

Evaluation and Measurement of the High-Quality Development Level of Agriculture in Shangqiu City

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Abstract: Shangqiu City, located in the eastern part of Henan Province, serves as one of the granaries in eastern Henan and has entered a crucial stage in implementing the rural revitalization strategy. High-quality agricultural development is a vital measure to promote rural revitalization, making the development of high-quality agriculture in Shangqiu City of great importance. Based on an analysis of the current state of agricultural development in Shangqiu City, this paper establishes an indicator system by collecting data from 2015 to 2024, measuring the level of high-quality agricultural development from three aspects: agricultural production, economic benefits, and ecological environment. The entropy method is employed to measure and analyze the impact of data on high-quality agricultural development in Shangqiu City. The results indicate an upward trend in the comprehensive score of high-quality agricultural development in Shangqiu City from 2015 to 2024. To promote high-quality agricultural development, Shangqiu City should focus on improving infrastructure, fostering agricultural innovation, and achieving sustainable agricultural development, thereby realizing the goal of high-quality agricultural development through relevant pathways.

Keywords: Shangqiu City; High-quality development; Entropy method

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1. Introduction and literature review

The concept of high-quality development was first proposed in the report of the 19th National Congress of the Communist Party of China, marking a shift in production across various social sectors from quantity to quality. The report of the 20th National Congress reiterated the importance of high-quality development and identified it as the primary task in building China into an agricultural powerhouse. Promoting high-quality agricultural development is essential for following the path of agricultural strength. At the Central Rural Work Conference in 2020, the President of the CPC has repeatedly emphasized the importance of food security and stable food supply, highlighting the need to leverage existing resources to meet the demands of

economic development and the people's need for food, thereby ensuring social stability. By pursuing a path of high-quality agricultural development, enhancing both the yield and quality of grain, and ensuring a stable food supply, we can address the primary challenges facing agricultural development at this stage^[1]. The 2023 Central Document No. 1 underscores the importance of strengthening agricultural development through various means, including grain production, the construction of high-quality farmland, increased investment in scientific and technological innovation, and the implementation of smart agriculture. It also emphasizes the need to consider ecological environmental construction and pursue a path of sustainable agricultural development^[2].

Currently, domestic research on the level of high-quality agricultural development encompasses several aspects. From the perspective of the connotation of high-quality agricultural development, Han Changfu breaks it down into the provision of high-quality products, favorable economic benefits, high production efficiency, excellent operator quality, strong international competitiveness of products, and high incomes for farmers^[3]. Zhang Junkuo and others argue that the core of high-quality development is to meet the people's ever-growing needs for a better life, characterized by high product efficiency, fairness in handling affairs, and sustainable development of green agriculture^[4]. In terms of the evaluation dimensions of high-quality agricultural development, Ma Ru and others construct an evaluation index system from five major dimensions: high-quality supply, high-quality market demand, development efficiency, economic operation, and openness to the outside world^[5]. Wang Xiaohong and others use four dimensions—the degree of green development, the degree of agricultural modernization, industrial stability, and agricultural economic efficiency—as indicators to evaluate the level of high-quality agricultural development^[6]. Regarding the path to improving high-quality agricultural development, Gao Qiang proposes four key measures: innovating production methods, optimizing production structures, strengthening supervision and management, and creating characteristic industries^[7]. Pan Yaru and others believe that increasing investment in infrastructure can significantly enhance high-quality economic development, with varying effects depending on the type of infrastructure investment^[8].

China has a large population, and the stability of food supply is a primary concern for people's livelihoods. Shangqiu City, as one of China's leading agricultural cities, shoulders the responsibility of providing grain production security for the country. Due to its plain topography, favorable geographical environment, land resources, and sunlight conditions, Shangqiu City provides a solid foundation for agricultural development. Over the past seven years (2018–2024), the grain sowing area in Shangqiu City has exceeded 1,400 thousand hectares, with a total grain output of over 7 million tons, ranking third in Henan Province in terms of grain production. In 2024, Shangqiu City's total agricultural output value reached 69.835 billion yuan, ranking fourth in Henan Province and occupying a leading position in the province. The crop sowing area in Shangqiu City has remained above 1,400 thousand hectares over the past seven years (2018–2024), effectively ensuring food supply and food security. This paper starts from the current agricultural situation in Shangqiu City, constructs an index system, analyzes existing problems, and thereby identifies the path to achieving high-quality agricultural development in Shangqiu City.

2. Research methodology

2.1. Construction of the evaluation index system

This paper draws on references and combines the actual situation of agricultural development in Shangqiu

City to construct an evaluation index system for high-quality agricultural development based on the principles of scientificity, comparability, data availability, and comprehensiveness ^[9–12]. The system encompasses three dimensions: agricultural production, economic benefits, and ecological environment (**Table 1**).

