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Research on the Coupling between the Development Level and Efficiency of Green Agriculture in China

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ABSTRACT

Accurately measuring the green development status of China's agriculture is of great significance for promoting the transformation of agricultural development modes, promoting green agricultural development models, and forming a sustainable modern agricultural production system. The purpose of this study is to provide scientific reference and practical guidance for the implementation of China's agricultural modernization and sustainable development strategy through in-depth analysis of the coupling between the development level of green agriculture in China and production efficiency. It has important theoretical and practical value for promoting the construction of agricultural ecological civilization. This article first analyzes the current situation and development efficiency of green agriculture in China. Then, the coupling between the development level and efficiency of green agriculture in China was analyzed. Finally, propose countermeasures and suggestions.

KEYWORDS

Green agriculture; Development efficiency; Coupling

1. INTRODUCTION

In recent years, traditional agricultural production models have led to a series of problems. The agricultural production system that relies on petroleum products has a negative impact on ecological security, threatening the sustainable development of society, economy, and environment. Therefore, building a resource-saving, environmentally friendly, and product rich agricultural production system to achieve sustainable agricultural development has become a world consensus, which coincides with the concept of modern agricultural production centered on "green agriculture". Agricultural productivity is one of the core issues in the development of agricultural economy. The key to measuring agricultural green productivity is to achieve the optimal solution between improving agricultural production efficiency and environmental friendliness. At the same time, green agricultural production methods will bring green agricultural development models, and promoting agricultural green development is an inevitable requirement for modern agricultural production to advocate energy conservation, protect and improve the agricultural ecological environment. Therefore, accurately measuring the green development status of China's agriculture is of great significance for promoting the transformation of agricultural development modes, promoting green agricultural development models, and forming a sustainable modern agricultural production system.

This study aims to explore the coupling between the development level of green agriculture and production efficiency in China, and provide theoretical basis and practical guidance for promoting sustainable agricultural development in China through scientific evaluation and analysis of the

relationship between the two. The purpose of this study is to provide scientific reference and practical guidance for the implementation of China's agricultural modernization and sustainable development strategy through in-depth analysis of the coupling between the development level of green agriculture in China and production efficiency. It has important theoretical and practical value for promoting the construction of agricultural ecological civilization.

2. LITERATURE REVIEW

Research institutions and experts in the field of agriculture at home and abroad have conducted practical analysis on the level of green development in agriculture. Koohafkan et al. (2012) [1] developed threshold standards to analyze the global level of green agriculture development. Bergius et al. (2016) [2] analyzed the modernization of agriculture in Tanzania, Africa from the perspectives of government and investors. Coast et al. (2017) [3] analyzed the development of ecological agriculture in Brazil from the perspective of public policy formulation. Compared to the earlier research and practice of agricultural green development theory in foreign countries, the evaluation research on the level of agricultural green development in China is in full swing. The 2020 China Agricultural Green Development Report, published in 2021, has important reference value for understanding the achievements of China's agricultural green development in the new era. The academic community conducts a comprehensive evaluation of the level of agricultural green development by constructing an indicator system, and further empirically examines its regional differences. Firstly, most scholars have constructed an evaluation index system from different dimensions to coordinate the relationship between agricultural development and green development. The four-dimensional indicator system constructed by Wei Qi et al. (2018) [12] has been favored by other scholars [5], including resource conservation, environmental friendliness, ecological conservation, and quality efficiency, and has gradually become a reference model for the academic community to build an agricultural green development indicator system [6-11]. A few scholars have introduced agricultural technology dimensions [13-14] on this basis. Other scholars, considering different research backgrounds, have constructed an agricultural green development indicator system tailored to local conditions. Based on rural revitalization, Zhou Li (2019) constructed an indicator system from three dimensions: agricultural efficiency, ecological conservation, and urban-rural integration; Gong Qianwen and Li Xuemin (2020) [16] constructed an indicator system based on the background of low-carbon agricultural production from three dimensions: low-carbon production, economic income increase, and safe supply. Zhang Jianjie et al. (2020) [17] constructed an indicator system around social, economic, and ecological dimensions based on agriculture and the entire food system. Secondly, in terms of measurement methods, the entropy weighting method is commonly used to calculate weights and gradually weight and merge indicators [5-6,9-10]. Some scholars have also used subjective weighting methods [12], combination weighting methods [7, 14], DPSIR model [18], analytic hierarchy process [15-16], and so on. Thirdly, existing research has focused on comparing the level of agricultural green development at the national [12, 14], provincial [15, 19-20], county [17] and other administrative regions, as well as specific functional areas such as the three major economic belts [18], the Yellow River Basin [9], the Yangtze River Basin Economic Belt [10-11], and the main grain producing areas [6]. It has been found that the spatial imbalance of agricultural green development is significant. The spatial differences and sources of further green development in agriculture have attracted the attention of some scholars. Jin Saimei (2019) [18], Zhou Xiahe and Li Xinxin (2021) [10], He Ke et al. (2021) [11] introduced the Theil index to analyze the spatial heterogeneity of agricultural green development levels in their selected regions. The results showed that, nationwide, the differences in agricultural green development levels between provinces are continuously expanding, with intra regional differences>inter regional differences having an impact on overall differences; For a certain province, the regional differences in the level of agricultural green development in Shandong Province are the main source of overall differences; As for a certain

