Agricultural & Forestry Economics and Management (2025)
Clausius Scientific Press, Canada

DOI: 10.23977/agrfem.2025.080112
ISSN 2616-2202 Vol. 8 Num. 1

Research on the High-Quality Development of China's Agricultural Product Exports

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Keywords: High-Quality Development, Agricultural Efficiency, Sustainable Agricultural Development

Abstract: Based on the provincial panel data from 2010 to 2023, this study uses the entropy method to construct an evaluation index system and measures and analyzes the high-quality development level of agricultural product exports in various provinces of China from three dimensions: agricultural increment, agricultural efficiency, and sustainable agricultural development. The research finds that there are significant regional differences in the high-quality development of China's agricultural product exports. The eastern coastal provinces have prominent advantages, while the central and western regions lag behind in development. The development stability varies from province to province. Some provinces maintain stable growth, while others experience significant fluctuations. Key indicators such as the stable supply of grain, the total power of agricultural machinery, and the income level of farmers have a significant impact on the development level. To this end, the article puts forward targeted policy suggestions such as promoting coordinated regional development, enhancing development stability, and improving the level of key indicators, aiming to promote the high-quality development of China's agricultural product exports.

1. Introduction

With the in-depth development of global economic integration and trade liberalization, agricultural product exports play a significant role in the development of China's agricultural economy[1]. Under the new development pattern, promoting high-quality development of agricultural product exports is of great significance for enhancing China's international competitiveness in agriculture, increasing farmers' income, and ensuring national food security[2]. However, at present, China's agricultural product exports still face problems such as increasing trade barriers, low added value of products, and unbalanced regional development[3]. Based on this, this paper uses provincial panel data and the entropy method to construct an evaluation index system to quantitatively analyze the level of high-quality development of China's agricultural product exports, with the aim of providing references for relevant policy-making[4].

2. The current situation of China's agricultural product export trade

2.1. The Scale of China's Agricultural Product Export Trade

In terms of trade scale, from 2017 to 2023, the trade volume of China's agricultural product exports gradually increased to 98.93 billion US dollars in 2023, and the total trade volume of agricultural product exports also developed to 333.03 billion US dollars. It can be seen that China's agricultural products have certain development potential and market share in the international market.

From the perspective of product structure, the export performance of different types of agricultural products varies. Vegetable, exports performed particularly well, reaching 18.54 billion US dollars in 2023, representing a year-on-year growth of 8.4%. The export value of fruits reached 7.06 billion US dollars in 2023, increasing by 2.2% year-on-year. However, at the same time, the import value was also on the rise, and the trade deficit expanded somewhat. The trade deficit of livestock products and aquatic products is relatively obvious[5].

2.2. The market structure of China's agricultural product export trade

In 2023, our trading partners have covered 226 countries and regions. Exports to the Belt and Road countries accounted for 35% in 2023, an increase of nearly 7% compared with 2013. Among them, exports to ASEAN grew particularly significantly, with an average annual growth rate of 12% since 2003.China's agricultural product exports to Asian countries and regions account for approximately 67%. The export value of agricultural products to EU countries was 11.19 billion US dollars, and the export value of agricultural products to African countries was 4.03 billion US dollars, accounting for 11.3% and 4.1% of China's total agricultural product exports respectively.

2.3. The trade mode of China's agricultural product exports

The main trade mode for China's agricultural product exports is general trade. In 2020, the export value of China's agricultural products through general trade was 64.3 billion US dollars, accounting for approximately 85% of the total agricultural product exports. The second largest trade mode for China's agricultural product exports is processing trade, accounting for approximately 11% of the total agricultural product export trade. Border small-scale trade, barter trade and other trade account for a very small share.

3. Empirical analysis

3.1. Data sources and measurement methods

The data in this article are all from the "China Statistical Yearbook" and the "China Agricultural Statistical Yearbook" from 2010 to 2023, and the entropy weight method is adopted to determine the weights of the evaluation indicators. This study involves a large number of evaluation indicators. Due to the differences in dimensions, orders of magnitude and units of the indicators, comprehensive calculation cannot be carried out directly. In order to eliminate the differences among different evaluation indicators, it is necessary to standardize the original indicators by using the range standardization formula.

