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Development of Family Farms in Inner Mongolia, China

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Abstract: As one of the new agricultural business subjects, family farms are the main force behind the development of agriculture and the leader of agricultural modernization in China. At present, the development of family farms in Inner Mongolia is on the rise, but there are still many problems, so it is crucial to evaluate the development of family farms to find out the problems for targeted development. In this paper, first, after double-screening objective data of family farm development evaluation indexes through the combination of the gray correlation degree and Spearman's rank correlation coefficient, we constructed an index system for evaluating family farm development including 19 indexes, such as whether to register a business license. Second, based on the index system constructed in the previous step, the index weight vector was measured using the AHP–entropy weight method, which reflects the cognitive experience of experts, while taking into account the objective laws of data. Next, based on the index weight, the scores of 755 family farms were calculated to measure the level of development of family farms, and the ratings were divided into three categories based on the scores using K-mean cluster analysis. The study found that: (1) The weight of the indicator on the rank of the new professional farmer was 0.102, ranking first; the weight of the indicator on whether the children of the person in charge have the intention to engage in farming and animal husbandry was 0.091, ranking second; and the weight of the indicator on the number of basic production facilities and necessary machinery and equipment was 0.088, ranking third. (2) The highest score of 755 family farms in Inner Mongolia was only 50.161 points, and the overall development of family farms was at an average level. Therefore, based on the results of the study, five paths were proposed to enhance the development of family farms.

Keywords: family farm; index screening; index weight vector; five paths

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1. Introduction

The concept of family farms was first proposed in the "No. 1 central document" [1] for 2013, which received wide attention from all walks of life, and a series of measures was proposed to support the development of family farms. The "No. 1 central document" [2] for 2021 proposed the implementation of the family farm cultivation program to cultivate large-scale agricultural business households into dynamic family farms. The "No. 1 central document" [3] for 2023 proposed to carry out in-depth action on new agricultural business entities and support new agricultural business entities, such as family farms, to run enterprises. "High-quality development" [4] is a new expression that was proposed in the 19th National Congress of the Communist Party of China in 2017, and the country has repeatedly launched videoconferences on the promotion of the high-quality development of family farms to deploy the development of family farms in 2019–2020. In 2020, the Ministry of Agriculture and Rural Affairs issued the "New Agricultural Business and Service Subjects High-Quality Development Plan (2020–2022)" [5], emphasizing family farms and farmers' cooperatives, which are the two types of new agricultural business entities. The "No. 1 central document" for 2023 proposed to promote the high-quality development of rural industries and support family farms and other development of the primary processing of agricultural products [3]. In October 2020, the Inner Mongolia government issued the

"Three-Year Action Plan for High-Quality Agricultural Development," which proposed to promote the green and high-quality development of family farms and other new business entities [6]. It can be seen that the development of family farms and other new business entities is gradually becoming the mainstream of agricultural development in China, so it is important to construct an evaluation model for the development of family farms. This paper first constructed an evaluation index system for the development of family farms by combining the gray correlation degree and Spearman's rank correlation coefficient. Second, it measured the index weight vector using the AHP–entropy weight method based on the index system constructed in the previous step and then calculated the score of each family farm based on the index weight to measure the level of development of family farms. Finally, based on the evaluation results, we proposed a path to improve the development level of family farms.

Relevance of constructing an evaluation model for the development of family farms:

First, for the macro aspect, the construction of an evaluation model for the development of family farms is conducive to promoting the rapid development of family farms, thus further promoting rural revitalization and the modernization of agriculture and rural areas and achieving common prosperity in rural areas.

Second, for family farms, the construction of an evaluation model for the development of family farms can enable family farm operators to adjust their business models according to the evaluation results in a timely manner, which is beneficial in the long-term development of family farms.

Third, for government departments, the construction of an evaluation model for the development of family farms can provide a decision-making basis and suggestions for agricultural and animal husbandry management departments and ultimately promote the rapid development of family farms in Inner Mongolia toward the road of health, green development, and ecological and environmental protection.

Current status of research on the construction of evaluation models for the development of family farms:

(1) Research on the Evaluation Index System for Development

Guo and Wang (2022) constructed an index system for evaluating the quality of family farm development in four dimensions: characteristics, inputs, outputs, and support [7]. Lin Xiang-yue (2021) constructed an evaluation index system for the high-quality development of family farms in four dimensions: economic, strategic, social, and ecological [8]. Mukairanmu Wusiman constructed a set of systems for evaluating the level of quality development of agriculture in five dimensions: product quality, green development, production efficiency, economic efficiency and policy support [9]. Li and Zeng (2015) [10] and Ke Xian-feng et al. (2020) [11] constructed an index system for the comprehensive evaluation of family farms based on research data using the expert consultation method and the hierarchical analysis method. Xin and Gao (2017) constructed a set of evaluation index systems including four aspects of operation scale, production organization, service socialization, and output efficiency for the development of China's new agricultural management system [12].

(2) Research on the Evaluation Model for Family Farms

Gordana Manevska-Tasevska et al. (2011) used the data envelopment analysis method to evaluate the operational efficiency of family farms [13]. Ren and Xue (2018) first constructed an evaluation index system for the development efficiency of 541 family farms in Shandong Province in three dimensions (economic efficiency, social efficiency, and ecological efficiency) and then used the AHP method to evaluate the development efficiency of the family farms [14]. Tiago T.S. Siqueira and Michel Duru (2016) used greenhouse gas emissions, integrated land use change, and soil carbon storage and other indicators to evaluate the ecological performance of a typical Amazonian dairy farm [15]. Lan Yong et al. (2022) measured the comprehensive index of the operating environment of family farms in Hunan Province using the entropy TOPSIS model [16]. Fan and Zhang (2022) used the

AHP–entropy weight method to comprehensively evaluate the high-quality development of family farms in six dimensions, including the characteristics of land management rights and the level of human capital investment [17]. Guan Di and Chen (2022) used the fuzzy comprehensive evaluation method to comprehensively evaluate the business performance of family farms [18].

(3) Research on Countermeasures for the Development of Family Farms

Gao and Li (2020) proposed four measures to promote the high-quality development of family farms, such as comprehensively promoting the balanced regional development of family farms and focusing on the implementation of work at the county level [19]. Geng Xian-hui et al. (2020) [20] and Pu Wen-bin (2023) [21] proposed paths for the high-quality development of family farms from the perspectives of industrial chain development, financial support, and improvement of socialized services for agricultural production. Feng Tao et al. (2023) proposed five countermeasures for the high-quality development of family farms in Jiaxing City, such as accelerating registration and the development of socialization services [22]. Based on the ecosystem perspective, Hou Ting-ting (2023) proposed a pathway for governments, enterprises, universities, and farmers to promote the high-quality development of family farms [23].

In summary, the authors used "development + family farm" as keywords for the search in the knowledge network, and the results included many new type of agricultural operating entity as the object of research literature. It can be seen that current research on the development of family farms needs to be enriched. Domestic scholars' research on the development of family farms is not deep, and the number of studies is low, mainly focusing on countermeasures for the development of family farms. In addition, the number of studies on the evaluation of the development of family farms is low. Based on the research data of 755 family farms in Inner Mongolia, this paper first constructed an index system for evaluating the development of family farms through the gray correlation degree and Spearman's rank correlation coefficient, then measured index weights through the entropy weight method, and finally measured the development score of each family farm based on the index weights.

2. Principle of Constructing an Evaluation Model for the Development of Family Farms

2.1. The Connotation of the Development of Family Farms

By referring to the research of Yang Xiao-wei [24] and other scholars, we concluded that the connotation of the development of family farms refers to family farms as part of new management subjects, under the standardized management of farm owners with a new management level, with the goals of obtaining high profits and maintaining the stability of farm development, driving the common development of surrounding farms or farmers, and striving to be the main force behind the development of China's agriculture and the front-runner of agricultural modernization.

