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Construction of Evaluation Index System of Agricultural Green Development Level in Jilin Province

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Abstract

At present, the rural green development of Jilin Province is faced with serious agricultural pollution, Carbon emissions from agricultural activities and farmers' daily lives increase, h meanwhile low agricultural efficiency. Assessing, evaluating and achieving rural green development in Jilin Province under our pursuit of the "double carbon" goal not only lays a theoretical foundation for sustainable green agriculture in the region, but also steadfastly advances the development of rural initiatives in Jilin Province. Based on the background of "dual carbon", the green development of agriculture in Jilin Province requires not only theoretical basis but also a scientific evaluation system. By combining scientific principles with practical insights, a measurement index model is established and an evaluation indicator system is constructed. Computer statistical software and the SSPS entropy weighting method are employed to objectively assign values to these indicators. This will improve the level of green agricultural development in Jilin Province, and it will also identify constraints. So that the green agricultural development of Jilin Province continues to progress, and conducive to the continuous optimisation of relevant government policies, thereby enabling farmers to improve their production and living conditions.

Keywords: Green agriculture, low-carbon economy, modelling of measurement indicators, evaluation indicator system.

1. Introduction

On the basis of the sixth estimate of the UN Intergovernmental Panel on Climate Change (IPCC), if humanity fails to take immediate measures to achieve net zero emissions of greenhouse gases such as carbon dioxide, global climate change will accelerate further, food security and even human production will then face serious challenges [1]. Therefore, in order to mitigate climate change, China made a solemn commitment to the world in September 2020 to "achieve the goal of carbon peaking by 2030 and carbon neutrality by 2060". Based on the "dual carbon" goals, Jilin Province, as a major agricultural production province in China, is a pioneer in the construction of green agriculture, should actively respond to the national call for energy conservation and carbon reduction, and develop sustainable and green agriculture in Jilin Province. However, over the years, the irrational farming methods and management methods have made the agricultural environmental issues very prominent in Jilin Province. Therefore, in accordance with the specific conditions of Jilin Province, a scientifically formulated measurement index model is established, and an evaluation indicator system is constructed. Additionally, the entropy weight method in computer statistical software such as SPSS is utilized to measure the values of the developed indices. It is of great significance to accurately measure and evaluate the level of green development of agriculture in Jilin Province. By evaluating and measuring the level of agricultural green development, we can discover the factors influencing its green development and propose targeted strategies and recommendations for agricultural green development in Jilin Province.

2. Research on Evaluation Indicator System of Agricultural Green Development at Home and Abroad

On the level of evaluating indicator systems for agricultural green development, foreign scholars have made considerable progress. In the European Community, five indicators are used to measure the overall level of agricultural green development, including land use efficiency, agricultural energy, fertilizer usage, pesticide usage, and per capita arable land, etc [2]. While in the UK, the department for agriculture, forestry and fisheries management used a four-level indicator system, focusing on agricultural output, resource utilization, agricultural funding, and farming management to analyse changing status and actual conditions in agricultural development [3]. In summary, in the study of the evaluation indicator system of agricultural green development, foreign research emphasizes the relationships between indicators, focus on sustainability and ecological needs in indicator selection, and uses models extensively for evaluation and analysis during indicator construction.

