables and core explanatory variables with 1% tail reduction and removing samples from eastern China, respectively. It can be seen that the influence of social learning on farmers' green breeding behavior has a positive effect at the significance level of 1%, which is consistent with the previous estimates and further supports the robustness of the primary regression results.

**Table 6.** Robustness test.

| | (1) | (2) | (3) |
|---|---|---|---|
| | **cc** | **c** | **c** |
| a | 2.159 *** | 0.378 *** | 0.342 *** |
| | (13.99) | (14.48) | (9.45) |
| sex | −0.219 *** | −0.038 | −0.033 *** |
| | (−3.87) | (−4.02) | (−2.68) |
| age | −0.017 *** | −0.003 *** | −0.003 *** |
| | (−7.07) | (−6.45) | (−5.98) |
| edu | −0.404 *** | −0.075 *** | −0.070 *** |
| | (−18.91) | (−20.55) | (−14.41) |
| zuzhi | 0.119 ** | 0.026 *** | 0.013 |
| | (2.35) | (3.09) | (1.07) |
| guimo | −0.083 *** | −0.023 *** | −0.013 ** |
| | (−3.37) | (−5.44) | (−2.15) |
| shouru | −0.114 | 0.009 | 0.000 |
| | (−1.48) | (0.68) | (0.01) |
| _cons | 4.453 *** | 0.783 *** | 0.811 *** |
| | (24.37) | (25.77) | (19.23) |
| $N$ | 1248 | 1248 | 674 |
| adj. $R^2$ | 0.531 | 0.5660 | 0.4900 |
| $F$ | 202.67 *** | 233.31 *** | 93.37 *** |

Note: *, **, ***: statistically significant at 10%, 5% and 1%, respectively; Standard error in parentheses.

#### 4.2.3. Mechanism Check

The test results of the moderating effect of environmental regulation on the influence of social learning on farmers' green breeding behavior are reported in Table 7. In general, with sex, age, education background, whether to join a cooperative, and beef cattle breeding scale and physical health as control variables, the direct effect of environmental regulation on social learning at the average level has a significant positive moderating effect at the 1% confidence level, and the moderating intensity is 0.300. This shows that under certain other conditions, when environmental regulation is increased by 1 unit, the direct effect increases by 0.300 units on average. Environmental regulation is divided into incentive-based, binding, and guided environmental regulation to test the regulatory impact, as shown in columns (2)–(4) of Table 6. It can be seen that incentive-based environmental regulation, binding environmental regulation, and guided environmental regulation all play a positive regulatory role at the 1% confidence level, especially since binding ecological regulation has the strongest effect. It shows that the effect of government mandatory means is the most obvious in the process of farmers' green breeding behavior through social learning in the sample range. In view of this, Hypotheses 2, 2a, 2b and 2c in this study are valid.

**Table 7.** Test of regulatory effects of environmental regulations.

| | **(1)** | **(2)** | **(3)** | **(4)** |
|---|---|---|---|---|
| | **c** | **c** | **c** | **c** |
| a | 0.111 ** | 0.049 | −0.019 | 0.066 |
| | (2.57) | (0.88) | (−0.32) | (1.16) |
| t | −0.417 *** | | | |
| | (−12.60) | | | |
| c.t#c.a | 0.300 *** | | | |
| | (3.80) | | | |
| t1 | | −0.081 *** | | |
| | | (−10.26) | | |
| c.t1#c.a | | 0.090 *** | | |
| | | (4.90) | | |
| t2 | | | −0.107 *** | |
| | | | (−13.44) | |
| c.t2#c.a | | | 0.095 *** | |
| | | | (5.22) | |
| t3 | | | | −0.078 *** |
| | | | | (−10.13) |
| c.t3#c.a | | | | 0.082 *** |
| | | | | (4.60) |
| gender | −0.032 *** | −0.031 *** | −0.034 *** | −0.036 *** |
| | (−3.75) | (−3.45) | (−3.95) | (−4.09) |
| age | −0.002 *** | −0.003 *** | −0.002 *** | −0.002 *** |
| | (−6.69) | (−7.14) | (−6.65) | (−6.30) |
| edu | −0.062 *** | −0.068 *** | −0.061 *** | −0.067 *** |
| | (−18.41) | (−19.49) | (−18.35) | (−19.32) |
| zuzhi | 0.024 *** | 0.022 *** | 0.025 *** | 0.026 *** |
| | (3.15) | (2.81) | (3.25) | (3.24) |
| guimo | −0.017 *** | −0.019 *** | −0.017 *** | −0.019 *** |
| | (−4.53) | (−4.90) | (−4.66) | (−4.91) |
| shouru | 0.019 | 0.014 | 0.017 | 0.020 |
| | (1.65) | (1.13) | (1.45) | (1.63) |
| _cons | 0.987 *** | 1.025 *** | 1.111 *** | 1.006 *** |
| | (31.02) | (27.94) | (30.14) | (27.60) |
| *N* | 1248 | 1248 | 1248 | 1248 |
| adj. $R^2$ | 0.655 | 0.622 | 0.657 | 0.623 |
| *F* | 264.086 *** | 229.091 *** | 266.672 *** | 229.601 *** |

