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Research Article

Benefit Evaluation of Comprehensive Development of Animal Husbandry in Heilongjiang Province Based on Variation Coefficient Method

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Abstract: Based on the current situation of the development of animal husbandry in Heilongjiang province, the four subsystems for evaluating the comprehensive development level of animal husbandry were determined as the environment and resources subsystem, the economic subsystem, the social subsystem, and the education technology subsystem. The variation coefficient method was used to evaluate the development level of animal husbandry in Heilongjiang province for a total of 13 years from 2005 to 2017. Specific ranking of each subsystem and overall are obtained. The results show that the total benefit has been steadily increasing. The economic subsystem, environment and resource subsystem are significantly related to the education technology subsystem. Except the social subsystem, the other three subsystems are significantly related to the total benefit index, and the correlation coefficient between the special education technology and the total benefit index reaches 0.945. According to the analysis results, several suggestions were proposed from the aspects of developing standardized scale breeding of livestock and poultry, building a modern breeding industry system, and increasing scientific and technological innovation services.

Keywords: Animal husbandry; Variation coefficient method; Comprehensive evaluation.

1. INTRODUCTION

There are rich resources, a vast area and a good environment in Heilongjiang province, which is also a major dairy province in China, in addition to being an important national commodity grain base, thereby, the development of animal husbandry has unique geographical and resource advantages.

The sustainable and healthy development of animal husbandry has made an irreplaceable contribution to accelerating the strategic adjustment of the rural economic structure, meeting the needs of urban and rural markets, improving people's living standards, accelerating the development of industrial integration, and promoting the continued growth of farmers' income.

In recent years, our province has vigorously developed large-scale animal husbandry using the advantages of planting industry resources, and has relied on the advantages of large-scale breeding to promote the production of bio-organic fertilizer, which may promote an ecological cycle with abundant grain, meat and fat being an effective way for sustainable use of resources and sustainable development of agriculture.

However, it can be seen from the literature that there is still a certain gap between the development level of animal husbandry in Heilongjiang province and advanced domestic provinces. In view of the current situation and problems, we need to analyze and evaluate in time, find differences, take measures, optimize development, which play an important role in the development of modern animal husbandry, accelerating the construction of new countryside, and promoting agricultural modernization.

It is necessary to scientifically and rationally determine the evaluation indicators in the comprehensive evaluation of the development level of animal husbandry. The evaluation indicators of animal husbandry development often have the characteristics of multiple indicators and large samples, furthermore, there is still a certain correlation between the indicators,

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which increase the complexity of the evaluation. Based on the principle of operability, comprehensiveness, comparability and scientific, and relative independence between indicators, we will comprehensively evaluate the production of animal husbandry from the aspects of economic, social, ecological and educational technology. Comprehensive evaluation and comparison provide an effective tool and scientific method to quantify, standardize and systematically advance scientific and technological progress and promote sustainable and coordinated development of animal husbandry production.

Based on the actual development of animal husbandry in our province, this study determined four subsystems of the evaluation index system including totally 20 secondary indicators. The variation coefficient method was adopted to evaluate the development level of animal husbandry in Heilongjiang province for a total of 13 years from 2005 to 2017.

2. Construction of Comprehensive Evaluation Index System for Animal Husbandry

According to the research at home and abroad and the regional characteristics and the actual development of animal husbandry of Heilongjiang province, the selection of indicators is determined on the principles of representative, scientific, comprehensive, easy access to indicator data. The indicator system is divided into two levels: the first layer contains four subsystems, namely the economic subsystem, the social subsystem, the environment and resources subsystem, and the education technology subsystem, and the second layer contains 20 secondary indicators shown in Table 1.

Table 1 Comprehensive Evaluation Index System for Animal Husbandry Development

First-level indicators	Second-level indicators	First-level indicators	Second-level indicators
A1 Economic subsystem	B1 Annual Per Capita Net Income of Rural Households (yuan)	A3 Environment and resources subsystem	B11 Water resources per capita（m^2）
	B2 Investment in fixed assets of Animal Husbandry		B12 Emission Volume of Sulphur Dioxide (10000 tons)
	B3 Gross Output Value of Animal Husbandry(10000 yuan)		B13 Consumption of Chemical Fertilizers (10000 tons)
	B4 Large Animal（10000 head）		B14 Consumption of Pesticide (10000 tons)
	B5 Slaughtered Fattened Hogs (10000 heads)		B15 Consumption of Agricultural Films (10000 tons)
	B6 Hogs (10000 heads)		B16 Epidemic surveillance and control system (person)
	B7 Poultry (10000 heads)	A4 Education technology subsystem	B17 Number of secondary title and above of green food processing (10000 persons)
A2 Social subsystem	B8 Number of Affected Households (household)		B18 Average years of education of the workforce (years)
	B9 Meat, Egg and Milk Products Per Capita		B19 Number of employment in urban non-private units at year-end
	B10 Total Sown Areas of Farm Crops (10000 hectares)		B20 Labor Technology Equipment Rate

