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Comprehensive Evaluation and Strategy Exploration of Rural Ecological Product Value Realization Driven by New-Quality Productivity

-- Taking Gaochun National Modern Agricultural Industrial Park as an Example

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Abstract: In the context of global sustainable development, realizing the value of rural ecological products is crucial. This paper examines this process, driven by new-quality productivity, using Gaochun National Modern Agricultural Industrial Park as a case study to provide insights for rural sustainable development. The comprehensive evaluation index system was developed by combining the AHP and Entropy Weight Method, incorporating data from statistical analysis, field surveys, and expert opinions. The study finds that: 1. Realizing the value of rural ecological products supports economic, social, and ecological sustainability. 2. Gaochun District has successfully leveraged its ecological advantages to promote rural economic development driven by new-quality productivity. 3. Further progress can be achieved through policy support, compensation optimization, and enhanced inter-departmental cooperation.

Keywords: Rural Ecological Products; Evaluation Index System; Comprehensive Evaluation.

1. Introduction

1.1. General Research Background

Rural ecological products are vital for maintaining ecological security, ensuring regulatory functions, providing a healthy living environment, and driving rural revitalization, warranting significant attention. Sustainable development is now a global priority, echoed in China's National Rural Industry Development Plan (2020–2025), which emphasizes enhancing ecological value and developing green, health-focused functions to attract consumers. New-quality productivity, a key driver of advanced productive forces, plays a crucial role in innovating rural ecological products and promoting sustainable development in the digital economy. However, mechanisms for realizing ecological product value remain unclear, and evaluation systems are incomplete. There is an urgent need to explore institutional mechanisms and refine comprehensive evaluation frameworks to transform ecological resources into economic assets.

1.2. Profile of the Area

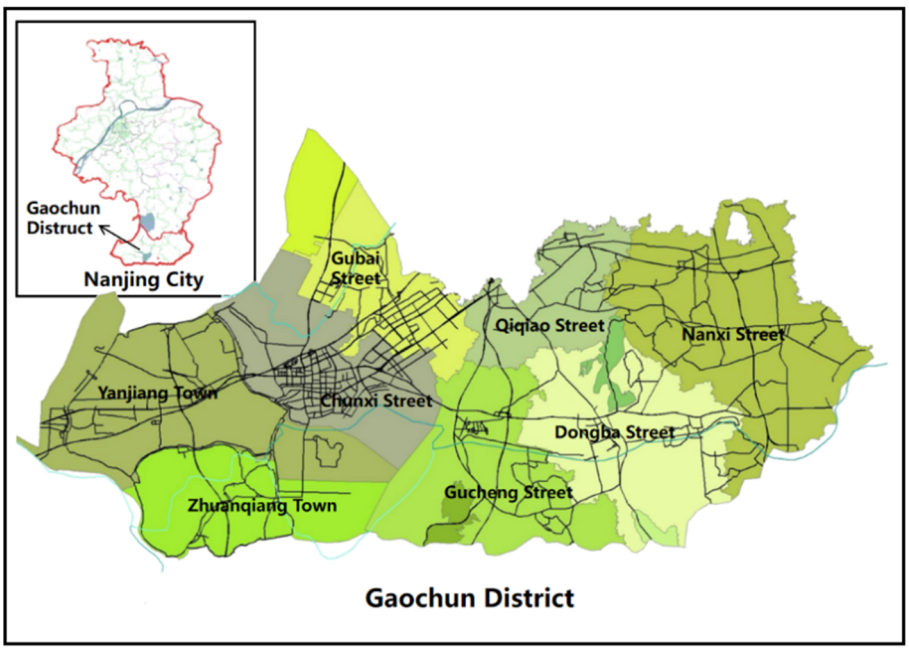


Figure 1. location map of Gaochun District

Gaochun District, located at the southern tip of Nanjing City, is bordered by Gucheng Lake to the south and Shijiu Lake to the north. It features a unique ecological landscape of "three mountains, two waters, and five parts of fields" as well as "two lakes, one river embracing one city." The district has a plain area of 291 square kilometers, accounting for 51.37% of the land area, while the hilly and upland areas cover 275.5 square kilometers, making up 48.63%. The ecological environment quality index of Gaochun District ranks among the top in the province. It is the first national ecological county in Jiangsu Province, with the ecological conservation area accounting for 70% of the district's total area. Below is the location map of Gaochun District (see Figure 1).