Table 1. Evaluation index system for high-quality agricultural development

Primary indicator	Secondary indicator	Indicator calculation method	Attribute
Agricultural production	Irrigated area of cultivated land	- thousand hectares	+
	Agricultural mechanization	Total power of agricultural machinery / Sown area of crops	+
	Expenditure on agriculture forestry and water affairs	Expenditure on agriculture forestry and water affairs / General public budget expenditure	+
	Rate of agricultural employment	Number of employees in primary industry / Total number of rural employees	+
Economic benefit	Labor productivity	Gross product of primary industry / Number of employees in primary industry	+
	Level of industrial coordination	Gross product of primary industry / Gross regional product	+
	Land output rate	Total agricultural output value / Sown area of crops	+
	Grain yield per unit sown area	Grain output / Grain sown area	+
Ecological environment	Pesticide usage	Pesticide usage / Sown area of crops	-
	Fertilizer usage	Amount of pure chemical fertilizer applied / Sown area of crops	-
	Plastic film usage intensity	Amount of agricultural plastic film used / Sown area of crops	-

Note: For positive indicators, a higher value is better; for negative indicators, a lower value is better.

2.2. Framework of the evaluation index system for high-quality agricultural development

The agricultural production indicators encompass three aspects: irrigated farmland area, agricultural mechanization, and expenditures on agriculture, forestry, and water affairs. The economic benefit indicators include five aspects: the ratio of agricultural industry personnel, labor productivity, industrial coordination level, land productivity, and grain yield per unit of sown area. The ecological environment indicators cover three aspects: the intensity of pesticide use, the intensity of fertilizer use, and the intensity of plastic film use.

2.3. Data sources

The data and information are sourced from the “Shangqiu Statistical Yearbook” and the “Henan Statistical Yearbook,” with data sampling spanning from 2015 to 2024. The sampled data is complete without any omissions.

2.4. Data processing

This paper employs the entropy method to measure the level of high-quality agricultural development, with the specific steps outlined as follows:

Step 1: Data Standardization

Select m evaluation years and n indicators, where the j -th ($j=1,2,\dots,n$) indicator in the i -th ($i=1,2,\dots,m$) year is denoted.

The selected indicators are classified into two types: positive and negative.

To ensure the accuracy of data evaluation, standardization processing is required.

Positive indicators: $X'_{ij} = \frac{X_{ij} - \min(X_{ij})}{\max(X_{ij}) - \min(X_{ij})}$

Negative indicators: $X'_{ij} = \frac{\max(X_{ij}) - X_{ij}}{\max(X_{ij}) - \min(X_{ij})}$

In the formula, X_{ij} respectively represents the initial value and the standardized value of the j -th ($j=1,2,\dots,n$) indicator in the i ($i=1,2,\dots,m$) year; $\max(X_{ij})$ and $\min(X_{ij})$ represent the maximum and minimum values of the j -th indicator, respectively.

Step 2: Non-negative Transformation

To avoid calculation errors caused by zero values in entropy calculation, the standardized data undergoes non-negative transformation, adopting the method of shifting the entire dataset rightward by 0.0001.

$$Y_{ij} = X'_{ij} + 0.0001$$

Step 3. Dimensionless processing

$$P_{ij} = \frac{Y_{ij}}{\sum_{i=1}^m Y_{ij}}$$

Step 4: Calculate the information entropy.

$$E = \sum_{j=1}^n P_{ij} \ln P_{ij} \left(k = \frac{1}{\ln m} > 0, E_j \geq 0 \right)$$

Step 5: Calculate the information utility value.

$$D_j = 1 - E_j$$

Step 6: Calculate the weights of each indicator.

$$W_j = \frac{D_j}{\sum_{j=1}^n D_j}$$

Step 7: Calculate the comprehensive score.

$$S_i = \sum_{j=1}^n W_j P_{ij}$$

3. Results and analysis

3.1. Weights of each indicator for high-quality agricultural development

As shown in **Tables 2** and **3**, the weights of the three primary indicators, ranked from highest to lowest, are economic benefit, agricultural production, and ecological environment. Economic benefit and ecological environment have experienced rapid growth, serving as significant driving forces behind the high-quality agricultural development in Shangqiu City. In contrast, agricultural production has shown the slowest growth. Economic benefit increased from 0.1408 in 2015 to 0.3008, while ecological environment rose from 0.4489 in 2015 to 0.8116 in 2024. Agricultural production, however, saw a slight decrease from 0.2480 to 0.1854 by

2014.

