

Measuring And Evaluating The Development Level Of Green Agriculture In China Under The Carbon Peaking And Carbon Neutrality Background

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Abstract. Under the background of "Carbon Dioxide Peaking and Carbon Neutrality", improving the level of green development in agriculture is of great significance for China to achieve the strategic goal of green and sustainable development. Starting from the four dimensions of agricultural inputs, agricultural outputs, agricultural environment and agricultural technology, and combining the factors affecting agricultural carbon emissions and the research results of scholars at home and abroad, the article constructs a system of indicators to measure the level of green development of Chinese agriculture, and evaluates the quality of China's agricultural green development and its evolutionary trend by using the factor analysis method. The results show that: ① Between 2001 and 2021, the level of China's agricultural green development increased by 200%, and the overall trend of steady increase was maintained. ② Agricultural economic development and technological progress have become the main driving force for the current increase in the level of green development of Chinese agriculture, while excessive inputs of agricultural production factors and the increase of greenhouse gases have become the main obstacles to the green development of agriculture. Therefore, based on the current situation of China's agricultural green development level, this paper puts forward suggestions from the three perspectives of the government, universities and farmers to help China's sustainable agricultural development.

Keywords: Agricultural green development; Factor analysis; Dual-carbon background; Level measurement.

1. Introduction

In order to meet the challenges posed by extreme weather on agriculture, low-carbon emission reduction has become a world consensus. With the September 2021 target of "carbon peaking and carbon neutrality", the green transformation of China's agriculture has been further promoted. China has accelerated the research of green and low-carbon technologies, and applied a large number of achievements in agricultural production, and developed various types of agricultural green development, such as smart agriculture and recycling agriculture, taking into account the actual situation of each region. Through the development of various forms of green agricultural development, it is hoped to solve China's long-standing problem of relative shortage of agricultural resources per capita, and to improve the quality of agricultural products and farmers' income. The report of the 20th Party Congress also pointed out that to build a beautiful China and cope with climate change, it is more necessary to realize green and low-carbon development and accelerate the development mode to green transformation. Therefore, through the measurement of the quality of green agricultural development, we can clarify the era of sustainable agricultural development, and help China build itself into an agricultural powerhouse and realize the modernization of agriculture and rural areas.

Scholars at home and abroad have focused on the research of agricultural green development in the aspects of sustainable agricultural development[1], agricultural resource protection[2] [3] and agricultural ecologization[4]. Scholars have put forward a series of views and theories on the concept and connotation of agricultural green development, current predicament and future outlook, and influencing factors. Yin Changbin and other scholars believe that the connotation of China's agricultural green development is to realize the greening of six aspects: agricultural layout, agricultural resource utilization, agricultural production means, agricultural industry links,

agricultural product supply, and agricultural product consumption[5] . A. Hidangmayum and other scholars, based on the positive role of nanobio-technology in environmental protection, believe that the development of green technology can effectively reduce the emission of agricultural pollutants and is the main way for agriculture to realize green development in the future. The development of green technology can effectively reduce the emission of agricultural pollutants and is the main way for agriculture to realize green development in the future. [6]Li Zhou and other scholars suggest that China should adopt effective strategies to achieve sustainable rural development and use this as a basis for coordinating and taking into account other aspects to accelerate the modernization of agriculture and rural areas, with a view to achieving truly green development. [7]Zhang Wenyan and other scholars constructed an indicator system through five aspects, including market factors, agricultural socialization services, production technology, capacity of business subjects and green production benefits, proving that the green development of agriculture is more affected by the subject than by market factors.[8]

To summarize, current research mostly focuses on qualitative studies such as theories, strategic choices, future and outlook, and lacks quantitative studies on the level of China's agricultural green development, especially in the context of dual-carbon. As the largest developing country in the world, China has the problems of shortage of agricultural factor resources and urgent ecological environment protection in the process of agricultural green development. Therefore, on the basis of existing research, this paper adds agricultural greenhouse gases and surface pollution into the index system for estimating the level of green development of Chinese agriculture, tries to use factor analysis to comprehensively examine the level of green development of Chinese agriculture, and bases itself on practice in order to solve the problems of green development of Chinese agriculture and realize the coordinated development of various regions, so as to help China's agriculture to realize the green transformation and achieve the goal of peak carbon and carbon neutrality and the goal of green development. We hope to help China's agriculture realize green transformation and achieve the goal of carbon peak and carbon neutral green development.