2.2. Main Features of Family Farms' Development

According to the connotation of the development of family farms proposed in this paper, the characteristics of the development of family farms should include the following aspects: first, the level of human development, which reflects the degree of the new management level of farm owners; second, the level of normative development, which reflects whether the family farm meets the standards; third, the level of efficiency development, which reflects whether the family farm can operate efficiently; fourth, the level of stable development, which reflects the sustainability of the development of the family farm; and fifth, the level of open development, which reflects the openness of the family farm to the outside world.

2.3. Concept Notes

1. The meaning of family farm: It usually refers to a new type of agricultural management body that uses family members as the main labor force; engages in large-scale, intensive, and commercialized agricultural production and operation; and uses agricultural income as the main source of income for the family [25].
2. The meaning of three products and one label: These refer to pollution-free agricultural products, green food, organic agricultural products, and geographical indications for agricultural products [26].
3. The meaning of gray correlation analysis: This means that in the process of system development, if the two factors change, the trend is consistent, that is, the degree of synchronous change is high, and then it can be considered that the two correlations are large; otherwise, the two correlations are small [27].
4. Rank correlation analysis method: Rank correlation analysis involves assigning ranks to the two element of a sample according to the size of the data. Instead of using actual data, this method analyzes the statistical relationship between the ranks assigned to each element in the sample. It is an indicator of statistical analysis that reflects the degree of rank correlation [28].

2.4. Difficulties of the Problem and Solution Ideas

(1) Difficulties in Constructing an Evaluation Model for the Development of Family Farms in Inner Mongolia

Difficulty 1: How to ensure that the constructed indicator system for the development of family farms not only requires that the screened indicators have practical significance but also requires that the screened indicators for the evaluation of development among various categories have the greatest information content and have a significant impact on the evaluation results of development.

Difficulty 2: How to construct an indicator weight vector that can measure the difference in importance between the evaluation indicators of the development of family farms.

(2) Solution Ideas for Difficulties

The solution of difficulty 1: The first round of screening the indicators of the development of Inner Mongolia family farms through gray correlation ensures that the screened indicators replace the information of the original indicators to the greatest extent. The second round of screening the indicators of the development of family farms through rank correlation on the basis of the first round of screening ensures that there is no duplicate information among the screened indicators in the development evaluation index system of Inner Mongolia family farms.

The solution of difficulty 2: The combination of subjective and objective weighting with AHP–EWM, which reflects the consistent cognitive experience of experts, while taking into account the objective laws of data, and this method solves the problem of what to use to measure the weights of the indicators in the evaluation index system for the development of family farms. The evaluation model for the development of family farms in Inner Mongolia is shown in Figure 1.

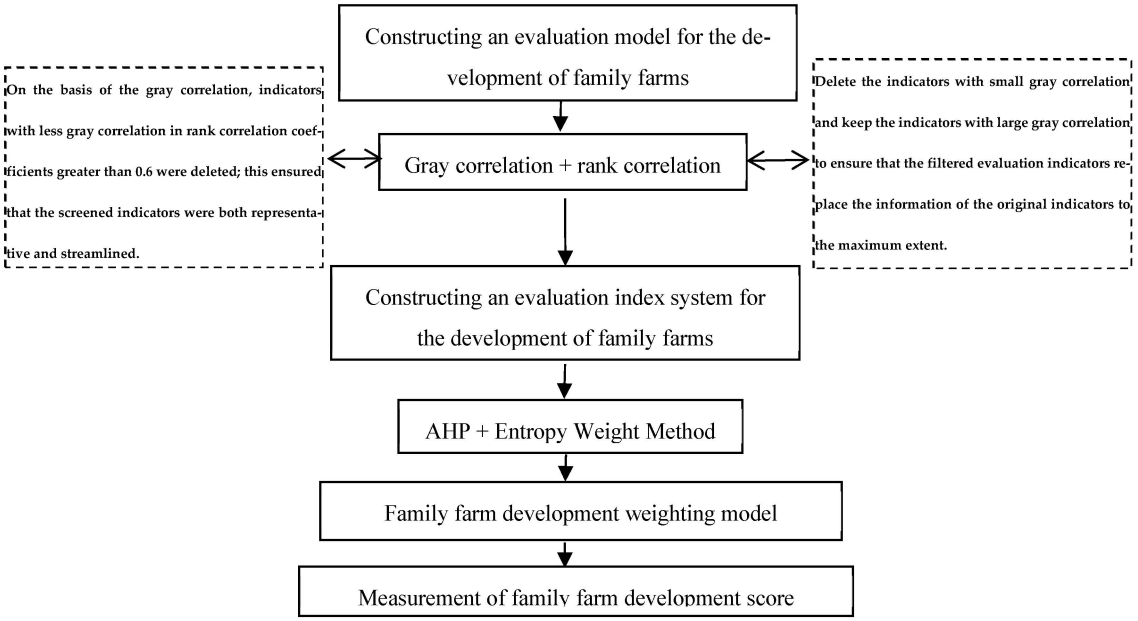

Figure 1. Principle of constructing an evaluation model for the development of family farms in Inner Mongolia.

3. Methodology and Modeling

3.1. Sampling Method

Our team intended to carry out research on family farms in 12 municipalities in Inner Mongolia. Due to the agricultural conditions and families, the methodology adopted was to first compile sampling frames for family farms in each league and city of Inner Mongolia for multi-order complex sampling and then carry out comprehensive and focused research on the family farms through a combination of online and offline methods. The research team was headed by the applicant, with the participation of seven members of the group and five master's degree students as the main force behind the research. The research was conducted among all the family farms certified by the Department of Agriculture and Animal Husbandry in 12 cities of Inner Mongolia. If difficulties were encountered in completing the offline field research, the research task was completed using online or telephone interviews.

3.2. Standardization of Data before Screening

Since different indicators have different scales, the indicator data need to be normalized to values between 0 and 1. Because some indicators cannot be directly quantified and need to be scored by the evaluator, they are referred to as qualitative indicators. Those indicators that can be quantitatively defined and precisely measured are called quantitative indicators, and scoring quantitative indicators is standardization. The 58 family farm development selection evaluation indicators were divided into qualitative and quantitative indicators. The quantitative indicators were divided into three categories: positive indicators, negative indicators, and interval-type indicators.

(1) Scoring of Qualitative Indicators

Qualitative indicators were 39 in number, such as the gender of operators and the number of registered or used trademarks. The specific scoring values are shown in Table 1.

Table 1. Family farm development selection index scoring values.

(1) Serial Number	(2) Guideline Layer	(3) Indicator Name	(4) Classification	(5) Scoring Value
1	Normative development level	Number of registered or used trademarks	Two or more	1.000
			One	0.500
			None	0.000
…	…	…	…	…
39	Open development level	Whether to drive the surrounding farmers and herdsmen/poor households	Yes	0.000
			No	1.000

(2) Scoring of Quantitative Indicators

a. Standardization of Positive Family Farm Index Data

Positive family farm development indicators indicate that the values of family farm indicators are consistent with the direction of development, i.e., higher values of development indicators represent higher levels of development of family farms. Taking annual profits as an example, the higher the value of annual profits, the higher the level of development of family farms, as shown in the following equation [29]:

$$y_{ij} = \frac{x_{ij} - \min\limits_{1 \le i \le s}(x_{ij})}{\max\limits_{1 \le i \le s}(x_{ij}) - \min\limits_{1 \le i \le s}(x_{ij})} \quad (1)$$

The meaning of Equation (1): "y_{ij}" denotes the standardized scoring value of the j-th indicator of the i-th family farm, "x_{ij}" denotes the observed value of the *j-th* standardized family farm indicator of the i-th family farm, and "s" denotes the number of family farms.

b. Standardization of Negative Family Farm Index Data

Negative family farm development indicators indicate that the value of family farm indicators is opposite to the direction of development, i.e., a smaller value of development indicators represents a higher level of development of family farms. Taking the date of establishment as an example, the smaller the value of the date of establishment, the longer the family farm has been established, and the higher the level of development of the family farm, as shown in the following equation [29]:

$$y_{ij} = \frac{\max\limits_{1 \le i \le s}(x_{ij}) - x_{ij}}{\max\limits_{1 \le i \le s}(x_{ij}) - \min\limits_{1 \le i \le s}(x_{ij})} \quad (2)$$

c. Standardization of Family Farm Index Data between Zones

The interval family farm index refers to the index indicating the better-quality development of a family farm when the index value of the family farm is within a specific interval. For example, if the age of the family farmer is within the range of 31–45 years, it

indicates a higher level of development of the family farm, and the specific equation is as follows [29]:

$$y_{ij} = \begin{cases} 1 - \frac{a_1 - x_{ij}}{\max(z_1 - \min\limits_{1 \le i \le s}(x_{ij}), \max\limits_{1 \le i \le s}(x_{ij}) - z_2)}, & x_{ij} < a_1 \\ 1 - \frac{x_{ij} - a_2}{\max(z_1 - \min\limits_{1 \le i \le s}(x_{ij}), \max\limits_{1 \le i \le s}(x_{ij}) - z_2)}, & x_{ij} > a_2 \\ 1 & , a_1 \le x_{ij} \le a_2 \end{cases} \quad (3)$$

The meaning of Equation (3): "a1" denotes the left interval endpoint of the optimal interval, and "a2" denotes the right interval endpoint of the optimal interval. The meaning of the remaining indicators is the same as in Equation (1).