In recent years, Chinese scholars have conducted a series of studies in this area. Zhaoliang et al. explored China's agricultural green production efficiency using the DEA model, focusing on factors such as labor quality, per capita GDP, investment in agricultural research, agricultural policies, and pesticide-related incidents [4]. Jiang Qianying et al. utilized the SBM model as a foundation, comprehensively addressed resource utilization and environmental protection, focusing on both original pollution and governance scenarios. They adhered strictly to green development principles and conducted a thorough analysis of China's agricultural green development performance [5]. Ye Lina and Gao Guiying utilized regression analysis to assess the extent of agricultural green development in Ningxia. They developed an evaluation indicator framework centered on living standards, alterations in pertinent environmental factors, and the efficacy of green economics [6]. Zhu Zhichuan and Weng Xinxin enhanced their evaluation of agricultural green development and sustainability by extending beyond the DEA model. They employed the coefficient of variation-G1 weighting technique to determine indicator weights, followed by applying the VRS model for in-depth analysis [7]. Huang Wenshu and Hu Lili conducted comprehensive research and evaluation on China's current total factor productivity in agricultural green development. They utilized the EBM model and Moran’s I index to analyze the impact of various factors thoroughly, employing the SDM model to further investigate these effects. Their study culminated in recommendations based on the research findings [8]. Zhang Jianjie et al.constructed an indicator system for China's agricultural green development based on the agricultural food system. Their approach emphasized scientific guidance and goal attainment, integrating the social, economic, and ecological sectors closely [9]. Gong Qianwen and Li Xuemin developed an agricultural green development index focusing on secure supply, economic growth, and low-carbon production as primary components [10]. In conclusion, domestic research primarily focuses on factors influencing agricultural green development and evaluation methods. These factors typically include living standards, resource environment, economic efficiency, and practices related to green production. Evaluation methods such as the DEA model, SBM model, and regression analysis are commonly employed, expanding the scope of research in this area. This paper will tailor its approach to local conditions, thoroughly assess the situation, and systematically integrate agricultural green development in Jilin Province. It will employ the entropy weight method to construct and implement an evaluation indicator system for assessing the level of agricultural green development in the province. Subsequently, the study will analyze the evaluation results to deduce the factors influencing agricultural green development in Jilin Province. Based on these findings, appropriate policy recommendations will be formulated to promote the green development of agriculture in the region.

3. Current Situation of Agricultural Green Development in Jilin Province

Jilin Province, as a major agricultural province, must prioritize green production practices. In 2015, Jilin Province established a platform for agricultural product quality and safety traceability. The province supports national policies and vigorously develops pilot zones for green agricultural development. And up to now, 6 national-level and 10 provincial-level pilot zones have been identified. In 2023, 16 nationally renowned agricultural brands were from Jilin Province (see Table 1 for details). The market position of Jilin Province's agricultural products in China has been gradually improving, and have a broad mass base. Moreover, the testing pass rate of Jilin's agricultural products is as high as 98.5%, which far exceeds the national standard. The samples of fruits, vegetables and edible mushrooms taken for testing had a pass rate of 99.4%.

Table 1 Nationally renowned agricultural brands from Jilin province

Year:	2023		
1 Yushu Rice	2 Dehui Rice	3 Gongzhuling Fresh Corn	4 Huangsongdian Black Fungus
5 Huadian Yellow Beef	6 Dongliao Black Pig	7 Dongchang Ginseng	8 Tonghua Blueberry
9 Tonghua Rice	10 Ji'an Royal Jelly	11 Ji'an Royal Jelly Powder	12 Jingyu Ginseng
13 Dunhua Ginseng	14 Dunhua Soybean	15 Longjing Apple Pear	16 Fusong Ginseng

3.1 Current situation of green agricultural production

Currently, Jilin Province advocates for green and efficient production models and builds a demonstration area for green agricultural development. In terms of fertilizer and pesticide usage, Jilin Province promotes deep fertiliser application technology, which not only improves the utilisation rate of fertilisers, but also promotes the joint use of organic fertilisers and compound fertilisers and other fertilisers. Compound fertilizers sourced from straw and animal manure to reduce the need for chemical fertilizers; scientific use of pesticides, and more use of new pesticide application machinery to reduce the amount of pesticides, and constantly improve the level of green production. Additionaly, Jilin Province is actively developing green aquaculture bases. Agricultural plastic film pollution in Jilin Province has also been gradually managed to gradually improve the level of green production. In the process of agricultural production in Jilin Province, details of agricultural production materials used are shown in Table 2.

Table 2 Usage of agricultural production materials in Jilin province (Unit: Ten Thousand Tons)

Year:	2021
Agricultural Fertilizers: 223	Pesticides: 4.7
Agricultural Plastic Film: 5.1	Agricultural Diesel: 65.8

Source: China Rural Statistical Yearbook (2022)

3.2 Analysis of agricultural carbon emission sources in Jilin province

As a major agricultural province, Jilin Province carries out a series of agricultural activities during the production process, such as the use of agricultural machinery, fertilizers inputs, pesticide application, and the use of agricultural plastic films [11]. However these activities contribute significantly to the increase in agricultural CO_2 emissions. The concept of low-carbon agriculture involves optimizing and upgrading modern agricultural practices to reduce CO_2 emissions and environmental pollution during agricultural production. This approach aims to achieve high-standard social benefits in agricultural production and promote sustainable practices that conserve resources and protect the environment. As a crucial commodity grain base in China, the development of agriculture in Jilin Province places certain demands on environmental and climate change considerations. Factors influencing carbon emissions in Jilin Province's agriculture mainly stem from fertilizer application, pesticide inputs, agricultural film usage, and agricultural machinery utilization.