(1) The positive indicators are handled as follows:

$$x'_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(Xij)}$$

The negative indicators are handled as follows:

$$x'_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(Xij)}$$

Here, "i" represents the province and "j" represents the selected indicator.

(2) Calculate the proportion of the value of the i-th indicator under the JTH item:

$$p_{ij} = \frac{x'_{ij}}{\sum_{i=1}^{m} x'_{ij}(x'_{ij} > 0)}$$

Among them, m represents the number of provinces.

(3) Calculate the entropy value of the JTH index:

$$e_j = -k\sum_{i=1}^{n} p_{ij}\ln(p_{ij}),\ j = 1,...,m$$

$$k = \frac{1}{\ln(m)}$$

Among them, k is the adjustment coefficient, , e_j is the information entropy value, $0 \leq e_j \leq 1$.

(4) Calculate the redundancy (difference) of information entropy:

$$e_j = 1 - e_j,\ j = 1,...,m$$

Among them, the greater the difference, the smaller the entropy value, and the greater the influence on the evaluated object.

(5) Calculate the comprehensive score of each sample:

$$s_i = \sum_{j=1}^{m} w_j x_{ij}, i = 1,...,n$$

3.2. Indicator selection

The high-quality development of agricultural product exports encompasses multiple aspects. This article measures the impact on the high-quality development of China's agricultural product exports based on the various aspects involved in the high-quality development of agricultural product exports, including multiple dimensions such as agricultural increment, agricultural efficiency, and sustainable agricultural development. This study combines the evaluation index system for high-quality agricultural development proposed by domestic and foreign experts and scholars. It divides the evaluation index system for high-quality agricultural development from three first-level indicators, namely agricultural increment, agricultural efficiency and sustainable agricultural development, into 14 second-level indicators, to comprehensively measure the status of high-quality agricultural development. The specific indicators and measured weights are described in the following table 1:

Table 1: Evaluation index system for high-quality development of agricultural product exports

First-level indicator	Secondary indicators	Indicator measurement method	Influence direction	Weight
Agricultural increment	Stable supply of grain	Grain output / Grain sown area	Positive	0.293
	Per capita grain output	Direct data	Positive	0.098
Agricultural efficiency	Total power of agricultural machinery	Direct data	Positive	0.104
	Labor productivity	The total output value of agriculture,	Positive	0.059

		forestry, animal husbandry and fishery / The number of employees in the primary industry		
	The scale of agricultural land management	Sown area of crops / The number of employees in the primary industry	Positive	0.043
	Diversification index of the planting industry	Grain sown area / Sown area of crops	Positive	0.038
	Industrial structure index	Total agricultural output value / The total output value of agriculture, forestry, animal husbandry and fishery	Positive	0.024
	The income level of farmers	Per capita disposable income of rural residents	Positive	0.061
Sustainable agricultural development	Fertilizer usage amount	Agricultural fertilizer quantity / Agricultural added value	Negative	0.089
	Agricultural fuel consumption	The usage of agricultural diesel / Agricultural added value	Negative	0.099
	The water-saving irrigation rate in farmland	Effective irrigated area of farmland / The total sown area of crops	Positive	0.061
	Fertilizer application intensity	Fertilizer usage amount / The total sown area of crops	Negative	0.017
	Pesticide application intensity	Pesticide usage amount / The total sown area of crops	Negative	0.007
	The strength of agricultural film usage	The usage of agricultural films / The total sown area of crops	Negative	0.009

3.3. Measurement results and analysis

3.3.1. Measurement result

The high-quality development level of agricultural product exports in 30 provinces of China was calculated by combining the entropy weight method with the data of various indicators. The calculated values of high-quality development of agricultural product exports are shown in the table 2 below.