3. Comprehensive Evaluation of the Development Level of Animal Husbandry Based on the Variation Coefficient Method

3.1 Data Processing

All data are from the《Heilongjiang Statistical Yearbook》 and 《Heilongjiang Rural Statistical Yearbook》 from the year 2006 to 2018, and some of the data used are directly obtained, while some are calculated indirectly.

The formula $b_{ij} = \frac{r_{ij} - r_{min}}{r_{max} - r_{min}}$ was adopted to process the index data, which was listed in Table 1.

Table 2 Standardized data of 20 indexes from year 2005 to 2017

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
B1	0.0000	0.0350	0.0965	0.1731	0.2103	0.3166	0.4627	0.5700	0.6791	0.7658	0.8338	0.9118	1.0000
B2	0.0000	0.0048	0.0230	0.0668	0.1262	0.1225	0.1809	0.2729	0.5348	0.5216	0.5562	0.8117	1.0000
B3	0.0100	0.0000	0.1026	0.2741	0.3097	0.3733	0.6112	0.6863	0.7072	0.7100	0.8512	0.9405	1.0000
B4	1.0000	0.1182	0.1638	0.1538	0.1989	0.2082	0.1680	0.1747	0.0997	0.1230	0.1451	0.0949	0.0000
B5	1.0000	0.2171	0.4908	1.1547	0.0000	0.1230	0.1700	0.3482	0.4260	0.5630	0.4836	0.4578	0.7967
B6	1.0000	0.0000	0.0410	0.2184	0.4030	0.4407	0.4861	0.5469	0.5191	0.5571	0.4779	0.4164	0.4865
B7	0.9557	0.0000	0.1274	0.2108	0.2701	0.3367	0.4979	0.7273	0.6503	0.6328	0.7956	0.9465	1.0000
B8	1.0000	0.6182	0.6548	0.6399	0.6663	0.6497	0.6464	0.6476	0.6555	0.6796	0.0205	0.0233	0.0000

B9	1.0000	0.0000	0.0953	0.1451	0.4197	0.6307	0.6177	0.8295	0.6322	0.8707	0.9855	0.9505	0.9851
B10	0.0000	0.1015	0.2706	0.3044	0.4330	0.5775	0.6921	0.7435	0.8240	0.9054	0.9950	1.0000	0.9824
B11	0.5586	0.5050	0.0569	0.0000	1.0000	0.7388	0.3149	0.7157	0.7722	0.6528	0.6730	0.7347	0.5454
B12	0.3536	0.4133	0.5492	0.5406	0.5326	0.4540	1.0000	0.9667	0.8563	0.7825	0.7127	0.1952	0.0000
B13	0.0000	0.1164	0.2328	0.2857	0.4595	0.6129	0.7423	0.8563	0.9013	0.9674	1.0000	0.9761	0.9607
B14	0.0000	0.1622	0.3243	0.3784	0.5135	0.7027	0.8108	0.8919	1.0000	0.9730	0.9459	0.9459	0.8378
B15	0.0000	0.1250	0.3438	0.4063	0.3750	0.5000	0.7188	1.0000	1.0000	0.9688	0.9375	0.9375	0.8125
B16	0.0000	0.0000	0.0000	0.0000	0.0000	0.5000	0.5000	0.5000	0.5000	1.0000	1.0000	1.0000	1.0000
B17	0.0000	0.0000	0.1667	0.2500	0.3167	0.3667	0.5000	0.5667	0.6667	0.6667	0.6667	1.0000	1.0000
B18	0.5000	0.5833	0.5000	0.5000	0.4583	0.3750	0.3333	0.0000	0.5417	0.6250	0.7083	0.9583	1.0000
B19	0.4705	0.4516	0.4180	0.4238	0.4402	0.4167	0.3858	1.0000	0.5172	0.2028	0.0000	0.0482	0.0813
B20	0.0000	0.0844	0.1489	0.2018	0.2860	0.3740	0.4602	0.5850	0.6588	0.7697	0.8530	0.9237	1.0000

3.2 Variation Coefficient Method

The coefficient of variation method is a relatively common objective weighting method in the field of statistics. It directly uses the information contained in each indicator and calculates the weight of the indicator, for which the basic idea is: in the evaluation of multiple indicators, once the degree of variation in the observed values of all the evaluated objects is large, it indicates that it is more difficult for the index to reach the average level, and it can clearly distinguish the ability of each evaluated object in some respect, therefore, it should be given larger weights, conversely, smaller weights.