Note: *, **, ***: statistically significant at 10%, 5% and 1%, respectively; Standard error in parentheses.

### *4.3. Discussion*

In terms of influencing factors on the environmental behavior of farmers, some scholars demonstrated that being an early adopter of organic farming practices and having frequent contact with young and highly educated farmers increases the probability of adoption of other agri-environmental measures [52]. Another study has found that some religious doctrines, public media, and educational activities can effectively modify attitudes and promote people's awareness and perception of the environment. It can be concluded that farmers' pro-environmental behavior may be related to their dependence on the rural community and the tendency towards behaviors that are consistent with other farmers [53]. Some scholars quantified the relationship between European farmers' adoption of sustainable agricultural practices and their underlying motivational factors. They found substantially stronger positive on general attitude, intention, and perceived usefulness than on economic outcomes and environmental awareness. Stimulating the adoption of sustainable agricultural practices thus requires reconsidering the currently strong emphasis on economic factors, especially by addressing socio-psychological factors via communication and training [54]. The above research conclusions are generally consistent with our empirical research results, confirming the impact of social learning on farmers' environmental behavior.

In addition, the transformation of the agricultural sector and the development of organic farming are highly valued in Europe. A study has evaluated the utilization of 256 pesticide active substances from the official EU pesticide database in both conventional and organic farming practices. The findings indicate that pesticides utilized in organic agriculture are more environmentally benign and present a reduced risk to humans and the environment in comparison to those employed in conventional agriculture [55]. Organic agriculture is also regarded as a highly effective means of circumventing the adverse consequences of chemical agriculture. A study has demonstrated that organic farm work systems can be an effective means of reducing greenhouse gas emissions in the agricultural sector [56]. In 2022, Nikola's study additionally indicated that global population growth will contribute to the expansion of organic farming [57]. It can be seen that there is a high level of interest in organic agriculture in Europe and around the world, which provides a strong support for the research value of our study. However, some past studies have found adverse effects of organic farming. On the one hand, in terms of environmental protection, some scholars have found that although many people believe that organic agriculture has a smaller negative impact on the environment than traditional agriculture, scientific evidence suggests that organic agriculture has a smaller impact on the environment [58]. On the other hand, in terms of output, a meta-analysis study in 2018 found that the time stability of unit yield in organic agriculture was significantly lower (15%) compared to traditional agriculture. Therefore, although organic farming promotes biodiversity and is generally more environmentally friendly, future efforts should focus on reducing yield differences [59]. Some scholars have discussed the limitations of organic agriculture from the perspective of nitrogen fertilizer. The study found that even with significant yield gains, organic systems could not feed a growing world population [60]. It has also been noted that organic farms achieve lower production effects in comparison to conventional farms, and this proportion also depends on the quality of natural farming conditions [61]. It can be seen that the impact of organic farming on society has two sides; our research confirms the effects of social learning and government environmental regulatory policies on the implementation of green breeding behavior by farmers, and while the impact of green farming practices implemented by farmers on their beef cattle output and cost income has not been fully considered, this content will be included in the next stage of research.