From **Figure 1**, it can be observed that the ecological environment has experienced the fastest growth overall, followed by agricultural production, while economic benefit has shown steady growth with minor fluctuations. The comprehensive evaluation score increased from 0.8376 in 2015 to 1.2979 in 2024, indicating an overall upward trend in the high-quality agricultural development in Shangqiu City. The difference between the scores in 2017 (0.2761) and 2024 (1.2979) is 1.0218, demonstrating a significant improvement in the level of high-quality agricultural development during this period.

Table 2. Weights of the evaluation indicator system for high-quality agricultural development

Primary Indicator	Secondary Indicator	Weight	Weight Rank
Agricultural production 0.3437	Cultivated irrigated area	0.0931	5
	Agricultural mechanization	0.2109	1
	Expenditure on agriculture, forestry and water affairs	0.0397	11
Economic benefit 0.4575	Employment rate of agricultural practitioners	0.1057	4
	Labor productivity	0.1266	2
	Industrial coordination level	0.0538	9
	Land productivity	0.1195	3
	Grain yield per unit sown area	0.0519	10
Ecological environment 0.2005	Pesticide application intensity	0.0756	6
	Fertilizer application intensity	0.0695	7
	Plastic film use intensity	0.0554	8

Note: The data have been rounded to four decimal places.

Table 3. Measurement results of each dimension of high-quality agricultural development from 2015 to 2024

Year	Agricultural production	Economic benefit	Production environment	Comprehensive score
2015	0.2480	0.1408	0.4489	0.8376
2016	0.0183	0.0953	0.1354	0.2490
2017	0.0400	0.0758	0.1603	0.2761
2018	0.0548	0.0337	0.1741	0.2626
2019	0.0638	0.0946	0.3171	0.4755
2020	0.1161	0.2745	0.5899	0.9805
2021	0.1169	0.2876	0.6548	1.0594
2022	0.1169	0.4081	0.7943	1.3193
2023	0.1179	0.3485	0.7793	1.2457
2024	0.1854	0.3008	0.8116	1.2979

Note: The data has been rounded to four decimal places.

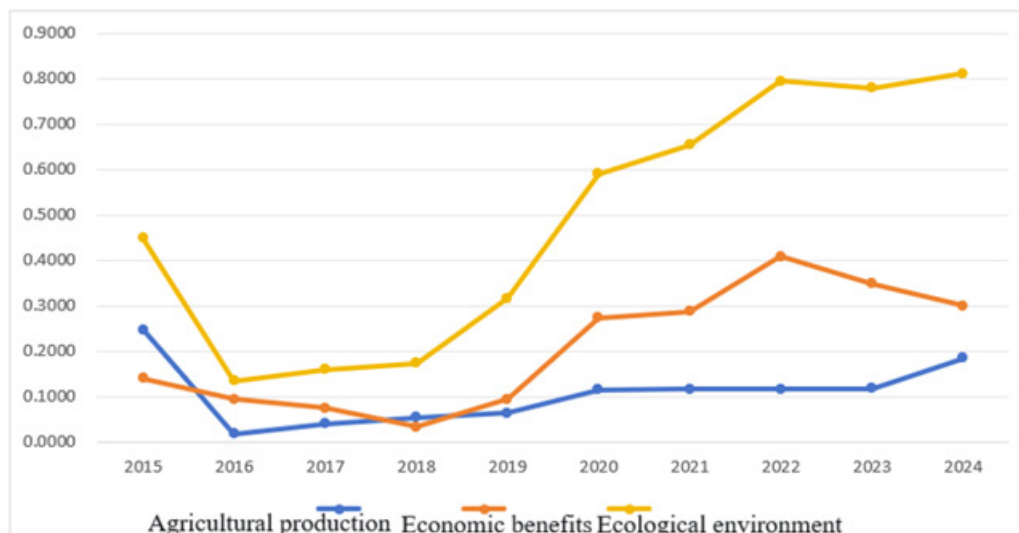


Figure 1. Changes in the comprehensive evaluation index for each dimension of high-quality agricultural development from 2015 to 2024

4. Conclusions and recommendations

To measure high-quality agricultural development in Shangqiu City, this paper constructed an indicator system consisting of 11 indicators across three dimensions and used the entropy method to calculate weights and comprehensive scores. The research findings are as follows: (1) The weights of the three dimensions of high-quality agricultural development in Shangqiu City, ranked from highest to lowest, are economic benefit, agricultural production, and ecological environment. Among the secondary indicators, agricultural mechanization, labor productivity, land output rate, and agricultural employment rate rank in the top four; the use of pesticides, fertilizers, and plastic film intensity occupy the middle values, highlighting the need to recognize their significant impact on high-quality agricultural development and actively implement measures to improve them. (2) The comprehensive level of high-quality agricultural development in Shangqiu City, ranked from highest to lowest, is ecological environment, economic benefit, and agricultural production. The use of pesticides and fertilizers has a significant impact on the ecological environment, while agricultural mechanization contributes the most to agricultural production, and labor productivity has the greatest impact on economic benefit.