4. Construction of Evaluation Indicator System for Agricultural Green Development Level in Jilin Province

To establish a set of evaluation indicator system to measure the agricultural green development level of in Jilin Province, it is essential to first select appropriate evaluation indicators. At the same time, indicators should be selected and constructed in consideration of the characteristics of agricultural development in Jilin Province.

4.1 Principles for constructing evaluation indicator system

When selecting and constructing measurement indicators for the green development level of agriculture in Jilin Province, the following principles should be adhered to:

(1) Principle of scientificity. In developing the evaluation indicator system for agricultural green development in Jilin Province, it is essential to employ scientifically rigorous methods for constructing indicators. Ensuring the

reliability of data sources is paramount, and the calculation formulas and methods must be logically sound and justified.

(2) Principle of operability. Selected indicators should be clear, straightforward, and easily obtainable. It is important to use known data as much as possible for indicator construction, ensuring both the accuracy of data and the feasibility of subsequent research. The data utilized in this paper originate from official publications such as the China Statistical Yearbook and the Jilin Statistical Yearbook.

(3) Principle of representativeness. Measurement indicators should reflect the focus of evaluation subjects, ensuring they are the most representative among numerous indicators. At the same time, selected measurement indicators should also emphasize main factors to demonstrate key aspects of the evaluation content, ensuring the evaluation indicator system is rigorous and scientific.

(4) Principle of conciseness. This paper follows the principle of using simplest and adopting fewer indicators to construct a comprehensive evaluation indicator system for the green development level of agriculture in Jilin Province. This study try to select fewer but representative indicators, aims to achieve a small but precise amount, thoroughly measuring and evaluating the green development level of agriculture in Jilin Province.

4.2 Selection of measurement indicators

The core content of agricultural green development mainly includes two aspects: agricultural production and agricultural living. Therefore, when optimizing the indicator system, important factors from these two aspects are considered [12]. The evaluation of agricultural production development efficiency mainly analyses from the perspectives of input indicators and output indicators. For agricultural living, selected indicators must cover aspects such as farmers' living standards and environmental protection to study these two aspects. Combined with the actual situation of Jilin Province and achievements from previous literature research, input and output indicators are selected for agricultural production; and for agricultural living, indicators such as farmers' living standards and ecological environment are selected, as well as a series of three-level indicators are decomposed from these indicators to construct an evaluation system of indicators for measuring the level of green development of agriculture in Jilin Province. Specific measurement indicators are listed in Table 3.

Table 3 Evaluation Indicator System for Measuring the Level of Agricultural Green Development in Jilin Province

Primary Indicator	Secondary Indicator	Tertiary Indicator	Quaternary Indicator
Green Development Level of Agriculture	Agricultural Production	Input Indicators	Land Input
			Labor Input
			Machinery Input
			Fertilizer Input
			Irrigation Input
		Output Indicators	Agricultural Total Output Value
			Total Carbon Emissions
	Agricultural Life	Living Standards Indicators	Per Capita Net Income of Farmers
			Agricultural Mechanization Rate
			Proportion of Rural Villages Benefiting from Tap Water
		Ecological Environment Indicators	Forest Coverage Rate
			Soil and Water Conservation Measures
			Proportion of Disaster-affected Area to Total Affected Area
			Industrial Wastewater Discharge

4.3 Measurement of indicators

(1) Input indicators. Normally, input factors include land, fertilizers, labor, machinery, irrigation, draft animals, pesticides, agricultural films, and other production materials [13]. In this paper, the input indicator for land is

selected as agricultural planting area; fertilizer input is represented by fertilizer application volume; labor input is measured by the number of employees in agriculture, forestry, animal husbandry, and fishery industries; machinery input is represented by total agricultural machinery power; and irrigation input is measured by effective irrigation area.