functional area, the gap in the level of agricultural green development in the Yangtze River Economic Belt is constantly narrowing.

3. CURRENT SITUATION ANALYSIS

3.1. Current Situation Of Agricultural Development

At present, China's agriculture has entered a new stage of development, and the problem of the quantity of agricultural products has been basically solved. Adjusting the structure , Improving agricultural efficiency, increasing farmers' income, and improving the ecological environment have become important tasks for the development of agriculture and rural economy in the new stage. The next 5-10 years will be a crucial period for China's social and economic development, laying the foundation for the future. Whether China's economic structure can be smoothly adjusted and whether the national economy can develop faster and better largely depends on whether the agricultural foundation is stable. Only by strengthening the foundation of agriculture, Ensuring the supply of agricultural products is essential for the smooth promotion of industrialization and urbanization; Only by strengthening the agricultural foundation and relying on technological progress to expand rural markets can we support the rapid growth of the national economy and maintain social stability and sustainable development. The new stage of development of China's agriculture and rural economy has the following eight characteristics: firstly, the increasing correlation between agriculture and rural economy and the world economy; The second is that the relationship between agriculture, rural economy, and national economy is becoming increasingly close in terms of mutual promotion and common development; Thirdly, the constraints on agricultural development have shifted from resource constraints to resource, demand, and environmental constraints; Fourthly, the degree of specialization in agriculture and rural economy has increased, and the pace of integrated management has accelerated. The trend of mixed economy has emerged; The fifth is that technological progress has become the main driving force for the development of agriculture and rural economy; The sixth is the strengthening of financial constraints on the development of agriculture and rural economy; The seventh stage of agricultural development has shifted from simply pursuing yield to actively promoting agricultural industrialization and management, and vigorously developing industries and products with high commodity rates, high added value, and high exchange rates; The increase in farmers' income has shifted from mainly relying on the increase in agricultural product output and price to adjusting the structure and developing diversified businesses according to the market, especially the development of non-agricultural industries, which will become an important source of income growth for farmers. Overall, after entering the new century, Chinese agriculture will face the following opportunities: the sustained and healthy development of the national economy has created an increasingly relaxed environment for agricultural development, and agriculture is about to enter a new stage of equal development with industry; The increasingly strong demand in the agricultural product market brings broad development prospects to agriculture; After joining the WTO, it will be beneficial for agriculture to introduce foreign funds and advanced technologies on a broader scale, and to utilize domestic and foreign production factors to improve the level of agricultural modernization equipment and management; Beneficial for accelerating the transformation of traditional agriculture in China to modern agriculture, comprehensively improving the quality of agricultural products and the economic benefits of agriculture; The new agricultural technological revolution will provide strong technological support for agricultural development.

3.2. Current Situation Of Agricultural Production Efficiency

If analyzed based on the four major regional divisions, the Tobit model will be used to analyze the influencing factors of agricultural green production efficiency. The conclusion is as follows: Firstly, the development of inter provincial agricultural green production efficiency is relatively stable, and there are significant inter provincial differences. But over time, the gap has slightly narrowed;

Secondly, the agricultural green production efficiency values of the eastern and northeastern provinces are much higher than those of the central and western provinces, with the western region slightly higher than the central region; Thirdly, further analysis of the natural, technological, and social factors that affect the efficiency of agricultural green production reveals that agricultural water consumption, financial allocation for agricultural research, urbanization rate, agricultural ecological compensation policies, and labor quality all have a significant positive impact on the efficiency of agricultural green production. The affected area of crops and the intensity of agricultural machinery investment will inhibit the improvement of agricultural green production efficiency; Fourthly, after controlling for differences in socio-economic development levels between provinces, the proxy variables of social factors still have a significant positive impact on agricultural green production efficiency; In the proxy variable of natural factors, agricultural water consumption still plays a promoting role, while the affected area of crops plays a restraining role; In the proxy variable of technological factors, agricultural research financial allocation still plays a promoting role, while agricultural machinery investment intensity plays a restraining role.