## 5. Conclusions and Recommendations

This paper empirically tested the impact of social learning on farmers' green breeding behaviors and sub-dimensions (farmers' green breeding intention, specific green farming behaviors, and sustainable green farming behaviors) by using the micro-survey data of the research group in the eastern and western provinces of Inner Mongolia Autonomous Region and Jilin Province from July to December 2023. Based on the perspective of environmental regulation, the regulation effects of incentive-based environmental regulation, binding environmental regulation, and guiding environmental regulation are discussed. The research shows the following conclusions. First, social learning has a significant positive impact on farmers' green breeding behavior and each sub-dimension, among which the effect on specific green farming behavior is the most positive, and after a series of robustness tests and endogeneity tests, this conclusion is still valid. Secondly, the positive influence of social learning on farmers' green breeding behavior can be strengthened through government environmental regulation. Overall, all sub-dimensions of environmental regulation (incentive-based, binding, and guided environmental regulation) exhibit a positive reinforcement effect; especially binding environmental regulation, which has the most significant reinforcement effect.

Based on the above research conclusions, the following policy recommendations are put forward:

Firstly, strengthen farmer training. Further, diversified farmer training activities should be carried out, the publicity of farmers' green breeding should be strengthened, the awareness of green farming should be deepened, the enthusiasm for implementing green farming should be improved, and the guiding role of training in the adoption of farmer behavior should combine the training needs of livestock and poultry farmers with the situation of industrial development and actual needs of various regions; in addition, personalized training programs should be formulated and targeted training according to the needs of different groups of farmers should be conducted, so that they can fully grasp the content and operation of green farming. For example, training for beef and poultry farmers in using veterinary drugs, health and epidemic prevention, waste treatment facilities, sick and dead cattle, and sewage treatment methods should be strengthened.

Secondly, strengthen learning and exchange between farmers and their neighbors. Encourage the establishment of mutual learning groups among individual farmers so they can help each other, stimulate farmers' awareness of green farming, and enable farmers to exchange experience in farming and solve problems in the farming process in a timely manner. At the same time, set up green farming demonstration households in villages, encourage demonstration households to drive farmers to carry out green farming, actively provide farmers with information consulting services and technical guidance, save farmers' learning time and cost, and avoid risks brought by the use of the process. In addition, the township government can set up different types of social, cultural, technical basic education courses and set up green farming knowledge and technology learning classes, so that farmers not only improve the basic knowledge in the study and expand the scope of knowledge but also enhance the mutual exchange and trust between farmers.

Thirdly, the frequency of farmers' use of mass media should be increased. Encourage farmers to use TV, mobile phone networks, and other mass media to learn about green farming and green farming technology. At the same time, village committees and township governments can use online media to create public accounts, send farmers related information on farming, environmental protection knowledge, and relevant national policies and introduce green farming technology and other agricultural production technology and equipment for science popularization. In addition, we can make good use of short video applications, cooperate with enterprises to introduce and use various technologies more intuitively, enhance the concept and awareness of farmers' autonomous use of network systems to solve problems, and improve the enthusiasm of farmers to use social media.

Fourthly, the environmental regulation policy system must be improved. The government's environmental regulation is still the leading means to control rural ecological pollution. The government must formulate reasonable and innovative environmental regulation policies according to the actual situation; refine policy implementation standards and penalties; and cultivate a stable, sustainable and flexible policy system. On the one hand, the government should increase subsidies, reduce the cost of green farming, improve farmers' enthusiasm to participate in green farming, punish illegal acts, give full play to the role of incentive-based regulation and restraint regulation, and accelerate the development of rural green farming. On the other hand, it is necessary to grasp the differences between different environmental regulations, further strengthen and innovate the environmental regulation system, refine the degree of punishment for restrictive regulations according to local conditions, and maintain its balance. To avoid the negative impact caused by farmers' psychological resistance, the ecological and social benefits of resource-based treatment behavior can be promoted in regions with relatively highly restrictive environmental regulations. In contrast, those with low restrictive regulations can focus on improving farmers' perception of economic benefits.

Fifthly, it is necessary to promote the coordinated development of environmental, economic, and social benefits in promoting green breeding behavior among farmers. Based on the environmental and social benefits brought about by green farming behavior, the economic benefits it brings to farmers should be strengthened. In addition, we should expanding our perspective on the beef cattle industry itself, increase the supervision of the primary market of the beef cattle industry, and create a favorable business environment, thus attracting labor and increasing the breeding scale by improving the income level of small-scale farmers. In addition, it is necessary to strengthen social public opinion supervision, establish a comprehensive mobile supervision platform, and build a supervision model for the pollution control of beef cattle breeding that is widely participated in, supervised, and shared by the whole population.

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