(2) Output indicators. Based on previous research findings, this study uses two types of output indicators: expected and non-expected indicators. The expected indicator is agricultural total output value, adjusted to eliminate data distortions caused by price changes. The non-expected indicator is total carbon emissions from agriculture. Quantifying carbon emissions is challenging due to the difficulty in measurement and the complexity involved. Additionally, for the selected representative agricultural production cities and counties within Jilin Province, data on pesticides and agricultural films are missing from statistical yearbooks, and their carbon emissions are much lower compared to fertilizers in agricultural production. Therefore, this study, considering practical constraints, does not calculate carbon emissions from pesticides and agricultural films at this stage. According to the formula provided by Liu Yingyuan and Feng Zhongchao (2014), Equation 1 is used:

$$E = \sum E_i = \sum T_i \times \&_i \quad (1)$$

Where: E represents the total carbon emissions from agricultural production; E_i represents the carbon emissions from various sources; $\&_i$ represents areas related to fertilizers, machinery plowing and irrigation; T_i represents the carbon emission coefficients of various agricultural carbon emissions. Data for $\&_i$ can be obtained from relevant statistical yearbooks in previous years. The emission coefficients of various emission sources are shown in Table 4.

Table 4 Agricultural Carbon Emission Sources, Carbon Emission Coefficients, and References

Carbon Source	Carbon Emission Coefficient	Reference Source
Fertilizer	0.8956 kg·kg^{-1}	T.o.West Oak Ridge National Laboratory, USA
Plowing	312.6 kg·kg^{-2}	College of Biology and Technology, China Agricultural University
Irrigation	25 kg·hm^{-2}	Dubey

(3) Living standard indicators. This indicator mainly reflects the secondary indicators of the green agricultural living standard in Jilin Province, mainly including three four-level indicators of per capita net income of farmers, agricultural mechanization rate, and the proportion of rural villages benefiting from tap water.

(4) Ecological environment indicators. This indicator mainly reflects the secondary indicators of the green agricultural living standard in Jilin Province, mainly including forest coverage rate, soil erosion control, proportion of disaster-affected area to disaster-stricken area, and industrial wastewater emissions. Among these, the forest coverage rate indicator refers to the proportion of forest area to fixed land area, reflecting the regional greening level and actual forest ownership. Generally, the higher the forest coverage rate, the better the ecological environment. The calculation formula for this indicator is shown in Equation 2. The proportion of disaster-affected area to disaster-stricken area indicator mainly reflects the relationship between natural disasters and the resistance of agricultural production and living. The smaller this proportion is, the less impact natural disasters have on agricultural production and living, indicating stronger resistance of agricultural production itself and a better ecological environment. The calculation formula for this indicator is shown in Equation 2.

$$\text{Forest coverage rate} = (\text{Forest area} / \text{Land area}) \times 100\% \quad (2)$$

Proportion of disaster-affected area to disaster-stricken area = (Affected area / Stricken area) × 100% (Equation 2)

4.4 Design of weighting for evaluation indicators of agricultural green development level

Determining indicator weights is crucial in evaluating the level of agricultural green development in Jilin Province, serving as the foundation for the evaluation system. The results of this determination directly influence the fairness

and scientific rigor of the entire assessment process. Various methods exist for determining indicator weights, including expert consultation, the analytic hierarchy process, and the entropy weight method. In contrast to approaches such as expert consultation and the analytic hierarchy process, this study employs the entropy weight method, which provides relatively objective results. The entropy weight method assigns values to indicators based on their information entropy: indicators with lower entropy values exhibit less dispersion and contain more significant information, thus receiving higher weights. Due to space constraints, the specific steps of the entropy weighting method are not detailed here.

5. Evaluation of Agricultural Green Development Level and Analysis of Results in Jilin Province

Relevant data on the measurement indicators of agricultural green development in Jilin Province for the years 2012 to 2021 were collected from multiple sources, including the China Statistical Yearbook, Jilin Statistical Yearbook, and government official websites. The entropy weight method was employed to determine the weights of these measurement indicators (see Table 5), enabling a specific analysis of the level of agricultural green development in Jilin Province.

Firstly, the selected measurement indicators covered extensive content, leading to variations in data. Normalization was therefore necessary to obtain dimensionless data and ensure uniformity across the indicators. Secondly, using the dimensionless data from 2012 to 2021, the entropy weight method was applied to determine the weights for each measurement indicator. Thirdly, leveraging the dimensionless data and their respective weights, indices were computed for each measurement indicator. These indices were then summed to derive the measurement index of agricultural green development in rural areas of Jilin Province from 2012 to 2021. The measurement index of agricultural green development in Jilin Province provides insights into the level of agricultural sustainability. A positive summed index indicates increasing agricultural greenness, with a higher index reflecting a more advanced level of greening. Conversely, a negative summed index suggests insufficient progress in achieving agricultural greening, highlighting the need for continued efforts to promote environmentally friendly agricultural practices and lifestyles.