The research area of this project—Gaochun National Modern Agricultural Industry Park—has already developed a considerable scale of ecological industries and boasts a rich variety of ecological products, which have successfully contributed to the local rural development. For example, aquaculture area of 155,100 acres, annual output of approximately 1.7 tons, crab value exceeding 1 billion yuan Well-known locally and in surrounding areas, abundant supply during peak season, sold widely across multiple regions in China, with stable online sales.

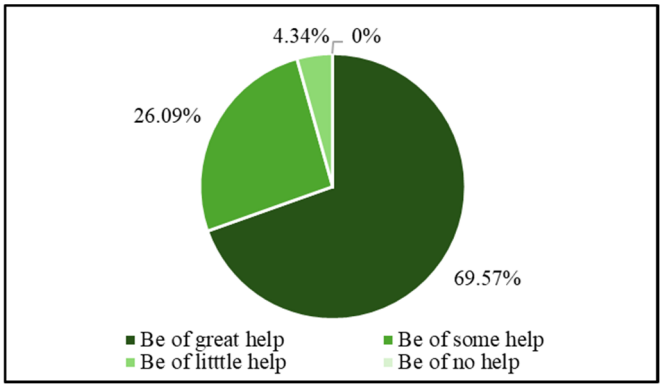


Figure 2. The development of the existing ecological industry in Gaochun to improve the living standards of villagers' degree of help

To further demonstrate the importance of realizing rural ecological product value, the research team conducted a field survey and questionnaire in Gaochun. Results indicate that over 50% of local villagers believe this value realization has significantly improved their living standards, while 32.1% think it has provided some help (see Figure 2). These findings underscore the need for quantitative analysis of the outcomes of rural ecological product value realization.

2. Literature Review

2.1. Current Research on Ecological Product Value Realization Mechanism

Scholars explore ecological product value realization through theoretical and practical lenses. Theoretically, Theoretically, frameworks based on economics and management emphasize property rights clarification and stakeholder boundaries, though insufficient property rights definition hinders progress. Practically, empirical studies in regions like the Yellow River Basin, Yangtze River Basin, and Inner Mongolia highlight pathways such as ecological rights trading, compensation, green finance, and industrial development.

2.2. Current Research on Ecological Product Value Accounting System

Recent studies employ methods like the quantitative factor, emergy, and functional value approaches. For example, Hong Minghai 0 assessed water resource value in Guizhou Province of China, while Guan Qingchun0 analyzed the Yellow River Delta's ecological product value by using emergy methods. Shenzhen pioneered China's first urban GEP accounting standard and an online GEP calculation platform, advancing ecological management in urban areas.

2.3. Literature Review

Existing literature has achieved certain results. However, existing research focuses on specific regions or ecosystem types, with limited attention to rural areas. Macro-level studies dominate, leaving gaps in quantitative methods and evaluation systems for rural ecological product value realization. Few studies examine the link between new quality productivity-driven development and rural ecological value realization. This paper addresses these gaps by analyzing the Gaochun National Modern Agricultural Industrial Park, using AHP and the Entropy Weight Method for a comprehensive evaluation of rural ecological product value realization.

3. Methods and Materials

3.1. Analytic Hierarchy Process (AHP)

Table 1. Influencing Factors for the Realization of the Value of Rural Ecological Products from the Perspective of New - quality Productivity Driving Forces

Author	Determinant
He Longbin, Li Zhuowei (2025) [3]	Value Measurement, Market-oriented Transaction, Industrialized Operation
Wang Huiqin, Ding Yuchen (2025) [4]	Ecological compensation, Construction of institutional system, Rural revitalization, Common prosperity
Li Hongwei (2024) [5]	The substantial increase in the total factor productivity of new - quality productive forces empower the realization of the value of ecological products
Zhang Enxiang (2024) [6]	Ecological product supply, Ecological industry, Policy and system, The role of market participants, Definition of roles in development activities

（1）Establishing the hierarchical structure model

The problem of the value realization mechanism of rural ecological products from the perspective of the driving force of new - quality productive forces is studied in layers. By comprehensively reviewing the literature, according to the research objectives and the influencing factors at each level (see Table 1), a corresponding hierarchical analysis structure model is constructed. It includes four levels: the target layer

(Layer A), the criterion layer (Layer B) and the sub - criterion layer (Layer C) (see Table 2). [7]