2. Analysis of the quality of China's agricultural green developmentSection Headings

2.1 Evaluation system for green development of Chinese agriculture

According to the "14th Five-Year Plan for National Green Agricultural Development" jointly issued by the Ministry of Agriculture and Rural Development and six departments of the National Development and Reform Commission, and taking into account the availability and scientificity of the data, a system of indicators for measuring the level of green development of agriculture in China is established from the perspective of the four dimensions of agricultural inputs, agricultural outputs, the agricultural environment, and agro-technological development. After careful selection, the data for this assessment come from the China Statistical Yearbook, the EPS data platform and Chinese government documents. Through them, a comprehensive and accurate data system was constructed to comprehensively assess the green development level of Chinese agriculture, and the following is the indicator system used (see Table 1 for details).

Table 1. Indicators for measuring the level of greening of agriculture

system level	Level 1 indicators	Secondary indicators	Indicator properties
Agricultural inputs	Natural resource inputs	Land resources X ₁	+
		Water resources X ₂	+
		Energy X ₃	-
	Agricultural input	Agricultural machinery power X ₄	+
		Fertilizer use X ₅	-
		Agricultural film use X ₆	-
		Pesticide use X ₇	-

Agricultural output	Expected outputs	Gross green agricultural output X_8	+
		Agricultural labor productivity X_9	+
		Farmers' income X_{10}	+
	Non-expected outputs	Agricultural GHG emissions X_{11}	-
		Surface source pollution X_{12}	-
Agricultural environment	Ecological factor	Forest cover X_{13}	+
		Effective irrigation coefficient X_{14}	+
		Cropland retention rate X_{15}	+
Agricultural technology	Green technologies in agriculture	Agricultural energy use efficiency X_{16}	+
		Level of agricultural mechanization	+
		X_{17}	+

2.2 Research methodology

In order to solve the problem of the large difference in magnitude between the variables, the article adopts the method of factor analysis. Factor analysis is a statistical technique to avoid the impact of high correlation between indicators on data analysis by eliminating overlapping information between them and extracting common factors from the group of variables.

This paper chooses to use principal component analysis in factor analysis to measure the level of China's agricultural green development, calculates the quality score of China's agricultural green development from 2001 to 2021, and visualizes the trend of China's agricultural green development and the influencing factors hindering its development through the score table.

2.3 Measuring the quality of China's agricultural green development

After the statistical processing of SPSS26, the comprehensive assessment of the quality of agricultural green development of 17 indicators was effectively factor analyzed. After the KMO test, the resulting KMO value was 0.807, which exceeded the threshold of 0.8, while the P value was as low as 0.000, which was lower than the significance of 0.05, indicating that there is a good interaction between the variables, and the factor analysis can be effectively implemented.

According to the requirements of the criteria, the evaluation indicators were subjected to principal component analysis. Criteria with eigenvalue greater than 1 and cumulative variance contribution rate not less than 80% were selected for analysis. After the study, it was found that 2 important parameters could cover 86.428% of the data. It can be concluded that there are differences in the loading coefficients of each variable of the two extracted male factors. The male factor F1 has more information loadings on 11 indicators such as land use for crop cultivation, agricultural energy consumption, power use of agricultural machinery, total value of green agricultural output, agricultural labor productivity, farmers' per capita income, effective irrigation coefficient, agricultural mechanization level, agricultural energy use efficiency, agricultural film use, forest coverage, etc., which are mainly related to the dimensions of agricultural economic development and green production technology Factor. Therefore, F1 is defined as the public factor of agricultural economic development and technological progress. And the male factor F2 has high information loadings on the six indicators of agricultural water consumption, pesticide use, agricultural greenhouse gas emissions, surface source pollution, fertilizer use, and arable land retention rate, which mainly involves the factors of agricultural production factor inputs and environmental protection related dimensions. Therefore, it can be defined as a common factor of agricultural factor input and environmental protection. The quality score of the level of green development of agriculture in China from 2001 to 2021 was further calculated

3. Comprehensive evaluation of China's green agriculture development level

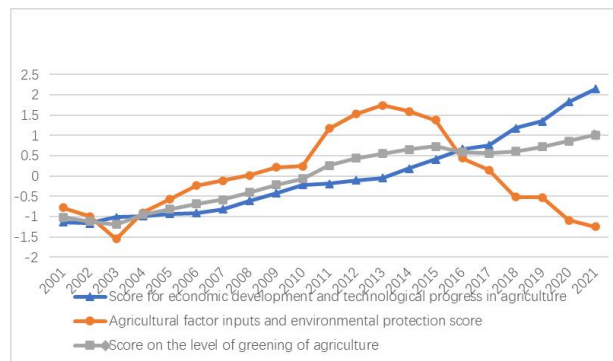


Fig. 1 Trends in the level of greening of Chinese agriculture, 2001-2021

By looking at Figure 1, it can be seen that China's agricultural green development level has shown a continuous upward trend since 2001. Specifically, between 2001 and 2003, China's agricultural green development suffered a serious setback, with the comprehensive score falling from -1.01 to -1.19, a decline of up to 17.8%; between 2004 and 2015, the level of China's agricultural green development developed at a high speed, with an average annual growth amount of 0.154; between 2015 and 2021, the growth rate of China's agricultural green development level slowed down. The average annual growth in this period was only 0.04, of which there was also negative growth in 2017, but the overall trend is slowly rising.