3.3. Indicator Selection

(1) First Screening of Indicators Using Gray Correlation

This paper intended to conduct the first screening of family farm quality development indicators through the gray correlation degree, following the concept that the larger the value of the gray correlation degree, the closer the degree of correlation between indicators, and the richer the original information content. The specific analysis steps are as follows:

Step 1: Determine the comparison series and reference series of family farm development evaluation.

Set: There are s family farms, each family farm has *j* indicators, and X_{ij} denotes the data of the *j-th* indicator of the *i-th* family farm after standardization. Then $X_{ij} = (X_{i1}, X_{i2}, \ldots X_{ij})$ is the comparison series. Since there is no clear causal relationship between the selected indicators, the series of each indicator in turn is used as the reference series for comparison, and the reference series is denoted as $\{X_{0k}(n)\} = \{X_{01}, X_{02}, X_{03} \ldots X_{0n}\}$, where "$n$" denotes the *n-th* reference series.

Step 2: Calculate the absolute difference series, the maximum difference, and the minimum difference of the evaluation indexes of the development of family farms.

The absolute difference sequence is the absolute value sequence that needs to make the difference between the reference sequence and the comparison sequence one by one. Set $\Delta_{0k}(n)$ as the absolute value of the difference between the *n-th* reference series and the *k-th* comparison series, and X_k(n) denotes the value of the *k-th* comparison series. The specific steps are as follows:

$$\Delta_{0k}(n) = |x_0(n) - x_k(n)| \quad (4)$$

The role of Equation (4): It is to use the difference between the reference series and the comparison series as a measure of the magnitude of the gray correlation.

Step 3: Calculate the coefficient of association for each indicator.

Set $\xi_{0k}(n)$ to denote the correlation coefficient between the reference series and the comparison series, $\Delta(min)$ as the minimum value in the absolute difference series calculated when the *k-th* comparison series is used as the reference series, ρ to denote the resolution coefficient, and $\Delta(max)$ as the maximum value in the absolute difference series calculated when the *k-th* comparison series is used as the reference series. Then the equation of $\xi_{0p}(n)$ is:

$$\xi_{0k}(n) = \frac{\Delta(min) + \rho\Delta(max)}{\Delta_{0k}(n) + \rho\Delta(max)} \quad (5)$$

The meaning of Equation (5): It reflects the degree of closeness between the indicators through the size of the gray correlation coefficient. Among them, when $\xi_{0k}(t) = 1$, the correlation coefficient is the largest; when $\xi_{0k}(t) = 0$, the correlation coefficient is the smallest; and when and $0 \le \xi_{0k}(t) \le 1$, the resolution factor "ρ" attenuates the effect of information distortion due to excessively large Δ(max), which varies in the range $0 < \rho < 1$, and generally takes the value of 0.5.

Step 4: Calculate the correlation of the indicators.

Set r_{0k} to denote the average of the correlation coefficients, with each indicator calculated when the *k-th* comparison sequence is used as the reference sequence, as specified in the equation:

$$r_{0k} = \frac{1}{s}\sum_{i=1}^{S} \xi_{0k}(n) \tag{6}$$

(2) Second Screening of Indicators Using Rank Correlation

a. Calculate the rank correlation coefficient.

Spearman's rank correlation coefficient indicates the strength of the association between two indicator variables. Let ρ_s denote the rank correlation coefficient and di denote the difference between the two ranks: *di = xi-xj*. ***n*** is the logarithm of the total indicator. So ρ_s is calculated as [30]:

$$\rho_s = 1 - \frac{6\sum d_i^2}{n(n^2-1)} \tag{7}$$

The meaning of Equation (7): When ρ_s is larger, it means that the two indicators are more substitutable for each other.

b. Selection of rank correlation coefficient thresholds and screening criteria for duplication of information

By referring to relevant literature [31], this paper selected the critical value of the rank correlation coefficient as 0.6. When the absolute value of the rank correlation coefficient between two indicators is greater than 0.6, it indicates that there is a high degree of mutual substitutability between these two indicators; at this time, one of the indicators should be deleted, and the method of deleting the indicators selected in this paper was to delete the indicator that had a smaller gray correlation in the two pairs of indicators where there was duplication of information.

3.4. Determination of Indicator Weights

3.4.1. Determination of Subjective Weights of Indicators based on the Cluster AHP –Method

Since subjective weights are based on the scoring by experts, the more important indicators are not filtered out. After consistency testing and discussion, it was finalized to adopt the scoring matrix of one expert.

Step 1: Construct a judgment matrix.

In order to minimize the subjectivity of the experts, this paper invited two agricultural experts and two university professors to score the importance of the factors in the guideline and target layers according to the 1–9 scale method, which requires experts to assign values to each indicator in the same guideline layer by comparing the indicators two by two and to derive the ratios between the indicators to form a judgment matrix.

Step 2: Calculate feature vectors, feature roots, and weights.

The maximum eigenvalue of each judgment matrix and its eigenvectors were calculated using the sum-product method. First, each column element of the judgment matrix was normalized, and second, each column of the judgment matrix after normalization was summed up by columns and the vector $W_T = (w_1, w_2, \ldots, w_n)$ was normalized. $W_T = (w_1, w_2, \ldots, w_n,)$ was finally the weight vector. Finally, the maximum characteristic root of the judgment matrix was calculated.

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{\lambda_{max} - n}{w_i} \tag{8}$$

Step 3: Performa a consistency test.

1) Set *CI* as the consistency index of the judgment matrix; max is the maximum eigenvalue of the judgment matrix and is calculated as follows:

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{9}$$

2) Set *CR* as the consistency ratio. *RI* is the average random consistency index and the exact values are shown in Table 2. Calculated as follows:

$$CR = \frac{CI}{RI} \tag{10}$$

When *CR* = *CI*/*RI* < 0.1, the judgment matrix meets the consistency test.

Table 2. Average random consistency metrics.