Based on the dimensionless data and weights assigned to agricultural green development indicators in Jilin Province (see Table 5), the measurement index was computed. Figure 1 illustrates trends from 2012 to 2021, showing an overall upward trajectory in agricultural green development. Despite a decline during 2014-2017, Jilin Province responded vigorously to national initiatives, particularly after China promoted low-carbon agricultural production and set "dual carbon" targets in 2020. The province shifted from traditional to low-carbon, green agricultural practices, intensifying efforts to promote environmentally friendly agriculture, which benefitted many farmers. Figure 1 reveals a significant increase in agricultural green development after 2017, with a notable peak in 2021, indicating substantial progress towards achieving a higher level of greening.

Additionally, from Figure 1, it is clear that the trends in the indices of input level, output level, living standard level, and ecological environment level vary. The input level index generally showed a gradual increase, despite significant declines in 2014-2015, however, its upward trend became more significant after 2017, albeit with a more moderate increase starting from 2019. This suggests that increased input of traditional agricultural production materials in Jilin Province posed certain obstacles to green agricultural production. The output level index followed a trend similar to the input level index, but after 2017, with China's heightened focus on promoting low-carbon, green agriculture, Jilin Province intensified efforts to reduce excessive use of fertilizers, pesticides, and plastic films in agricultural production. Instead, there was a shift towards adopting emerging green environmental technologies for agricultural production, leading to significant environmental benefits in the years following 2017. Figure 1 demonstrates a gradual improvement in the agricultural ecological environment in Jilin Province year by year. With the improvement of agricultural ecological environment in Jilin Province and the benefits derived by farmers from green agricultural production, farmers' incomes have also increased. In recent years, Jilin Province has continuously increased efforts in green agricultural construction, leading to an overall gradual rise in farmers' living standard index, especially evident from 2017 to 2021. This demonstrates that with the continuous advancement of agricultural green development in Jilin Province, farmers' living standards are continually improving.

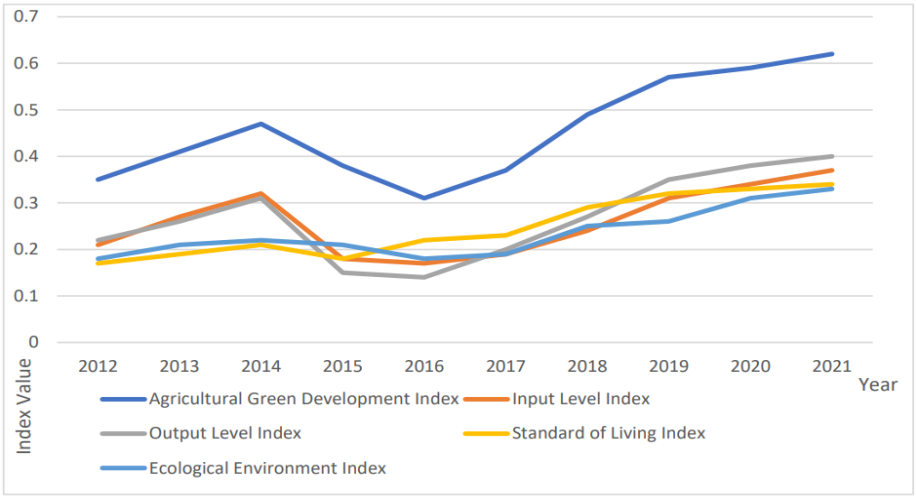

Figure 1 Analysis of agricultural green development index in Jilin province

Table 5 Indicator weights for measuring the level of agricultural green development in Jilin province.