The Coefficient Was Calculated By The Formula:

$$v_i = \frac{sd_i}{\bar{x}_i} \quad (\mathrm{i} = 1,2,\cdots,20) \qquad (1)$$

Where, v_i was the *i*th variation coefficient, which was also called coefficient of standard deviation; sd_i and $\bar{x}_i$ were the standard deviation and the average value of the *i*th indicator calculated by the data from year 2005 to 2018, respectively.

The Weights Were Calculated By The Formula:

$$w_i = \frac{v_i}{\sum_{i=1}^{13} v_i} \quad (i = 1,2,\cdots,20) \qquad (2)$$

The calculated standard deviations, mean values, coefficients of variation and weight values of the indicators are shown in the table.

Table 3 standard deviations, mean values, coefficients of variation and weight values of the indicators

Index	sd_i	$\bar{x}_i$	v_i	w_i	Index	sd_i	$\bar{x}_i$	v_i	w_i
B1	0.3510	0.4657	0.7536	0.0559	B11	0.2853	0.5591	0.5103	0.0379
B2	0.3290	0.3247	1.0131	0.0752	B12	0.2947	0.5659	0.5208	0.0387
B3	0.3479	0.5059	0.6877	0.0510	B13	0.3632	0.6240	0.5821	0.0432
B4	0.2452	0.2037	1.2039	0.0894	B14	0.3395	0.6528	0.5201	0.0386
B5	0.3387	0.4793	0.7067	0.0525	B15	0.3517	0.6250	0.5627	0.0418
B6	0.2506	0.4302	0.5824	0.0432	B16	0.4312	0.4615	0.9342	0.0693
B7	0.3361	0.5501	0.6110	0.0454	B17	0.3297	0.4744	0.6950	0.0516
B8	0.3098	0.5309	0.5836	0.0433	B18	0.2577	0.5449	0.4729	0.0351
B9	0.3596	0.6278	0.5728	0.0425	B19	0.2581	0.3735	0.6910	0.0513
B10	0.3497	0.6023	0.5806	0.0431	B20	0.3361	0.4881	0.6886	0.0511

The evaluated scores of the economic subsystem, social subsystem, environment and resource subsystem, and education technology subsystem of animal husbandry development, are calculated by the formula was

$$BI_i = \sum_{j=1}^{13} x_{ij} w_i \quad (i = 1,2,\cdots,20) \qquad (3)$$

$$I_{A1} = \sum_{k=1}^{7} BI_k \ , \ I_{A1} = \sum_{k=8}^{9} BI_k \ , \ I_{A1} = \sum_{k=10}^{15} BI_k \ , \ I_{A1} = \sum_{k=16}^{20} BI_k \qquad (4)$$

BI_i was the benefit index of animal husbandry development, x_{ij} was the standardized values of the *i*th index in the *j*th year, w_i was the *i*th weights values, *n* was the number of indicators per subsystem. By using the formula (3) and (4), we can obtain the trend of the animal husbandry development benefit and rank of the four subsystems listed in the following table :

Table 4 Index of animal husbandry development benefit in Heilongjiang Province from year 2005 to 2017

Index Year	Economic subsystem		Society subsystem		Environment and resources subsystem		Educational Technology subsystem		Overall	
	Index	Ranking	Index	Ranking	Index	Ranking	Index	Ranking	Index	ranking
2005	0.2289	3	0.0858	13	0.0348	13	0.0417	13	0.3912	9
2006	0.0243	13	0.0268	12	0.0560	12	0.0480	12	0.1550	13
2007	0.0603	12	0.0324	11	0.0720	11	0.0552	11	0.2199	12
2008	0.1220	9	0.0339	10	0.0779	10	0.0625	10	0.2963	11
2009	0.0845	11	0.0467	6	0.1325	9	0.0696	9	0.3333	10
2010	0.1054	10	0.0550	4	0.1449	8	0.1072	8	0.4124	8
2011	0.1382	8	0.0543	5	0.1738	6	0.1155	7	0.4817	7
2012	0.1779	7	0.0633	2	0.2097	4	0.1451	6	0.5961	6
2013	0.1975	6	0.0553	3	0.2172	1	0.1483	5	0.6182	5
2014	0.2116	5	0.0665	1	0.2138	3	0.1754	3	0.6673	3
2015	0.2270	4	0.0428	7	0.2148	2	0.1722	4	0.6567	4
2016	0.2535	2	0.0414	9	0.1963	5	0.2042	2	0.6954	2
2017	0.2903	1	0.0419	8	0.1708	7	0.2113	1	0.7143	1
Average	0.1632(0.0807)		0.0497(0.0161)		0.1473(0.0665)		0.1197(0.0607)		0.4798(0.1917)	