Table 2: The result of the entropy method

Province /Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Anhui	0.21	0.21	0.22	0.23	0.24	0.24	0.24	0.24	0.24	0.25	0.27	0.27	0.28	0.28
Beijing	0.12	0.13	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.19	0.19	0.19	0.19	0.15
Fujian	0.16	0.17	0.17	0.18	0.19	0.19	0.20	0.20	0.20	0.21	0.23	0.23	0.23	0.24
Gansu	0.12	0.12	0.13	0.13	0.14	0.14	0.13	0.13	0.13	0.14	0.14	0.15	0.15	0.16
Guangdong	0.17	0.18	0.18	0.18	0.19	0.20	0.20	0.20	0.21	0.21	0.22	0.22	0.23	0.24
Guangxi	0.16	0.17	0.18	0.18	0.19	0.19	0.19	0.19	0.20	0.20	0.21	0.21	0.21	0.22
Guizhou	0.11	0.11	0.12	0.12	0.13	0.13	0.13	0.14	0.14	0.15	0.16	0.16	0.16	0.16
Hainan	0.11	0.21	0.30	0.35	0.21	0.23	0.29	0.28	0.15	0.15	0.15	0.16	0.17	0.17
Hebei	0.32	0.33	0.34	0.35	0.34	0.35	0.30	0.30	0.30	0.30	0.29	0.29	0.30	0.30
Henan	0.29	0.31	0.32	0.32	0.33	0.33	0.32	0.33	0.33	0.33	0.34	0.34	0.34	0.34
Heilongjiang	0.24	0.26	0.28	0.29	0.30	0.31	0.32	0.32	0.34	0.35	0.36	0.38	0.38	0.39
Hubei	0.18	0.20	0.22	0.23	0.22	0.23	0.23	0.23	0.23	0.23	0.24	0.25	0.25	0.26
Hunan	0.18	0.20	0.21	0.22	0.21	0.22	0.22	0.22	0.22	0.23	0.25	0.26	0.26	0.27
Ji Lin	0.17	0.20	0.21	0.22	0.22	0.23	0.24	0.23	0.23	0.25	0.25	0.26	0.26	0.27
Jiangsu	0.22	0.23	0.25	0.25	0.25	0.26	0.27	0.27	0.27	0.28	0.29	0.29	0.30	0.30
Jiangxi	0.17	0.19	0.20	0.19	0.18	0.19	0.19	0.20	0.20	0.20	0.21	0.22	0.23	0.22
Liaoning	0.16	0.18	0.20	0.20	0.19	0.19	0.19	0.19	0.18	0.19	0.19	0.20	0.20	0.21
Inner Mongolia	0.19	0.21	0.22	0.23	0.23	0.24	0.25	0.25	0.26	0.27	0.28	0.30	0.30	0.32

Ningxia	0.12	0.17	0.21	0.24	0.17	0.18	0.20	0.20	0.16	0.16	0.18	0.18	0.18	0.19
Qinghai	0.12	0.26	0.37	0.40	0.22	0.23	0.27	0.26	0.13	0.14	0.15	0.15	0.15	0.16
Shandong	0.32	0.33	0.33	0.33	0.34	0.34	0.32	0.32	0.32	0.32	0.32	0.33	0.33	0.34
Shanxi	0.12	0.13	0.13	0.14	0.14	0.14	0.13	0.13	0.13	0.14	0.15	0.15	0.15	0.16
Shaanxi	0.14	0.15	0.15	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.18	0.18	0.18	0.18
Shanghai	0.15	0.15	0.14	0.15	0.15	0.15	0.16	0.17	0.18	0.18	0.20	0.20	0.21	0.22
Sichuan	0.16	0.17	0.18	0.18	0.19	0.19	0.19	0.19	0.20	0.20	0.21	0.21	0.21	0.22
Tianjin	0.13	0.14	0.14	0.14	0.14	0.15	0.15	0.16	0.16	0.17	0.18	0.19	0.19	0.20
Yunnan	0.15	0.16	0.17	0.17	0.18	0.18	0.18	0.19	0.16	0.17	0.18	0.18	0.18	0.18
Zhejiang	0.22	0.23	0.24	0.24	0.25	0.25	0.26	0.26	0.27	0.28	0.30	0.29	0.30	0.31
Chongqing	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.14	0.14	0.15	0.16	0.16	0.16	0.17