Primary Indicator	Secondary Indicator	Weight of Secondary Indicator (%)	Tertiary Indicator	Weight of Tertiary Indicator (%)	Quaternary Indicator	Weight of Quaternary Indicator (%)
Green Development Level of Agriculture	Agricultural Production	57.55	Input Indicators	33.33	Land Input	7.66
					Labor Input	6.34
					Machinery Input	6.32
					Fertilizer Input	7.57
					Irrigation Input	5.44
			Output Indicators	24.22	Agricultural Total Output Value	10.16
					Total Carbon Emissions	14.06
	Agricultural Life	42.45	Living Standards Indicators	17.23	Per Capita Net Income of Farmers	6.74
					Agricultural Mechanization Rate	5.68
					Proportion of Rural Villages Benefiting from Tap Water	4.81
			Ecological Environment Indicators	25.22	Forest Coverage Rate	7.01
					Soil and Water Conservation Measures	6.05
					Proportion of Disaster-affected Area to Total Affected Area	5.14
					Industrial Wastewater Discharge	7.02

In summary, the improvement of agricultural green development index in Jilin Province reflects to some extent that agricultural production and living are gradually transitioning towards greenization. Despite some indices

showing a downward trend, the overall trend is upward, indicating the gradual manifestation of achievements in agricultural green development in Jilin Province, but further efforts are still needed. Jilin Province is an important grain production base in China, and it must not only provide green and high-quality agricultural products to the people but also create a green production space and high-quality living and ecological environment for farmers within the province, thus requiring vigorous promotion. Although the current level of agricultural green development in Jilin Province is relatively low, the current agricultural development has gradually transitioned from the original traditional and lacking green development to gradual greenization, providing impetus for achieving sustainable agricultural green development in Jilin Province.

6. Recommendations for Optimizing Green Agricultural Development in Jilin Province from the Perspective of "Dual Carbon"

After assessing the current carbon emissions in agricultural production in Jilin Province and identifying challenges in agricultural green development, it is clear that the issue of "high-carbon" agricultural practices persists. This indicates that Jilin Province still needs a considerable amount of time to transition towards low-carbon and green production modes. Therefore, based on research, in order to better promote the development of green agriculture in Jilin Province, efforts should focus on strengthening the following aspects in the future.

6.1 Promoting the scientific development of agricultural production technology in Jilin province

Scientific technology is the guarantee for developing green agriculture. Jilin Province should integrate agricultural resources based on agricultural production big data through a coordinated mechanism of scientific technology and agricultural production. Scientifically manage factors contributing to increased carbon emissions in agricultural production, promote standardized and green production of agricultural products. To improve the adverse effects of these factors on the agricultural environment, it is necessary to introduce scientific technologies and methods to develop high-yield and disease-resistant seeds, fundamentally reducing the input of pesticides, fertilizers, and reducing the increase in carbon emissions during application. Secondly, active research and development of new varieties of pesticides and fertilizers are needed, which not only increase crop yields but also reduce carbon emissions during their application. Lastly, strengthen the input of scientific technologies in agricultural cultivation processes, such as cultivation and irrigation technologies, to not only reduce carbon emissions from diesel used in agriculture but also liberate labor, improve the comprehensive utilization of land, and promote the development of agricultural production towards intensification and efficiency. At the same time, improve the comprehensive utilization of agriculture, such as straw return and water-saving planting technologies, not only alleviate the pressure on the agricultural environment caused by agricultural production but also bring natural organic fertility to the soil, enabling efficient recycling of agricultural resources.

6.2 Promoting the connection between farmers in Jilin province and agricultural production trusteeship

Carbon emissions from agriculture in Jilin Province remain high, and agricultural production trusteeship holds significant potential for reducing these emissions through technology, scalability, and substitution effects. Therefore, there is a critical need to vigorously expand agricultural production trusteeship. This involves increasing incentives for farmers to utilize trusteeship services, particularly by enhancing participation among small-scale farmers. This approach aims to strengthen the connection between farmers and agricultural production trusteeship. Simultaneously, enhancing agricultural production trusteeship services is crucial to further promote the adoption of green practices in agricultural production. This effort should focus on accommodating the diversity among farmers and enhancing their capacity to engage in low-carbon production under the guidance of agricultural production trusteeship. Emphasize support for small farmers, while also considering the trusteeship needs of large-scale farmers. In terms of service, emphasize serving small farmers, provide them with service and policy support, focus on solving the problems of scale production for small farmers, and ensure that small farmers benefit in the end. At the same time, promote the concentration and integration of small farmers' cultivated land, promote scale production, reduce costs, increase land output rate, and save energy consumption. At the same time, consider the trusteeship needs of large agricultural producers, fully respect their trusteeship intentions, actively guide and adjust their trusteeship enthusiasm, and promote moderate-scale agricultural operations.