***n* (Order)**	**1**	**2**	**3**	**4**	**5**
RI	0	0	0.52	0.89	1.12

3.4.2. Determination of Objective Weights of Indicators based on the Entropy Weight Method

(1) Calculate the contribution degree f_{ij}, entropy value e_j, and coefficient of variation g_j for each indicator.

a. Set f_{ij} as the weight of the *i-th* family farm under the *j-th* indicator, x_{ij} to denote the observed value of the *j-th* standardized family farm indicator for the *i-th* family farm, and *s* to denote the number of family farms (i = 1, s; j = 1, m). The calculation formula is as follows:

$$f_{ij} = \frac{X_{ij}}{\sum_{i=1}^{s} X_{ij}} \tag{11}$$

b. Set e_j as the entropy value of the *j-th* indicator in the evaluation system for family farms in Inner Mongolia. The calculation formula is as follows [32]:

$$e_j = -\frac{1}{\ln s} \sum_{i=1}^{s} f_{ij} \ln(f_{ij}) \tag{12}$$

The role of Equation (12): It can calculate the degree of dispersion of the indicators in the evaluation system for the development of family farms in Inner Mongolia, because the greater the degree of dispersion of the indicators in the evaluation system, the greater the impact of the indicator on the evaluation system for the development of family farms in Inner Mongolia.

c. Set g_j as the coefficient of variation. Then the formula for g_j is:

$$g_j = 1 - e_j \tag{13}$$

(2) Set the entropy weight of each indicator in the evaluation of development of family farms in Inner Mongolia as W^*_j, and the calculation formula is as follows:

$$W_j^* = \frac{g_j}{\sum_{j=1}^{s} g_j} \tag{14}$$

3.4.3. Measurement of Comprehensive Weights

Set Z_j as the subjective weight of the indicators in the evaluation system for the development of family farms in Inner Mongolia; W*$_j$ is the objective weight of the indicators. By referring to Zhang Liheng [33], assigning subjective weights Z_j and objective weights, each accounting for 0.5, set E_j as the comprehensive weight:

$$E_j = \frac{(Z_j \cdot W_j^*)^{0.5}}{\sum_{j=1}^{m} (Z_j \cdot W_j^*)^{0.5}} \quad (15)$$

3.5. Measurement of Scores

The comprehensive weights of the evaluation system for the development of family farms in Inner Mongolia and the indicator data of previous years were linearly weighted to finally obtain the score for the development of family farms in Inner Mongolia.

$$F_i = 100 \cdot \sum_{j=1}^{m} x_{ij} \cdot E_j \quad (16)$$

The role of Equation (16): This formula derives a percentage rating of the development of family farms in Inner Mongolia. A higher rating indicates that the level of development of family farms in Inner Mongolia is high, and a lower rating indicates that the level of development of family farms in Inner Mongolia is low.

4. Empirical Analysis

4.1. Sample Situation

(1) Sample Situation and Indicator Selection

The sample of this study came from the questionnaire research on family farms in 12 leagues and cities of Inner Mongolia conducted by the research group from 2020 to 2023. In the end, 755 complete family farms were selected by processing the questionnaire data with missing values. The regional distribution of the research data is shown in Table 3. The details of the sample data are shown in Tables 4–8.

Table 3. Regional distribution of research data.

(1) Serial Number	(2) Region	(3) League and City	(4) Sample Size (Households)	(5) Proportion (%)	(6) The Sum of the Proportion of Each Region (%)
1	Central Inner Mongolia region	Hohhot City	35	4.63%	19.73%
2		Xilin Gol League	73	9.67%	
3		Ulaanchabu City	41	5.43%	
4	Western Inner Mongolia region	Baotou City	43	5.70%	31.66%
5		Erdos City	48	6.36%	
6		Wuhai City	19	2.52%	
7		Alxa League	30	3.97%	
8		Bayan Nur City	99	13.11%	
9	Eastern Inner Mongolia region	Chifeng City	99	13.11%	48.61%
10		Tongliao City	112	14.83%	
11		Hulunbuir City	76	10.07%	
12		Hinggan League	80	10.60%	

Table 4. Description of the indicators of the level of normative development.

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
Date of establishment	Before 2000	64	8.48%
	2001–2010	46	6.09%
	2011–2023	645	85.43%
Number of trademarks registered or in use	Two or more	132	17.48%
	One	93	12.32%
	None	530	70.20%
Whether to register a business license	Yes	347	45.96%
	No	408	54.04%
Is the degree of mechanization higher than the local average?	Yes	601	79.60%
	No	154	20.40%
Whether a written contract is in place	Yes	741	98.15%
	No	14	1.85%
Whether timely payments are made	Yes	739	97.88%
	No	16	2.12%
Whether it has independent office space	Yes	640	84.77%
	No	115	15.23%
Whether pollutant emissions meet environmental requirements	Yes	477	63.18%
	No	278	36.82%
Whether there are professional financial managers	Yes	70	9.27%
	No	685	90.73%
Is there an account opening permit?	Yes	189	25.03%
	No	566	74.97%
Whether there is a bad record of illegal operation or breach of trust	Yes	118	15.63%
	No	637	84.37%
Whether the operator receives reminders on a regular basis	Yes	97	12.85%
	No	658	87.15%

Table 5. Description of the indicators of the level of development efficiency.

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
What level of model family farms were assessed?	None	105	13.91%
	Flag county, allied city level	16	2.12%
	Autonomous region	634	83.97%
Number of three products and one label certified	None	589	78.01%
	One	27	3.58%
	Two or more	139	18.41%
Whether existing production technologies can meet the production needs of family farms	Yes	346	45.83%
	No	409	54.17%
Number of distribution channels for agricultural and livestock products	None	5	0.66%
	Three or less	699	92.59%
	Four or more	51	6.75%
Amount of funds (million yuan/RMB)	[0,50]	196	25.96%
	(50,200]	118	15.63%
	(200,500]	431	57.09%
	(500,+∞)	10	1.32%

Table 5. *Cont.*

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
Whether to obtain honorary certificates	Yes	304	40.26%
	No	451	59.74%
Forms of production and business decision making	Self-determination and consultation with experts	134	17.75%
	Management backbone joint decision	202	26.75%
	The person in charge calls the shots.	419	55.50%
Value of assets (million yuan/RMB)	[0,50]	135	17.88
	(50,200]	226	29.93%
	(200,500]	338	44.77%
	(500,+∞)	56	7.42%
Annual profit (million yuan/RMB)	[0,10]	81	10.73%
	(10,50]	559	74.04%
	(50,200]	99	13.11%
	(200,+∞)	16	2.12%
Frequency of product sales on the farm (number of times)	Continuous sales	313	41.46%
	More than two centralized sales twice a year	239	31.66%
	Centralized sales one to two times per year	203	26.89%
Share of sales of the farm's products to permanent regular sales recipients in the total output of the farm (%)	≤25%	435	57.62%
	(25%,50%]	171	22.65%
	(50%,100%]	149	19.74%

Table 6. Description of the indicators of the level of human development.

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
Gender of operator	Male	664	87.95%
	Female	91	12.05%
Military service or not	Yes	6	0.79%
	No	749	99.21%
Physical fitness of the operator	Favorable	683	90.46%
	General	63	8.34%
	Poor	9	1.19%
Marital status of the operator	Married	700	92.72%
	Unmarried	55	7.28%
Number of students enrolled in the operator's household (persons)	None	196	25.96%
	One to two persons	530	70.20%
	Three or more	29	3.84%
Year of birth of the operator	Before 1970	215	28.48%
	1970–1985	472	62.52%
	1986 and beyond	68	9.00%
Educational qualifications of the operator	Junior high school and below	226	29.93%
	High school, secondary, and specialized	359	47.55%
	Bachelor's degree or above	170	22.52%

Table 6. *Cont.*

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
Presence of government workers in the operator's household	Yes	60	7.95%
	No	695	92.05%
Presence of highly educated persons in the operator's family	Yes	477	63.18%
	No	278	36.82%
Operator's social position	Deputy to the National People's Congress (NPC) and above	157	20.79%
	Head of village cadres' social organizations	67	8.87%
	Other	531	70.33%
Whether or not you are a member of the party	Yes	227	30.07%
	No	528	69.93%
Number of specialized training sessions received	None	481	63.71%
	One or two times	103	13.64%
	Three or more times	171	22.65%

Table 7. Description of the indicators of the level of robust development.

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
Length of time the operator has been engaged in farming (years)	[0,10]	72	9.54%
	[11,20)	198	26.23%
	[20,+∞)	485	64.23%
New professional farmer level	None	373	59.28%
	Junior ranking	102	13.51%
	Middle level	96	12.72%
	High level	184	24.37%
Transferred land area/total land operation area (%)	[0%,50%]	481	63.71%
	(50%,100%)	274	36.29%
Annual flow-through costs (million yuan/RMB)	[0,50]	474	62.78%
	(50,100]	275	36.42%
	(100,+∞)	6	0.80%
Total number of operating land parcels (blocks)	Two and under	566	74.97%
	Three or four pieces	110	14.57%
	Five or more	79	10.46%
Period of circulation (years)	[0,10]	614	81.32%
	[11,20]	141	18.68%
Population in the labor force/total household size (%)	[0%,50%]	374	49.54%
	(50%,100%]	381	50.46%
Price volatility of agricultural commodities	Modest recurrent changes	508	67.28%
	Frequent and large changes	247	32.72%
Number of possible natural disasters (times)	None	83	10.99%
	One or both	303	40.13%
	Three or more	369	48.88%
Whether the children of the person in charge have an intention to engage in agriculture	Yes	266	35.23%
	No	489	64.77%

Table 8. Description of the indicators of the level of openness (See details in the Supplementary Materials).