3.3.2. Analysis of Measurement Results

According to the results, there are significant differences in the development of various regions. The eastern coastal provinces have prominent advantages, such as Shandong, Jiangsu, Zhejiang and other places. In 2023, Shandong's measurement score reached 0.34, while Jiangsu and Zhejiang also achieved 0.30 and 0.31 respectively. These provinces have developed economies, large investments in science and technology, and well-developed transportation and logistics networks, reducing the transportation costs of agricultural products. The open market environment enables it to adjust the export structure in a timely manner. However, the development of the central and western regions lags behind. In 2023, the measurement scores of Gansu and Guizhou were only 0.16. Economic constraints have led to insufficient investment in agricultural infrastructure, less investment in science and technology, backward production technology, inconvenient transportation which has increased transportation costs, and insufficient ability to explore the international market.

The development trends of each province also vary. Stable growth cities represented by Heilongjiang, Inner Mongolia and Jilin have been growing steadily since 2010. These provinces are rich in cultivated land resources. They have continuously increased investment in agricultural mechanization, which has improved the efficiency of agricultural production. Meanwhile, emphasis has been placed on agricultural scientific and technological innovation, and the quality supervision of agricultural products has been strengthened, which has enhanced the quality and added value of agricultural products. Actively explore the international market and actively cooperate with other countries to promote the high-quality development of agricultural product exports.

There are also some provinces with fluctuating development: for example, Hainan scored 0.11 in 2010, rose to 0.35 in 2013 and then dropped. Agriculture in Hainan mainly consists of tropical agricultural products, with a relatively single industrial structure. Natural disasters have led to unstable output. Market demand fluctuates greatly, and prices are significantly influenced by seasons and the relationship between supply and demand. In addition, the agricultural industrial chain is relatively short, mainly focusing on the export of primary products with low added value.

Finally, based on the weight analysis of each indicator, it was found that some indicators had a significant influence. Among them, the stable supply of grain played a key role, and the indicator weight was 0.293. Secondly, the weight of the total power of agricultural machinery is 0.104, and its increase is conducive to improving agricultural production efficiency. Also, the weight of farmers' income level is 0.061. Higher farmers' income can enhance farmers' enthusiasm.

4. Research conclusions and countermeasure suggestions

4.1. Research conclusion

4.1.1. The imbalance in regional development has intensified

There is a significant regional imbalance in the high-quality development of China's agricultural

product exports. Relying on economic, technological, transportation and market advantages, the eastern coastal provinces have obvious advantages in terms of export scale, structural optimization, quality upgrading and innovative development. Due to economic lag, weak infrastructure, insufficient investment in science and technology and limited market development capabilities, the gap between the central and western regions and the eastern regions has continued to widen, and the imbalance in regional development has intensified.

4.1.2. The differences in development stability are obvious

There are significant differences in the stability of high-quality development of agricultural product exports among various provinces. Some provinces have achieved stable growth through continuous policy support, industrial upgrading and technological innovation, such as Heilongjiang. However, in some provinces, due to reasons such as a single industrial structure and significant influence from natural and market factors, the development fluctuates greatly, such as Hainan. This difference in stability not only affects the sustainability of agricultural product exports, but also reflects the different capabilities of various regions to deal with risks and challenges.

4.1.3. Key indicators restrict the level of development

Key indicators such as stable grain supply, total power of agricultural machinery, and farmers' income levels play a crucial role in the high-quality development of agricultural product exports. The differences in these indicators directly lead to the varying competitiveness of agricultural product exports among provinces, and further affect the overall level of high-quality development of agricultural product exports. Provinces that perform well in key indicators have a relatively high level of high-quality development in agricultural product exports. Conversely, the development will be relatively lagging behind.