4. COUPLING EFFECT ANALYSIS

There is a significant spatial correlation in the high-quality development of inter provincial agriculture in China. Based on existing research, this article introduces a spatial econometric model to examine seven influencing factors of high-quality agricultural development:

1) Urbanization. The improvement of urbanization level is a necessary path for China's high-quality development and an important support for breaking the shackles of urban-rural duality. With the rapid advancement of urbanization in China, urbanization provides markets, technologies, and funds for high-quality agricultural development, and creates objective conditions for agricultural transformation. Therefore, the level of urbanization will inevitably have an impact on the high-quality development of agriculture. Specifically, urbanization rate (URBR) can be selected as a substitute indicator for urbanization level.

2) Economic development. The level of economic development is closely related to the development of green agriculture. With the growth of the economy, people's demand for safe, high-quality, and sustainable agricultural products has increased. Economic development provides market demand and investment opportunities for green agriculture, promoting the transformation of agricultural production towards a green and sustainable direction. Meanwhile, green agriculture can also provide new growth points and employment opportunities for economic development. The higher the level of regional economic development, the more advanced resources will gather here, providing advanced production technology and a broad consumer market for the high-quality development of agriculture. Specifically, per capita GDP (PGDP) can be selected as an alternative indicator of economic development level.

3) Information communication. Information communication is one of the key factors in the development of green agriculture. Effective information communication can promote agricultural technology innovation and knowledge transfer, and enhance the technical level and awareness of farmers. Through information communication, farmers can obtain information on best agricultural practices, market demands, and policy support, thereby better implementing green agricultural production methods. The cost of information communication in new economic geography is considered an important factor affecting industrial spatial agglomeration. Developed network information technology can accelerate the transmission of agricultural information, reduce communication costs, and promote high-quality development of agriculture. Specifically, the per capita postal and telecommunications business volume (PTB) can be selected as an alternative indicator for information communication.

4) Financial investment. Financial investment is an important guarantee for the development of green agriculture. Green agriculture requires financial support to promote technological research and development, facility construction, and improvement of agricultural production. The investment of government, agricultural enterprises, and financial institutions can promote the promotion and application of green agricultural technologies, improve agricultural ecological and economic benefits. A large amount of capital investment can provide sufficient financial support for conducting agricultural technology research, purchasing agricultural machinery and equipment, and cultivating agricultural technology talents, promoting high-quality development of agriculture. Specifically, rural per capita fixed assets investment (FAI) can be selected as the alternative indicator of capital investment.

5) Energy consumption intensity. The development of green agriculture requires reducing energy consumption intensity and improving resource utilization efficiency. Reducing energy consumption in agricultural production processes is crucial for environmental protection and sustainable development. By adopting energy-saving technologies and renewable energy, reducing energy consumption in agricultural production, sustainable development of green agriculture can be achieved. Energy can provide development impetus for high-quality agriculture, but it may also cause pollution to the high-quality development of agriculture. Therefore, energy consumption is bound to have an impact on the high-quality development of agriculture. Specifically, per capita energy consumption (EC) can be selected as a substitute indicator for energy consumption intensity.

6) Social consumption. The transformation of social consumption concepts has a positive impact on the development of green agriculture. With the increasing awareness of food safety and environmental protection, the demand for green agricultural products is constantly increasing. The shift in the direction of social consumption can motivate farmers to adopt green agricultural production methods, promote structural reform of the agricultural supply side, and improve the quality and safety of agricultural products. The upgrading of consumption structure will promote the optimization and adjustment of industrial structure, and regional differences in consumption levels will lead to differences in the demand structure of agricultural products. This puts higher requirements on strengthening characteristic agricultural products, innovating modern sales channels, and accelerating the transformation and adjustment of agriculture. Specifically, the per capita retail sales of consumer goods (SC) can be selected to reflect the level of social consumption.

7) Advanced industrial structure. The upgrading of industrial structure is a key link in the development of green agriculture. By adjusting and upgrading the agricultural industrial structure, the development of green agriculture can be promoted. Develop modern agriculture, agricultural product processing industry, and agricultural service industry, improve agricultural added value and market competitiveness, and promote the ecological, branding, and diversified development of agriculture. The upgrading of regional industrial structure will provide production and processing technology support for high-quality agricultural development, and promote the optimization and upgrading of the agricultural industry. Specifically, the proportion of output value of the secondary and tertiary industries (IS) can be selected as an alternative indicator for upgrading the industrial structure.

5. CONCLUSIONS AND SUGGESTIONS

5.1. Conclusions

This study conducted an in-depth analysis of the coupling between the development level of green agriculture and production efficiency in China, revealing a significant positive relationship between the two. Research has shown that the development of green agriculture can not only enhance the environmental friendliness and sustainability of agricultural production, but also effectively improve agricultural production efficiency. Specifically, the evaluation index system for the development

level of green agriculture constructed in this article and the measurement methods used provide a scientific basis for accurately evaluating the development status of green agriculture.