4.1. Limit the use of pesticides and fertilizers

Shangqiu City is an important grain-producing city in Henan Province, with its main grain-producing areas investing heavily in production factors such as pesticides, fertilizers, and water. However, these inputs have not yet met the needs of high-quality agricultural development in Shangqiu City. Due to the lack of emphasis on protecting the ecological environment and the efficiency of land recycling during production, Shangqiu City faces ecological issues such as declining farmland quality and water pollution, increasing the difficulty of environmental governance and requiring improved governance effectiveness. Therefore, to accelerate the achievement of high-quality agricultural development in Shangqiu City, addressing resource and environmental issues is one of the urgent challenges the city must overcome. Various regions in Shangqiu

City should actively promote various means of environmental protection, strengthen the dissemination of information related to green agricultural development, guide producers to adopt green production methods during production, implement pesticide and fertilizer use according to policy requirements to achieve zero growth, and protect the ecological environment. Secondly, regions should strictly implement farmland protection measures, improve the utilization efficiency of land resources, actively carry out the recycling of agricultural film, establish new standards for agricultural film production, and accelerate the promotion and application of thickened mulch film. Finally, regions should adopt relevant measures and policies to provide producers with services such as production materials and spiritual propaganda, enhance producers' emphasis on green production, reduce agricultural pollution and resource waste, protect farmland water conservancy facilities, and improve the sustainability of agriculture.

4.2. Improve infrastructure construction

To achieve high-quality agricultural development in Shangqiu City, it is essential to leverage the role of the government effectively, implementing proactive policies and measures that favor agricultural development. The government should enhance the supporting role of infrastructure in agriculture, increase investment in digital infrastructure construction, and provide corresponding guarantees for farmers' production. To achieve the goal of high-quality agricultural development, various regions in Shangqiu City must prioritize the construction of agricultural infrastructure and improve mobile digital construction. Focusing on roads and mobile networks, an integrated logistics system for production and consumption should be established to facilitate the free flow of production factors between urban and rural areas, enhance the equal exchange level of various production factors, shorten the distance from production to consumption, and accelerate the development of the rural economy ^[13]. Agricultural infrastructure construction is a crucial foundation for addressing the "three rural issues" (agriculture, rural areas, and farmers). Constructing high-standard farmland helps improve agricultural production levels and enhance farmland's disaster resistance and mitigation capabilities. Simultaneously, accelerating the digitization of infrastructure such as water and electricity and roads provides fundamental support for accelerating the construction of an agricultural powerhouse and promoting agricultural and rural modernization ^[14]. Nowadays, in the era of highly developed internet, farmers and agricultural enterprises can cooperate to sell local specialty agricultural products through live streaming at agricultural production sites, increasing sales volumes. Relying on complete infrastructure and logistics system construction, the distance from production to consumption of agricultural products is shortened, promoting the development of rural modernization.

4.3. Promote agricultural technological innovation

The fundamental way to promote high-quality agricultural development is through technological innovation. Innovation and development serve as the driving force behind high-quality agricultural development in Shangqiu City, with the core position of agricultural technological innovation remaining unwavering. The government should first strengthen agricultural technological innovation by formulating policies to promote advanced agricultural technologies and management models. Various regions should actively respond and provide technical services to producers to improve agricultural production efficiency and product quality. Secondly, increase support for agricultural research institutions, enhance agricultural technology levels, accelerate the construction of a modern agricultural industrial system, and rely on technological innovation to

increase agricultural output and improve the core competitiveness of grain in Shangqiu City. Various regions in Shangqiu City should increase efforts in technological and management innovation to support high-quality agricultural development and promote agricultural modernization. Finally, strengthen the construction of characteristic agricultural industries and the branding of agricultural products. Shangqiu City should leverage its regional advantages to ensure a stable supply of grain such as wheat; from the perspective of sustainable agricultural development, various regions should base themselves on local characteristic resources, transform resources into products and industries, explore characteristic agricultural products in different regions, and use agricultural technological innovation to create characteristic agricultural product brands unique to each region. By formulating policies for effective resource allocation and assisting in promoting the innovative development of various types of agricultural enterprises, the cultivation and growth of characteristic agricultural product industries can be ensured, thereby promoting high-quality agricultural development.

Therefore, under the background of the rural revitalization strategy, Shangqiu City should promote high-quality agricultural development by systematically advancing green agricultural development, improving infrastructure services, taking agricultural technological innovation as the driving force, and strengthening the construction of advantageous characteristic agricultural industries and agricultural product branding, thereby accelerating the achievement of the goal of becoming a modern agricultural powerhouse in Shangqiu City.

Disclosure statement

The author declares no conflict of interest.

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