3.3 Evaluation of Each Subsystem and Overall

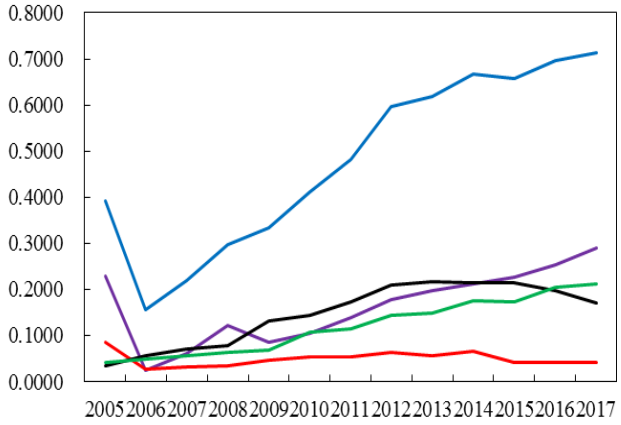

Figure1 Development trend of each subsystem and total benefit

Note: Purple represents the economic subsystem, red represents the social subsystem, black represents the environment and resources subsystem, green represents the education technology subsystem, and blue represents the development trend of total benefits.

From the development trend, it can be seen that the social subsystem has developed more slowly in the past 13 years. The economic subsystem dropped significantly in 2006, and then slowly increased, with occasional fluctuations. The environment and resource subsystem reached the highest in 2012 and 2013. The educational technology subsystem has been rising steadily and slowly, so the overall development trend has been increasing except for the decline in 2006, which reached its maximum in 2017.

Table 5 Pearson Correlation Analysis Results

	A1	A2	A3	A4	Overall
A1	1.000	0.438	0.540	0.770**	0.889**
A2	0.438	1.000	0.147	0.049	0.335
A3	0.540	0.147	1.000	0.865**	0.860**
A4	0.770**	0.049	0.865**	1.000	0.945**
Overall	0.889**	0.335	0.860**	0.945**	1.000

From the results of the Pearson correlation analysis, it can be seen that the economic subsystem, environment and resource subsystem and education technology subsystem are significantly related at the significance level of 0.01, with significant coefficients of 0.770 and 0.865, respectively. The economic subsystem, environment and resources subsystem, and the education technology subsystem are significantly related to the total benefit index, with coefficients of 0.889, 0.860, and 0.945, respectively.

4. DISCUSSION AND CONCLUSION

Heilongjiang Province is one of China's largest animal husbandry provinces. Beef production, milk production and quality enjoy high reputation at home and abroad. Comprehensive, objective, scientific, and easy-to-operate evaluation of animal husbandry benefits plays an important role in improving breeding quality, strengthening industrial management, and then increasing the output and quality of meat and dairy products. This article constructs an evaluation system with 4 first-level indicators and 20 second-level indicators. Using the coefficient of variation method for comprehensive evaluating, the comprehensive ranking

of each subsystem and the development trend of total benefits are obtained. The results show that the total benefit has been steadily increasing. Trends and related analysis were carried out, and it was concluded that the economic subsystem, environment and resource subsystem are significantly related to the education technology subsystem, indicating that the advancement of education technology can significantly accelerate economic development, and better exploit and protect the environment and resources. Except the social subsystem, the other three subsystems are significantly related to the total benefit index, and the correlation coefficient between the education technology and the total benefit index reaches 0.945.

The correlation analysis of the four subsystems has once again verified that science and technology are the first productivity. Promoting the actual transformation of scientific and technological innovation results is an important means to improve the efficiency of dairy farming and increase the contribution of science and technology in the dairy farming process. Suggestions are as follows: first, increase the scientific research and development of dairy farming, improve new breeds, promote new technologies, etc., and improve dairy cows. Second, provide technical training to dairy farm staff, such as studying at advanced domestic and foreign advanced pastures, communicating, on-site observations, and conducting training courses, etc.. The managers of the pasture should strengthen the sense of responsibility, strengthen management, and improve all aspects of production and operation. For example, the feeding link must be as accurate as possible to reduce waste and improve the utilization rate. The breeding link must strengthen the responsibility awareness. The breeding cost link must improve the system and control the cost, conduct regular training work to strengthen the professional quality of technicians and breeders. The state and local governments should provide strong support of scientific and technical personnel and funds needed.

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