(1) Indicator Name	(2) Category	(3) Quantity (Household)	(4) Proportion (%)
Number of cooperatives or associations	None	446	59.07%
	One	182	24.11%
	Two or more	127	16.82%
Number of basic production support facilities and necessary machinery and equipment	None	26	3.44%
	(0,10)	660	87.42%
	[10,+∞)	69	9.14%
Whether or not short-term employment	Yes	239	31.66%
	No	516	68.34%
Whether or not insurance is purchased	Yes	333	44.11%
	No	422	55.89%
Amount of insurance claim received/ total premium paid (%)	0	514	68.08%
	(0,1]	200	26.49%
	(1,+∞)	41	5.43%
Insurance coverage ratio (%)	(0%,50%)	582	77.09%
	[50%,100%]	173	22.91
Incentives enjoyed (types)	Category 3 and below	657	87.02%
	Category 4 and above	98	12.98%
Government subsidies as a percentage of investment (%)	(0%,10%)	674	89.27%
	[10%,50)	75	9.93%
	[50%,100]	6	0.79%
Number of permanent employees	None to two persons	452	59.87%
	Three or more	303	40.13%
Whether or not new technologies are used	Yes	487	64.50%
	No	268	35.50%
Whether to drive the surrounding farmers and herdsmen/poor households	Yes	431	57.09%
	No	324	42.91%

The findings of this paper are summarized as follows: In these 755 family farms studied, the species of crops or livestock and other species (specifically Mongolian horses, cows, sheep, pigs, donkeys, bees, chickens, maize, grains miscellaneous grains and beans, economic forests, sunflower, soya beans, alfalfa, grapes, apricot trees, peach trees, camelids, cantaloupe, agrodon, otters, pumpkins, cucumbers, fishponds, tomatoes, cistanchettes, flying geese, buckwheat, sugar beets, strawberries, potatoes, wheat, cucurbits, ostriches, ducks, and geese) were investigated.

4.2. Indicator Selection and Data Standardization

(1) Selected indicators

Based on the results of the questionnaire and the analysis of 20 pieces of related literature, we constructed an evaluation system for the development of family farms in Inner Mongolia, which includes 5 first-level criterion layers and 58 selected indicators, and we deleted 2 indicators in the unobservable and single-observable results in order to satisfy the observability of the indicators. In the end, 56 evaluation indicators of the development of family farms in Inner Mongolia were retained. Specific indicators are shown in Table 9.

Table 9. Selected indicators for evaluating the development of family farms in Inner Mongolia.

(1) Serial Number	(2) Standardized Layer	(3) Indicator Name	(4) Indicator Status
1	Level of normative development	Establishment date	Retained
...		...	...
12		Whether the operator receives reminders on a regular basis	Retained
13	Efficient level of development	What level of model family farms were assessed?	Retained
...		...	...
23		Total investment	Deleted
24		Total liability	Deleted
25		Share of sales of the farm's products to permanent regular sales recipients in the total output of the farm	Retained
26	Human level of development	Gender of the operator	Retained
...		...	...
37		Number of professional training sessions received	Retained
38	Robust level of development	Length of time the operator has been engaged in farming (years)	Retained
...		...	...
47		Whether the children of the person in charge have an intention to engage in agriculture	Retained
48	Openness level of development	Number of cooperatives or associations	Retained
...		...	...
58		Whether to drive the surrounding farmers and herdsmen/poor households	Retained

(2) Data standardization

Substituting each type of indicator into Equations (1)–(3), respectively, the standardized data for the final indicators are shown in columns (6)–(729) of Table 10.

4.3. The Construction of Evaluation Index System for Development of Family Farms

4.3.1. First Round of Screening of Indicators using Gray Correlation

(1) Determine the reference series, comparison series, and absolute difference series.

We took the standardized data series of establishment date X_1 as the reference series and the other indicators as the comparison series, and we substituted the standardized data in columns (6)–(729) in Table 10 into Equation (4) to obtain the absolute value matrix of the difference between the reference series and the comparison series. We found the maximum difference Δ(max) and the minimum difference Δ(min) in the t absolute difference matrix.

(2) Calculate the coefficient of association for each indicator.

Sequentially, we used X_1, $X_2 \ldots X_{56}$ as reference sequences to calculate the correlation coefficients with the rest of the comparison series and then substituted them into Equation (5) to find the correlation coefficients ξ0k(n), and the specific results are shown in Table 11.

(3) Calculate the relevance.

Substituting the data in Table 11 into Equation (6), the correlation between the comparison series and the reference series was calculated sequentially, and the correlation was used to measure the degree of closeness between the indicators of the development of each family farm. The gray correlation of each indicator is shown in Table 12.

Table 10. Selected indicators of the development of family farms.

(1) Serial Number	(2) Standardized Layer	(3) Indicator Layer	(4) Nature of the Indicator	(5) Indicator Name	Standardized Data		
					(6) Sample 1	…	(729) Sample 755
1	Level of normative development	X1	Negative	Establishment date	0.098	…	0.490
2		X2	Qualitative	Number of trademarks registered or in use	0.800		0.000
…		…	…	…	…		…
12		X12	Qualitative	Whether the operator receives reminders on a regular basis	1.000		0.000
13	Efficient level of development	X13	Qualitative	What level of model family farms were assessed?	0.800	…	0.000
14		X14	Qualitative	Number of three products and one standard certified	0.000		0.000
…		…	…	…	…		…
23		X23	Positive	Share of sales of the farm's products to permanent regular sales recipients in the total output of the farm	0.200		0.000
24	Human Level of development	X22	Negative	Number of students enrolled in the operator's household	0.667	…	0.667
25		X23	Interval	Year of birth of the operator	1.000		0.810
…		…	…	…	…		…
35		X35	Qualitative	Number of professional training sessions received	1.000		0.000
36	Robust level of development	X36	Qualitative	New professional farmer levels	0.000	…	0.000
37		X37	Interval	Length of time the operator has been engaged in farming and ranching (years)	0.255		0.574
…		…	…	…	…		…
44		X44	Negative	Annual flow-through costs	0.980		0.858
45		X45	Negative	Transferred land area/total land operation area	0.333		1.000
46	Openness level of development	X46	Qualitative	Number of cooperatives or associations	0.500	…	0.000
47		X47	Positive	Number of basic production support facilities and necessary machinery and equipment	0.080		0.060
…		…	…	…	…		…
56		X56	Qualitative	Whether to drive the surrounding farmers and herdsmen/poor households	0.000		0.000

Table 11. Gray correlation coefficient matrix.

(1) Indicator	(2) X1	(3) X2	(4) X3	...	(57) X56
X1	1.000	0.562	0.674	...	0.433
X2	0.563	1.000	0.575	...	0.595
...	...	...	...	...	...
X28	0.425	0.637	0.565	...	0.912
...	...	...	...	...	...
X56	0.433	0.595	0.548	...	1.000

Table 12. Gray correlation of indicators of the development of family farms.