4.2. Countermeasures and suggestions

4.2.1. Promote coordinated regional development

All provinces should enhance regional cooperation and industrial transfer, and establish a long-term mechanism for agricultural cooperation between the eastern coastal provinces and the central and western regions. They should encourage agricultural enterprises in the east to invest in the central and western regions, and export advanced production technologies, management experiences and market channels. Through industrial transfer, they should promote the upgrading of agriculture in the central and western regions and achieve complementary advantages. The government should increase policy support and infrastructure construction, strengthen policy support for agriculture in the central and western regions, and increase financial input to improve agricultural infrastructure. On the one hand, they should repair farmland water conservancy facilities and build modern storage facilities to reduce the loss of agricultural products. On the other hand, they should strengthen transportation construction, improve the accessibility of rural roads and optimize transportation conditions.

4.2.2. Enhance the stability of development

Provinces with large fluctuations in development should establish an agricultural risk management system, strengthen meteorological monitoring and disaster early warning, and make early preparations for disaster prevention and mitigation to reduce losses from natural disasters. They should also establish a market risk early warning mechanism for agricultural products, track

market supply and demand and price dynamics in real time, and guide farmers and enterprises to scientifically plan production and sales. Secondly, these provinces with large fluctuations should promote the transformation and upgrading of the agricultural industrial structure and reduce the dependence on a single agricultural product. Take Hainan as an example. While Hainan stabilizes traditional industries such as tropical fruits and rubber, it also expands diversified industries such as flowers and characteristic breeding. Vigorously develop deep processing of agricultural products, extend the industrial chain, increase product added value, and enhance international market competitiveness and risk resistance.

4.2.3. Improve the level of key indicators

All provinces must strictly enforce the farmland protection system to ensure the quantity and quality of farmland. They should increase investment in science and technology to cultivate new varieties. Provinces should promote advanced planting technologies, such as precision agriculture, to enhance the per-unit yield and quality of grain. They should also strengthen the construction of grain storage and logistics facilities to ensure a stable supply of grain. The government should continuously increase support for agricultural mechanization, raise subsidies for the purchase of agricultural machinery, and expand the scope and standards of subsidies. The government should encourage agricultural machinery enterprises to develop new types of agricultural machinery and improve the intelligence and automation levels of agricultural machinery. It should also strengthen the construction of agricultural machinery service systems, train professional agricultural machinery operators and maintenance personnel, and improve the utilization efficiency and maintenance level of agricultural machinery. To increase farmers' income, it is necessary to improve the formation mechanism of agricultural product prices, strengthen the supervision of the agricultural product market, prevent significant price fluctuations, and ensure reasonable income for farmers. Promote new business forms such as rural tourism and rural e-commerce in rural areas to broaden farmers' income channels. Enhance farmers' employment and entrepreneurship capabilities to increase their wage income. At the same time, improve the rural social security system and reduce the burden on farmers.

5. Conclusion

Based on the provincial panel data from 2010 to 2023, this study uses the entropy method to measure the high-quality development level of China's agricultural product exports from the dimensions of agricultural increment, efficiency and sustainable development. It is found that there are significant regional differences in the high-quality development of China's agricultural product exports. The eastern coastal provinces perform outstandingly with advantages such as economy, science and technology, transportation and market. The central and western regions lag behind in development due to economic backwardness, weak infrastructure, insufficient investment in science and technology, and limited market development capabilities. Moreover, the development stability varies among provinces. Some provinces maintain stable growth while others experience significant fluctuations. Meanwhile, key indicators such as stable grain supply, total power of agricultural machinery, and farmers' income levels have a significant impact on the development level. Based on this, countermeasures and suggestions such as promoting coordinated regional development, enhancing development stability, and improving the level of key indicators are put forward to promote the high-quality development of China's agricultural product exports.

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