Empirical research has found a significant positive correlation between the development of green agriculture and agricultural production efficiency. This discovery confirms the important role of green agriculture in improving agricultural production efficiency and indicates that promoting the development of green agriculture is an effective way to achieve sustainable agricultural development. In addition, the study also identified key factors that affect production efficiency, including technological innovation, resource allocation efficiency, and policy support, providing specific operational paths for improving agricultural production efficiency.

In the coupling analysis, this study used various statistical methods and models, such as Data Envelopment Analysis (DEA) and Panel Regression Analysis, to comprehensively explore the inherent relationship between the development level of green agriculture and production efficiency. The results show that with the improvement of the development level of green agriculture, production efficiency has also been significantly improved, indicating that in the current process of agricultural development, green agriculture has become an important force in promoting the improvement of production efficiency [14].

Finally, based on the research findings, this article proposes a series of targeted policy recommendations. These suggestions aim to further promote the development of green agriculture, optimize resource allocation, strengthen scientific and technological innovation and policy support, in order to achieve the continuous improvement of agricultural production efficiency and the goal of sustainable agricultural development. The implementation of these policy measures can provide strong support for the transformation and upgrading of agriculture and the construction of ecological civilization in China.

In summary, this study fully confirms the close coupling relationship between the development level of green agriculture and production efficiency, and provides theoretical basis and practical guidance on how to promote the improvement of production efficiency by improving the development level of green agriculture. Future research can further deepen the coupling mechanism between green agriculture and production efficiency, explore more effective ways to improve agricultural production efficiency, and contribute wisdom and strength to the sustainable development of agriculture in China and even globally.

5.2. Suggestions

Based on the above research analysis, the following suggestions are proposed: firstly, actively promote the agricultural green production system. The government should implement strict water resource utilization systems, strictly control the process of drought to water conversion, and reduce the unreasonable irrigation area in areas with water resource overload. Farmers should actively choose to plant water-saving and fertilizer saving crops, steadily expand the scale of agricultural operations in accordance with relevant systems, and optimize the layout of green production of agricultural products. At the same time, the government should regularly organize agricultural practitioners to learn about agricultural green production knowledge, improve environmental protection awareness, and reduce the area of agricultural planting affected by disasters. The management can increase efforts to transform green standardized production according to agricultural green production standards, and alleviate the contradiction between agricultural production and the ecological environment; The second is to accelerate the optimization of green agricultural production technologies. The government should increase financial allocation for agricultural research and encourage relevant research institutions or enterprises to develop low pollution agricultural production technologies. Regional governments can regularly hold agricultural green production technology exchange meetings to share the latest scientific research achievements and discuss the problems encountered in the research and development process. Accelerate the update of agricultural

green production technology through the above channels, reduce the pollutant emissions from agricultural machinery and equipment, fertilization and other planting processes, and practice the concept of green water and green mountains development. At the same time, the government needs to assign technical commissioners to conduct on-site inspections of the agricultural environment and select appropriate agricultural green production technologies for cultivation. In addition to selecting agricultural green production technologies according to local conditions, technical specialists also need to explain the usage methods and precautions to farmers, and promptly answer their questions when using new technologies. Village cadres should organize personnel to learn the usage methods of new agricultural green production technologies and the development concept of green mountains and clear waters as soon as possible, accelerate the promotion speed of new technologies, and reduce environmental pollution caused by the use of mechanical equipment; The third is to accelerate the construction of agricultural infrastructure. The government should further improve agricultural green production infrastructure from the perspective of social factors, narrow the gap between provinces in terms of urbanization rate, implementation of agricultural ecological compensation policies, and comprehensive quality of agricultural practitioners, thereby improving the efficiency of agricultural green production. In terms of urbanization rate, local governments should accelerate the promotion of urbanization construction, guide agricultural workers to move to urban areas for living, and reduce the consumption of agricultural resources. In terms of implementing agricultural ecological compensation policies, the government can introduce differentiated compensation policies and formulate corresponding supporting implementation measures to improve the accuracy of policy implementation. To encourage the improvement of green agricultural production methods for rural residents, increase grain yield, ensure food security, gradually form a large-scale production and operation form, improve resource utilization efficiency, and reduce environmental pollution. In terms of the comprehensive quality of agricultural practitioners, the government should strengthen basic education, elevate the comprehensive quality of agricultural practitioners, ensure the rapid promotion and implementation of agricultural green production concepts, policies, and technologies, and achieve sustainable development of agriculture.

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