The changes in the growth of China's agricultural green development level scores at different stages are roughly the same as those of China's agricultural economic development and technological progress scores, with an overall upward trend. Since 2001, China's green agriculture has made remarkable progress, including the rising per capita income of farmers, labor productivity in agriculture, and the total value of green agricultural output, which has made a significant contribution to China's green agricultural development. At the same time, the improvement of agricultural production technology in recent years is also an important factor in the level of development of green agriculture. Mechanized production, water-saving appliances and other advances in production technology for China's agricultural green development to provide technical support. In recent years, China is accelerating the construction of green agriculture and low-carbon agriculture, cultivating brands of special agricultural products, helping to revitalize the countryside through the creation of "one village, one product", improving relevant policies and regulations, and advancing the process of modernization of agriculture, so as to improve the quality and efficiency of agricultural development, escort farmers' income, and provide impetus for the development of the countryside.

The curve of China's agricultural green development level score and the curve of agricultural factor input and environmental protection score changed in opposite directions before and after 2014. Between 2001 and 2014, China's agricultural production was mostly intensive, agricultural factor inputs were not too high, and every year China carried out ecological protection by returning farmland to forests and grasslands, which did not bring serious environmental problems, so both of them were on an upward trend. However, over time, from 2014 to the present, due to the long-term use of chemical fertilizers, pesticides and other factors of agricultural production, the existing arable land is facing land degradation problems such as land salinization, land fertility decline. Farmers have increased the use of factors of production such as pesticides and fertilizers in order to increase yields, creating a vicious circle. In addition, the excessive use of agricultural factors also generates a large amount of agricultural surface pollution and releases a large amount of greenhouse gases, posing a challenge to China's carbon neutrality. Therefore, excessive agricultural inputs have become a stumbling block to the green development of Chinese agriculture. However, with the emergence of new technologies such as biocontrol and water-fertilizer integration, the negative impacts of traditional agricultural factor inputs have been mitigated. In order to further promote the sustainable development of agriculture in China, environmentally friendly science and technology

should be vigorously promoted and applied to replace traditional agricultural factors of production such as pesticides and chemical fertilizers, to reduce the irrational consumption of agricultural resources, and to avoid the excessive release of greenhouse gases, with a view to achieving sustainable agricultural development.

4. Summary

4.1 Conclusion

The purpose of this paper is to assess the level of green development of Chinese agriculture through four indicators, namely, agricultural inputs, agricultural outputs, agricultural environment and agricultural technology. Factor analysis is used to objectively assess the quality of China's agricultural green development and provide data support for China to realize sustainable agricultural development. The results of the study show that:

(1) Although the level of green development in China's agriculture has progressed slowly in recent years, it has maintained a steady upward trend overall, providing a good foundation for future development.

(2) Agricultural economic development and technological progress have become the main driving force behind the current increase in the level of green development in Chinese agriculture, while excessive inputs of agricultural production factors and the increase in greenhouse gases have become the main obstacles to green development in agriculture.

4.2 Recommendations

As history progresses and society develops, China's agricultural development has entered a new period. In order to establish an environmentally friendly society and resource-saving agriculture, promote the green transformation of agricultural development, raise the level of green agricultural development, and guide and promote the coordinated development of agricultural development and ecological environment improvement, the following suggestions are made:

(1) The government increases financial support for agriculture and encourages the innovation and promotion of green technology; improves regulations related to the green development of agriculture and restricts agriculture to excessive inputs of production factors; and publicizes the concept of green development and strengthens the awareness of environmental protection for the main body of production.

(2) Colleges and universities will strengthen cooperation with agricultural enterprises, farmers, farms and other agricultural subjects, focusing on the joint efforts of industry, academia and research enterprises to improve the efficiency of agricultural green technology transformation.

(3) Farmers should establish the concept of high-quality development of agriculture, cultivate brand awareness of agricultural products, strengthen technological learning, reduce inputs of agricultural production factors, vigorously develop low-carbon agriculture, eco-agriculture, and digital agriculture, improve the efficiency of agricultural resource use, and reduce agricultural carbon emissions.

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