Evaluation and Research on the Level of Agricultural Green Development in Heilongjiang Province

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Abstract. This study uses Heilongjiang Province's agricultural green development as its research object. It builds an evaluation index system for agricultural green development and employs the entropy value method to calculate the proportion of each element to assess the province's overall level of agricultural green development based on data from 2011 to 2020. The overall level of green agricultural development in Heilongjiang fluctuated and increased.

Keywords: Green development of agriculture · index system · entropy value method

1 Introduction

In the new era, China has entered a stage of rapid development, and the development of agriculture is particularly rapid. However, the overexploitation and consumption of natural resources and the overuse of pesticides and fertilizers have also brought great harm to the sustainable development of China's agriculture. Faced with the aggravation of environmental pollution and the loss of natural resources, China began to pay attention to the green transformation of agriculture. Scholars at home and abroad discussed the influencing factors of green agricultural development from multiple perspectives. On the one hand, from the economic level, it is found that agricultural industry agglomeration (Xue Lei et al., 2020) [1], international trade (Gai Mei et al., 2022) [2], and human capital level (Liu Y et al., 2023) [3] all have significant positive effects on agricultural green development, on the other hand, from the level of technology and innovation, it is found that the level of information technology (Ogutu S et al., 2014) [4], digital technology (Fan Shengyue et al., 2021) [5], Green innovation (Yang Yang and Li Erling, 2021) [6] can significantly promote the green development of agriculture. Research design.

1.1 Selection of Measurement Methods

The entropy method is employed in this study to thoroughly assess the index system. These are the precise steps:

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(1) The data in the index system comes from different levels, initially normalized to remove the impact of various dimensional notions between indicators, the data is standardized first.

Positive indicators:

$$y_{ij} = \frac{x_{ij} - min(x_{ij})}{max(x_{ij}) - min(x_{ij})}, i = 1, 2, ..., m, j = 1, 2, ..., n \quad (1)$$

Negative indicators:

$$y_{ij} = \frac{max(x_{ij}) - x_{ij}}{max(x_{ij}) - min(x_{ij})}, i = 1, 2, ...m, j = 1, 2, ..., n \quad (2)$$

where x_{ij} represents the ith index value of the jth sample, i represents the province, j represents the indicator, and max and min reflect, respectively, the jth indicator's lowest and highest values.

(2) Use the entropy value method to determine the index weight.

Calculate the weight of the value of the jth programme indicator under indicator i:

$$p_{ij} = \frac{y_{ij}}{\sum_{i=1}^{m} y_{ij}} \quad (3)$$

When p_{ij} equals 0, replace it with 0.000001.

Calculate the entropy value e_j of the jth evaluation index:

$$e_j = -\frac{1}{ln\, m} \sum_{i=1}^{m} p_{ij} ln(p_{ij}), k > 0, 0 \leq e_j \leq 1 \quad (4)$$

Calculate the variance coefficient for each indicator:

$$d_j = 1 - e_j \quad (5)$$

Calculate the weight of the jth evaluation indicator:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j}, j = 1, 2, ..., n \quad (6)$$

(3) Obtain the agricultural green development level's overall score.

$$Z_i = \sum_{j=1}^{m} w_j y_{ij}, j = 1, 2, ..., m \quad (7)$$

1.2 Construction and Weight of Evaluation Index System

This essay assesses the degree of green agricultural growth in four different ways: resources, environment, ecology and economy and society, and determines the weights of each index using the entropy weight method. The specific index system and index weights are detailed in Table 1, and the research data in this paper are mainly derived from the Heilongjiang Statistical Yearbook, China Rural Statistical Yearbook and Heilongjiang Statistical Bulletin.

From Table 1, ecological preservation generally has a bigger influence on agriculture environmentally friendly growth than environmental friendliness, with economic benefits having little to no influence.

Table 1. Weight of evaluation indicators for agricultural green development in Heilongjiang Province

Target layer	Level 1 indicators	First-level metric weights	Secondary indicators	Secondary metric weights
Evaluation index system of agricultural green development in Heilongjiang Province	Resource utilization	0.2017	Cultivated land replanting index	0.0633
			Effective irrigation area	0.0290
			Agricultural machinery efficiency level	0.0363
			Per capita electricity consumption in rural areas	0.0484
			Water consumption per unit of agricultural output value	0.0247
	Environmentally friendly	0.2566	Intensity of pesticide application	0.0792
			intensity of fertilizer application	0.1012
			Strength of agricultural film application	0.0450
				0.0313
	Ecological protection	0.3820	Desertification arable land rate	0.1178
			Forest cover	0.0605
			Soil erosion control area	0.0538

(*continued*)

Table 1. (*continued*)

Target layer	Level 1 indicators	First-level metric weights	Secondary indicators	Secondary metric weights
			Ecological afforestation area	0.0644
			Area of nature reserve	0.0370
			Disaster resilience	0.0485
	Economic benefits	0.1597	Per capita disposable income of rural residents	0.0423
			Grain yield per unit area	0.0236
			the combined worth of forestry, agriculture, animal husbandry, and fishing	0.0287
			Land yield	0.0261
			Agricultural labor production efficiency	0.0390

2 Results and Analysis Thorough Analysis of Heilongjiang PRovince's Agricultural Growth

According to Table 2, Hei-longjiang Province's overall agricultural green development level fluctuated higher from 2011 to 2020, from 0.2241 in 2011 to 0.8673 in 2020, indicating that the agricultural development of Heilongjiang Province gradually became greener during the study period. In addition, the growth rate in 2011–2012 was slower, from 0.2241 to 0.2739, only an increase of 0.0498; from 2012 to 2013, the level of agricultural green development in Heilongjiang Province showed a downward trend under the influence of environmental friendly indicators, and its comprehensive score decreased from 0.2739 to 0.2171; from 2014 to 2020, the level of agricultural green development in Heilongjiang Province showed linear rapid growth, and the comprehensive score increased from 0.2908 to 0.8673.

Table 2. Detailed rating of Heilongjiang Province's level of agricultural green development

	Resource utilization	environmental friendliness	ecological protection	economic benefits	comprehensive evaluation
2011	0.0524	0.0786	0.0932	0.0000	0.2241
2012	0.0699	0.0258	0.1476	0.0306	0.2739
2013	0.0792	0.0291	0.0441	0.0647	0.2171
2014	0.0734	0.0219	0.1126	0.0830	0.2908
2015	0.0690	0.0635	0.1330	0.0897	0.3553
2016	0.0830	0.0479	0.2390	0.0916	0.4615
2017	0.0969	0.0871	0.2844	0.1083	0.5767
2018	0.1725	0.1057	0.2484	0.1227	0.6493
2019	0.1825	0.2393	0.2652	0.1349	0.8218
2020	0.1909	0.2531	0.2687	0.1544	0.8673

3 Conclusions

The assessment index system of agricultural green development was built using Heilongjiang Province data from 2011 to 2020, and the entropy value technique was used to assess the level of agricultural green development in Heilongjiang Province overall., and it was found that the weights of ecological protection, environmental friendliness, resource utilization and economic benefits on agricultural green development were 0.3820, 0.2566, 0.2017 and 0.1597, Heilongjiang's agricultural green development level fluctuated and rose, the growth was slower in 2011–2012, and then grew rapidly, and in 2020, Heilongjiang Province's green development level was the highest, reaching 0.8673, indicating that Heilongjiang Province's agricultural green development has been improved in all aspects, and the level of agricultural green development is in a good state.

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