(1) Serial Number	(2) Indicator	(3) Gray Correlation	(4) Screening Results
1	X1	0.615	Removing
2	X2	0.599	Removing
3	X3	0.663	Retained
4	X4	0.634	Retained
5	X5	0.665	Retained
6	X6	0.657	Retained
7	X7	0.587	Removing
8	X8	0.650	Retained
9	X9	0.589	Removing
10	X10	0.591	Removing
11	X11	0.588	Removing
12	X12	0.580	Removing
13	X13	0.597	Removing
14	X14	0.592	Removing
15	X15	0.647	Retained
16	X16	0.618	Removing
17	X17	0.664	Retained
18	X18	0.666	Retained
19	X19	0.650	Retained
20	X20	0.600	Removing
21	X21	0.580	Removing
22	X22	0.595	Removing
23	X23	0.591	Removing
24	X24	0.624	Retained
25	X25	0.591	Removing
26	X26	0.621	Removing
27	X27	0.629	Retained
28	X28	0.619	Removing
29	X29	0.618	Removing
30	X30	0.648	Retained
31	X31	0.648	Retained
32	X32	0.585	Removing
33	X33	0.595	Removing
34	X34	0.664	Retained
35	X35	0.632	Retained
36	X36	0.650	Retained
37	X37	0.634	Retained
38	X38	0.599	Removing
39	X39	0.641	Retained
40	X40	0.649	Retained
41	X41	0.636	Retained
42	X42	0.668	Retained
43	X43	0.590	Removing
44	X44	0.593	Removing
45	X45	0.662	Retained
46	X46	0.594	Removing
47	X47	0.560	Removing
48	X48	0.635	Retained

Table 12. *Cont.*

(1) Serial Number	(2) Indicator	(3) Gray Correlation	(4) Screening Results
49	X49	0.640	Retained
50	X50	0.645	Retained
51	X51	0.615	Removing
52	X52	0.646	Retained
53	X53	0.589	Removing
54	X54	0.626	Retained
55	X55	0.620	Removing
56	X56	0.614	Removing

(4) Conduct the first round of screening using gray correlation.

The gray correlation mean of each indicator is usually set as the boundary, and in this paper, the gray correlation mean was 0.621, and indicators larger than the gray correlation mean were retained, while indicators smaller than the gray correlation mean were deleted. As can be seen in column (3) of Table 12, X_1, X_2, X_7, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}, X_{16}, X_{20}, X_{21}, X_{22}, X_{23}, X_{25}, X_{26}, X_{28}, X_{29}, X_{32}, X_{33}, X_{38}, X_{43}, X_{44}, X_{46}, X_{47}, X_{51}, X_{53}, X_{55}, X_{56}, and other 29 indicators with gray correlation less than the mean value were deleted, and the specific screening results are shown in Table 12.

4.3.2. Second Screening of Indicators using Spearman's Rank Correlation Coefficient

The standardized data of the 27 indicators of the development of family farms screened in the first round were substituted into Equation (7), and the Spearman coefficient matrix of the 27 indicators was calculated using SPSS software (IBM SPSS Statistics V21.0). The rank correlation coefficients between the indicators of the development of family farms that were above 0.6 and the rank correlation coefficients between them are shown in Table 13.

Table 13. Spearman's rank correlation coefficients for indicators of the development of family farms.

Serial Number	Rank Correlation Coefficients Greater Than 0.6		(3) Coefficient rij	(4) Second Screening to Remove Indicators
	(1) Relevant Indicators i	(2) Relevant Indicators j		
1	X3	X5	0.772	X3
2	X3	X6	0.634	X6
3	X5	X6	0.639	X6
4	X18	X42	0.728	X18
5	X3	X17	0.628	X3
6	X5	X17	0.669	X17
7	X5	X42	0.620	X5
8	X17	X42	0.625	X17
9	X17	X18	0.652	X17
10	X18	X34	0.616	X34
11	X34	X42	0.711	X34
12	X35	X37	0.903	X35

Since there were correlations between X_3, X_5, X_6, X_{17}, X_{18}, X_{34}, X_{42}, and X_{45}, X_{42}, which had the largest gray correlation, was retained as 0.668 among these eight indicators. Taking the 12th line of Table 13 as an example, the rank correlation coefficient of X_{35} and X_{37} was 0.903, while the gray correlation of X_{35} was 0.632 and that of X_{37} was 0.634. Based on the principle of retaining indicators with high gray correlation, X_{35} was deleted and X_{37} was retained.

Through the second screening of rank correlation analysis of the 27 indicators screened out using the first analytical method of gray correlation, of the 27 evaluation indicators of the development of family farms, 8 were deleted, and finally, 19 evaluation indicators for the development of family farms were screened out using the combined method of

gray correlation and rank correlation, and the final evaluation indicator system for the development of family farms is shown in Table 14.

Table 14. System of indicators for evaluating the development of family farms.

(1) Serial Number	(2) Standardized Layer	(3) System of Indicators	(4) Subjective Weights (Normalized)	(5) Objective Weighting	(6) Portfolio Weighting	(7) Arrange in Order
1	Normative level of development	X11 Whether to register a business license	0.021	0.045	0.033	14
2		X12 Is there an account opening permit?	0.082	0.094	0.088	5
3		X13 Number of basic production facilities and necessary machinery and equipment	0.021	0.124	0.072	3
4		X14 Whether there are professional financial managers	0.076	0.043	0.059	8
5	Efficient level of development	X21 Period of circulation	0.022	0.018	0.020	18
6		X22 Whether existing production technologies can meet the production needs of family farms	0.116	0.015	0.066	7
7		X23 Whether the children of the person in charge have an intention to engage in agriculture	0.062	0.119	0.091	2
8	Human level of development	X31 Presence of government workers in the operator's household	0.034	0.045	0.039	12
9		X32 Military service or not	0.019	0.089	0.054	10
10		X33 New professional farmer level	0.148	0.057	0.102	1
11	Robust level of development	X41 Amount of insurance claim received/total premium paid	0.007	0.039	0.023	15
12		X42 Insurance coverage ratio	0.015	0.020	0.018	19
13		X43 Government subsidies as a percentage of investment (%)	0.027	0.019	0.023	16
14		X44 Number of permanent employees	0.094	0.078	0.086	4
15		X45 Whether to drive the surrounding farmers and herdsmen/poor households	0.057	0.060	0.058	9
16	Openness level of development	X51 Amount of funds	0.061	0.024	0.042	11
17		X52 Share of sales of the farm's products to permanent regular sales recipients in the total output of the farm	0.009	0.033	0.021	17
18		X53 Value of assets	0.040	0.033	0.036	13
19		X54 Annual profit	0.091	0.045	0.068	6

The final 19 indicators were retained after the first round of screening of the indicators of the development of family farms in Inner Mongolia through gray correlation to ensure that the screened indicators of the development of family farms replaced the information about the original indicators to the greatest extent possible. On the basis of the first round of screening, the second round of screening of the indicators of the development of family farms through hierarchical correlation was conducted to ensure that there was no duplicate information among the screened indicators in the development evaluation index system for Inner Mongolia family farms. Therefore, the 19 indicators retained in the end not only ensure that the filtered evaluation indicators replace the information about the original indicators to the greatest extent possible but also ensure that the filtered indicators are both representative and streamlined.

4.4. Measurement of Indicator Weights

4.4.1. Measurement of Subjective Weights

Due to the space factor, this paper set out only the process of calculating the subjective weights for the indicators of the level of normative development, and R_1 is the judgment matrix of the normative development level:

$$R_1 = \begin{bmatrix} 1 & 3 & 5 \\ 1/3 & 1 & 3 \\ 1/5 & 1/3 & 1 \end{bmatrix} \quad (17)$$

According to Equation (8), the maximum characteristic root of this judgment matrix is calculated as 3.039, and according to Equation (9), the *CI* value is calculated as 0.019. Because of this third-order judgment matrix constructed, the random consistency *RI* value is obtained as 0.520 through the query of Table 2, and the *CR* value is calculated as 0.037 through Equation (10). If the *CR* value is less than 0.1, then the judgment matrix satisfies the consistency test, and if the CR value is 0.037 < 0.1, then this judgment matrix passes the consistency test. The subjective weights of each indicator after normalization are shown in column (4) of Table 14.