6.3 Adjusting the financial subsidies for agriculture in Jilin province

Firstly, farmers as the main participants in agricultural activities play a leading role in improving the agricultural production environment. Therefore, agricultural subsidies are directly granted to farmers to support their environmentally friendly agricultural production, significantly driving improvements in the agricultural production environment [14]. Secondly, provide support for agricultural engineering construction through agricultural subsidy policies. From the perspective of protecting the long-term agricultural production environment in Jilin Province, the construction of environmentally friendly agricultural production engineering is also necessary, such as the national returning farmland to forest project and the Northeast protective forest construction project, which play a driving role in improving the agricultural production environment in Jilin Province. And the promotion of clean energy is not to be ignored. At present, there are many clean energy projects involved in the green agricultural production process in Jilin Province, such as biogas projects and geothermal greenhouse planting projects. Therefore, it is also essential to strengthen subsidies for these green agricultural development projects, which help solve the high-carbon issues in traditional agricultural production activities in Jilin Province. Finally, strengthen subsidies for green agricultural production enterprises in Jilin Province, reduce taxes and provide financial support to ensure the smooth operation of these enterprises in low-carbon environments. In order to enable these enterprises to conduct green agricultural production activities, it is necessary to increase research and development funds for green agricultural products, establish special funds, encourage the use of organic fertilizers and pesticides, vigorously promote the advantages of low-carbon and green agricultural products, guide consumers towards low-carbon and green agricultural product consumption, thereby improving the overall production efficiency of green agricultural elements in Jilin Province.

6.4 Strengthening the construction of green agricultural standard system in Jilin province

The construction and improvement of the green agricultural standard system are key to the development of green agriculture. Research has found that to further develop green agriculture, it is necessary to comprehensively strengthen the construction of the standard system, improve the guarantee mechanism for standard implementation, actively refer to relevant standards when formulating policies related to green agriculture. At the same time, create and improve standardized statistical systems, adopt means such as production permits and product traceability to promote standard implementation. Increase supervision of standard implementation, ensure strict implementation of relevant standards through administrative management and law enforcement. Further improve the assessment system for local standards, establish mechanisms for local standard promotion, interpretation, promotion, implementation, and evaluation feedback. Supervise and inspect enterprises producing green products, further strengthen the construction of the standard system for green agricultural products. In addition, establish a sound green agricultural supervision system, which is essential for transforming Jilin Province's agricultural production environment. Mandatory standardization systems can effectively improve the agricultural production environment, reduce agricultural pollutant emissions, thereby reducing carbon emissions from agriculture, and promoting the optimization and upgrading of Jilin Province's agricultural production environment.

7. Conclusion

This paper integrates the specific conditions of Jilin Province, focusing on both agricultural production and rural livelihoods, to construct an evaluation indicator system for assessing the level of agricultural green development. Utilizing the entropy weighting method within computer statistical software SPSS, indicators are weighted accordingly. This comprehensive indicator system enables the measurement and evaluation of the agricultural green development level in Jilin Province based on the values derived from these indicators. The results indicate that the green development index of agriculture in Jilin Province is on the rise, reflecting the progress of agricultural development towards greening. As a major grain-producing province in China, Jilin Province shoulders the important task of grain production and is a national commodity grain base. Jilin Province not only plays a role in providing green, safe, and high-quality agricultural products but also ensures food security. In addition, agricultural economic efficiency, farmers' income, and living standards are all positively correlated with the development of green agriculture: the better the green agricultural development, the higher the agricultural economic efficiency, farmers' income, and living standards, and provide rural residents with a better production

and living environment. At the same time, we should pay more attention to the protection and governance of agricultural ecological environment. Although the green agricultural production in Jilin Province is still in the primary stages, rural lifestyles have not completely shifted towards low-carbon and green modes. However, research shows that agricultural production and life in Jilin Province are gradually moving towards greening. Green development cannot be achieved without joint efforts from all sectors. Only through joint efforts from all parties can we better promote Jilin Province's agriculture towards low-carbon and green development.

Data Availability

Data supporting the findings of this study are available from [THIRD PARTY NAME], but the availability of these data is limited and they are used with permission from the current study and are therefore not publicly available. However, the author may obtain the data upon reasonable request and with the permission of [third party name].

Conflicts of Interest

There is no conflict of interest between the authors of this article. All authors have reviewed the manuscript and approved its submission to your journal. We confirm that the manuscript has not been published before and is not currently under consideration for publication elsewhere.

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