4.4.2. Measurement of Objective Weights

(1) Contribution f_{ij}, entropy e_j, and coefficient of variation g_j for each indicator

1) Due to a limitation of space, this paper only enumerated the entropy weight method algorithm for X_{21} indicator flow years, which was used to obtain the contribution of the indicator period of circulation of the first family farm through Equation (11):

$$f_{21} = 0.186/(0.186 ++ 0.014) = 0.002$$

2) Based on Equation (12), the entropy value of X_{21} was obtained:

$$e_1 = -1/\ln(19)[0.002\ln(0.002) ++ 0.000277\ln(0.000277)] = 0.9577$$

3) The coefficient of variation of X_{21} was obtained through Equation (13):

$$g_{21} = 1 - e_1 = 1 - 0.9577 = 0.0423$$

(2) Determination of entropy weights of indicators

From Equation (14), the entropy weight W^*_{21} of the indicator period of circulation was:

$$W^*_{21} = g_1/(g_1 ++ g_{19}) = 0.018 \quad (18)$$

Similarly, this was used to derive objective weights for the other indicators, as shown in column (5) of Table 14.

4.4.3. Measurement of Portfolio Weights

According to Equation (15) used to obtain the combination weights of the indicators in the evaluation index system for the development of family farms in Inner Mongolia, the normalized combination weights and ordering of the specific indicators are shown in Table 13, rows (6)–(7). Taking the indicator period of circulation as an example, the combination weight E_{21} is:

$$E_{21} = \frac{(0.022 \cdot 0.0018)^{0.5}}{\sum_{j=1}^{m} (0.341 + \cdots + 0.058)^{0.5}} = 0.020$$

Table 14 shows the weights of the indicators in the evaluation system for the development of family farms in Inner Mongolia. In the aforementioned evaluation index system, the indicators of the grade of new professional farmers, whether the children of the person in charge have an intention to engage in agriculture, and the number of basic production facilities and necessary machinery and equipment were in the first, second, and third places, reaching 0.102, 0.091, and 0.088, respectively; the proportion of the sales volume of the

products of the farm to the total output of the farm, the duration of the transfer, and the ratio of insurance coverage were in the last three places.

4.4.4. Measurement of Ratings

The development scores of 755 family farms in Inner Mongolia were calculated according to Equation (16), and the results are shown in Table 15.

Table 15. Development scores of 755 family farms.

(1) Serial Number	(2) Family Farms	(3) Score	(4) Arrange in Order
1	S1	11.196	591
2	S2	26.212	259
...	...	...	...
285	S285	45.735	8
...	...	...	...
391	S391	47.724	2
...	...	...	...
730	S730	50.161	1
...	...	...	...
755	S755	22.558	333

This paper used SPSS software to classify the final scores of 755 family farms into three echelons through K-mean cluster analysis. According to the clustering results, the first echelon of Inner Mongolia family farms with a high-quality development level had an average score of 36.990 and contained 150 family farms, the second echelon of Inner Mongolia family farms with an average-quality development level had an average score of 23.588 and contained 320 family farms, and the third echelon of Inner Mongolia family farms with a poor-quality development level had an average score of 9.910 and contained 285 family farms. These scores represent the level of development of family farms in Inner Mongolia. The higher the score, the higher the level of development of family farms. That is, the closer the score is to 100, the higher is the level of development of family farms. The maximum score of 50.161 was calculated using Equation (16). The maximum score of only 50.161 represents that the level of development of family farms in Inner Mongolia needs to be improved. This value of 50.161 was the score of the highest-rated family farm out of 755 family farms. Countermeasure suggestions on how to improve the level of development of family farms in Inner Mongolia have been presented in part VI of this paper.

In the first tier, the maximum value was 50.161 points and the minimum value was 30.687 points. In the second tier, the maximum value was 30.413 points and the minimum value was 17.072 points. In the third tier, the maximum value was 16.954 points and the minimum value was only 0.169 points. The closer the high-quality level score is to 100, the higher is the level of high-quality development of the family farm. Of these 755 family farms, the highest score was 50.161 points. Only 1 of the 755 family farms even exceeded 50 points, which indicates that the level of development of family farms in Inner Mongolia is in urgent need of improvement, which requires the government and relevant departments to pay attention to these indicators and develop them in an effort to improve the level of development of family farms in Inner Mongolia.

5. Problems in the Process of Establishing the Development of Family Farms

This paper finally screened out 19 family farms' development evaluation index systems by combining gray correlation with rank correlation; based on the index system constructed in the previous step, the vector of index weights was measured using the AHP–entropy weight method; based on the index weights, 755 family farms were rated, in order to measure the level of development of the family farms; and based on the ratings, the results were divided into three categories using K-mean cluster analysis. Therefore, this section

will introduce the problems that lead to the low level of development of family farms in Inner Mongolia.

5.1. There Are Many Risks Faced by Family Farms, and the Awareness of Farmers to Prevent Agricultural Risks Is Weak

Agricultural production is fragile, and multiple links in production are threatened by multiple factors, such as natural risks, market risks, and technological risks [34]. The first risk factor is natural risks, which cannot be avoided, such as floods, hailstorms, or pests and diseases. In recent years, the probability of animal disease risk in China has been increasing, and if the family farms and ranches with imperfect infrastructure suffers a loss, the farm operators cannot bear it. Inner Mongolia has a large east–west span, resulting in significant differences in the natural environment between the east and the west, with more precipitation and fertile soil but crops susceptible to frost damage in the east and less precipitation and more windy weather in the west [35]. The second risk factor is market risks [36]: In China, with the transition from a planned economy to a socialist market economic system, all production and business activities of farmers are no longer arranged according to government plans and orders but are based on the supply and demand of agricultural products' market and price signals to make decisions. However, many family farms do not belong to production cooperatives or do not have sufficient access to information [37], resulting in incomplete information for farmers and ranchers and in them having to sell their agricultural products at lower prices than they expected, further resulting in poor farm and ranch returns.

5.2. Land Transfer Is Difficult

First, farmers have a strong local sentiment that makes land transfer difficult. Fei Xiaotong [38] once said in his book *China in the Countryside* that people in the countryside are dependent on the soil and that ordinary farmers are reluctant to transfer their land because of their dependence on the land. Second, in the course of the research, almost 100% of the family farms wanted to lease land in concentrated areas, but at present, they need to communicate and coordinate with many farmers involved in land transfer, which takes a lot of manpower and financial resources, resulting in low motivation to transfer land in the mainstream. In addition, 70% of the farmers find it cumbersome to sign a new contract after the expiry of the term. Finally, the contract for the transfer of land is not standardized, resulting in a lot of disputes later, which also greatly reduces the enthusiasm of the farmers to transfer land. Research data also show that most of the farmers in Inner Mongolia do not have a contract or that the contract agreement is not standardized.

5.3. Inadequate Socialized Service System

First, most family farms in Inner Mongolia are disconnected from each other and operate alone in the overall agricultural market [39]. They do not have cooperatives and other social organizations to unite, which leads to a lack of information, science and technology, and other technical services. For most of the family farms, the land operation area is not large, and production materials cannot be purchase in large quantities at preferential rates, resulting in higher costs of production but increasingly lower prices of agricultural products, which leads directly to income loss for the farm owners and a loss of farming incentives. Second, most of the current family farms use a large number of agricultural fertilizers, resulting in high costs, and irregularities in fertilizer use result in low usage and other issues. And due to a lack of modern technology and management techniques for guidance, there is an urgent need to improve the agricultural socialized service system and for farmers and social organizations to perform joint resource sharing.

5.4. Low Overall Quality of Farmers and Lack of Business Management Talents in Family Farms

According to research data, 30% of farmers have less than junior high school education [40]. They have not received higher education and systematic scientific knowledge,

and the overall quality of culture is low, making it difficult to connect with modern agriculture, which is not conducive to the sustainable development of agriculture. Most farmers do not have advanced professional knowledge of production but, rather, plant and farm based on experience, and even if local institutions carry out training for farmers, they simply do not have the time to attend or do not consider it necessary, resulting in a lack of awareness of training and professional skills. In our investigation, we found that almost 100% of the children of farmers have no intention of continuing to work in the farming industry and most of them choose to stay in the cities after graduation, which directly leads to a lack of highly educated management personnel in the countryside; at the same time, due to the difference in development between urban and rural areas and the many development opportunities in the cities, most of the migrant workers choose to work in the cities, resulting in the loss of a large amount of labor in the countryside, which also indirectly leads to a lack of management personnel in the countryside.

5.5. Farmers Have Difficulty in Raising Funds and Obtaining Loans

According to the summary of the survey results, almost all family farms have varying degrees of capital shortages. First, because most of the current channels of raising funds are from private loans, although there are many banks and other financial institutions set up for special funds for family farms, the conditions for loans to farm and ranch operators are set at a high threshold and most family farmers almost difficult to reach. This leads to difficulties in obtaining loans for farms. Second, in recent years, due to various factors, such as epidemics, the price of land rent, agricultural production materials, and oil has risen significantly, which has led to a significant increase in the cost of inputs, such as fertilizers and farm machinery, resulting in increased input costs for family farms. Finally, because the price of agricultural products fluctuates greatly, the farmer's error in judgment leads to higher input costs than profits, due to the large amount of money invested in the former, resulting in no spare funds to support the development of farms.

6. Cultivation Path for the Development of Family Farms

As can be seen from Table 15, the highest score of 755 family farms in Inner Mongolia is only 50.161 and the overall development of family farms is at an average level. So, in order to improve the level of development of family farms in Inner Mongolia as well as to solve the five aforementioned problems, this paper put forward a path of development of family farms in Inner Mongolia.

6.1. Developing Awareness of Risk Prevention among Farmers and Increasing Financial Disaster Relief Funds for Agriculture

First, as family farms are exposed to many risk factors, such as natural risks and market risks [34], farmers need to strengthen their awareness of risk prevention, take precautionary measures in advance, and strengthen the construction of agricultural infrastructure, such as mulching, to prevent frost damage. Farmers should enhance their ability to anticipate risks and deal with emergencies in advance to ensure that losses on their farms are minimized. Second, almost 100% of the farmers in the questionnaire survey said that there is insufficient funding for agricultural disaster relief and that the government should increase funding for agricultural disaster relief and post-disaster reconstruction and, at the same time, make a good natural disaster prediction and monitoring system so that farmers can anticipate natural disasters in advance and take preventive measures.

6.2. Regulating Land Transfer Systems and Developing Active Land Transfer Policies

First, relevant departments should conduct lectures for farmers to popularize the knowledge about land transfer, and strengthen the publicity of the significance of land transfer so that they can understand that land transfer is a way to make full use of land resources to increase production and income, thus dispelling the fear of transferring land. Second, the government should formulate a positive and perfect land transfer policy

and strengthen the supervision in the process of land transfer to prevent irregularities in land transfer. In order to solve the problem of a short land transfer period, relevant policies should be introduced to extend the original period. Third, land transfer contracts should be standardized, and local governments should provide farmers with the necessary information services and relevant legal advisory services [41].

6.3. Accelerating the Construction of Socialized Service Systems

Sound agricultural cooperatives and other social organizations can implement one-stop services for family farms, incorporating measures before, during, and after the farming process. First, an agricultural information network exchange platform should be established so that farmers who are new to the network platform can learn about the agricultural market and the latest policy on agriculture and can also mutually exchange planting tips and experience. For some farmers who have little contact with the internet, the cooperatives can also set up a special agricultural information service center. Second, the role of cooperatives and other social organizations is to unite small farms that operate independently in order to achieve large-scale operation and resource sharing, while multi-family farms can come together to purchase production materials at preferential prices to reduce production costs. Third, to support and encourage the local development of good family farms or leading enterprises to lead the development of neighboring farms, the government should develop a good farm or enterprise to provide appropriate material incentives to stimulate more farms to form a healthy competition [42].

6.4. Multiple Ways to Improve the Overall Quality of Farmers and to Strengthen the Building of Rural Human Resources

First, the government should set up special funds for farmer cultivation, while relevant departments should conduct more training work to improve the knowledge and professional skills of farmers during the agricultural leisure time, and the government and other institutions can conduct regular lectures on law and insurance to diversify the development of farmers [43]. Second, in order to strengthen the construction of a rural talent team, talents and professional technicians should be introduced to drive local farmers to master planting and related technologies. Third, we should continue to improve the system of agricultural science and technology missionaries, regularly conduct training seminars on planting techniques, and actively introduce new technologies to drive the development of neighboring farmers and herdsmen together. Finally, almost 100% of the children of farmers do not want to continue to engage in agriculture and animal husbandry and most of them choose to stay in the cities after graduation, which directly leads to a lack of higher education of management personnel in rural areas, so in order to ensure family farm successors, it is necessary for the local government to formulate preferential policies to attract college students and vocational and technical personnel to return to their hometowns to build [44].

6.5. Establishment of an Efficient Rural Financial System

A rural financial system should be established with an efficient level of development [45]. First, the number of rural financial service institutions should be increased to provide diversified services for farmers' needs, while training the staff to adapt to the construction of an efficient rural financial system. Second, to reduce the guarantee conditions of financial institutions, it is most important to establish a credit system for farmers. Relevant departments should truthfully collect credit information of all local farmers, improve the credit evaluation mechanism of farmers according to indebtedness and repayment ability and other indicators, and actively promote the importance of trustworthiness in order to avoid farmers' breach of trust.

7. Conclusions

7.1. Main Conclusions

This paper took 755 family farms in Inner Mongolia as samples, constructed an evaluation index system for the development of family farms in Inner Mongolia, measured the weights of the indexes through the AHP–entropy weight method, then calculated the scores of the development level of the 755 family farms, and classified the 755 family farms through the K-means method. Finally, based on the results of empirical analysis and research facts, the problems existing in the process of the development of family farms in Inner Mongolia were identified and corresponding countermeasures proposed. The conclusions of this paper are as follows.

In this paper, first, the gray correlation method was used for the first round of indicator screening, 2 unobservable indicators were deleted from 58 indicators, the mean gray correlation of each indicator was set as the boundary, 29 indicators with gray correlation less than the mean were deleted from the remaining 56 indicators in the first round, and 27 indicators were retained in the end. Rank correlation analysis was used for the second round of filtering indicators, only indicators with high gray correlation were retained, and 8 indicators were deleted from the 27 indicators. Finally, the evaluation index system for the development of family farms in Inner Mongolia containing 19 indicators was screened.

Second, this paper measured the indicator weights through a combination of AHP and the entropy weight method. The results were as follows: The weight of the indicator on the rank of the new professional farmer was 0.102, ranking first; the weight of the indicator on whether the children of the person in charge have the intention to engage in farming and animal husbandry was 0.091, ranking second; and the weight of the indicator on the number of basic production facilities and necessary machinery and equipment was 0.088, ranking third.

Third, the weights of the indicator combinations and the indicator data of the past years were linearly weighted to finally obtain the high-quality development score of family farms in Inner Mongolia. A higher rating indicates that the level of development of family farms in Inner Mongolia is high, and a lower rating indicates that the level of development of family farms in Inner Mongolia is low. The highest score for high-quality development of family farms in Inner Mongolia was calculated to be only 50.161. Subsequently, the K-means method was used to categorize the ratings of the 755 family farms into three categories: high level of high-quality development, average level of high-quality development, and poor level of high-quality development.

Based on the aforementioned findings, this paper proposed a development path for family farms in Inner Mongolia. First, regulatory oversight should be strengthened in all aspects of family farms. Second, local governments need to formulate preferential policies to attract college students and vocational and technical talents to return to their hometowns; third, the government should set up special funds for the cultivation of farmers, carry out regular training, and improve the system of agricultural science and technology specialists; fourth, social organizations, such as agricultural cooperatives, should be perfected to provide integrated services for family farms in the prenatal, mid-term, and postnatal stages; and finally, an efficient rural financial system should be established.

7.2. Main Features

One of the features of this paper is that it is based on the theory of development through the gray correlation–rank correlation method to construct an indicator system of two rounds of screening for the development of family farms in Inner Mongolia, which not only ensures that the screened indicators are representative and streamlined but also ensures that the evaluation indicators of development after the quantitative screening have a high degree of substitutability of the original amount of information and are not duplicated by the information.

The second feature of this paper is that the current research of scholars mainly focuses on the scale economy theory and sustainable development theory of family farms, and the

number of studies on the integration of development theory into family farms is low, so this paper intended to further enrich the research theory of family farms by implementing development theory into the research of family farms.

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