Table 2. Evaluation Index System for the Realization of the Value of Rural Ecological Products in Gaochun National Modern Agricultural Industrial Park

Target layer	Criterion layer	Index layer	Indicator attribute	Indicator unit
Comprehensive Evaluation Results of the Realization of the Value of Rural Ecological Products in Gaochun National Modern Agricultural Industrial ParkA	Ecological benefits B_1	Coverage area of important ecological function protection zones C_1	Forward direction	km^2
		The up - to - standard rate of water quality sections of major water bodies C_2	Forward direction	%
		The rate of good air environmental quality C_3	Forward direction	%
	Economic benefits B_2	The output of agricultural products C_4	Forward direction	Hundred million yuan
		Gross Regional Product(GRP) C_5	Forward direction	Hundred million yuan
		The sown area of grain in the whole districtC_6	Forward direction	ten thousand mu(1mu≈ 0.0667 hectares)
		Per capita disposable income of rural residentsC_7	Forward direction	Yuan
	Social benefits B_3	Subsistence allowance standardsC_8	Forward direction	Yuan per month
		Urbanization rate of permanent residents C_9	Forward direction	%
		Expenditure on general public services C_{10}	Forward direction	Hundred million yuan
		The number of newly added jobs C_{11}	Forward direction	People

(2) Construct the judgment matrix

The 1 - 9 scale method proposed by Satty et al. is adopted to make pairwise comparisons of different influencing factors at the same level. That is, assign values (see Table 3) to the importance of the i-th factor and the j-th factor relative to the factor at the upper level to determine the relative weights of each index factor, which is represented by a_{ij}.

Table 3. Matrix scale values and their meanings

Scale value	Meaning of the comparison between two elements
1	Be of equal importance
3	The former slightly more important than the latter
5	The former obviously more important than the latter
7	The former strongly more important than the latter
9	The former extremely more important than the latter
2, 4, 6, 8	Represent the intermediate value of above - mentioned adjacent judgments
Reciprocal	If the ratio of the importance of factor *i* to factor *j* is b_{ij}, then the ratio of the importance of factor *j* to factor *i* is $b_{ji} = 1/b_{ij}$.

(3) Find the maximum eigenvalue of the judgment matrix and its corresponding eigenvector.

Judge the judgment matrix through the consistency index and ratio test. The calculation formulas are as follows:

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n}\frac{(Bp)_i}{p_i},$$

$$CI = \frac{\lambda_{max}-n}{n-1},$$

$$CR = \frac{CI}{RI}$$

Where: λ_{max} is the maximum eigenvalue of the judgment matrix;Bp_i is the column vector composed of the weights of each evaluation index; CI is the consistency index; RI is the average random consistency index; CR is the random consistency ratio.[8]

(4) Normalize the calculated eigenvector to obtain the weight vector (Wj). Otherwise, reconstruct the judgment matrix.

3.2. Entropy Weight Method

(1)Determine the initial evaluation matrix of a certain evaluation index for a certain sample.

$$R = (X_{ij})_{n\times m}$$

(2)Normalize the initial evaluation matrix. Use the range method for positive transformation and standardization to obtain a new evaluation matrix B. The expression is as follows:

$$B = (Z_{ij})_{n\times m},$$

Positive - oriented indicator: $Z_{ij} = \frac{X_{ij}-X_{j_{min}}}{X_{j_{max}}-X_{j_{min}}}$,

Negative - oriented indicator: $Z_{ij} = \frac{X_{max}-X_{ij}}{X_{j_{max}}-X_{j_{min}}}$

(3)Calculate the proportion of it to the corresponding evaluation index.

$$P_{ij} = Z_{ij} / \sum_{i=1}^{n} Z_{ij}\ ,(j=1,2,\ldots,m)$$

(4)According to the definition of entropy, the entropy value of the evaluation index is calculated as follows:

$$H_j = -\frac{1}{\ln n}\left(\sum_{i=1}^{n} P_{ij}\ln P_{ij}\right)$$

(5)According to the definition of entropy, the entropy value of the evaluation index is calculated as follows:[9]

$$V_j = -\frac{1-H_j}{\sum_{j=1}^{m}(1-H_j)}$$

3.3. Determination of Combined Weights based on the AHP - Entropy Weight Method

To make the indicator weights more accurate and scientific, this paper uses the multiplication synthesis method to calculate the combined weights of each evaluation indicator. The formula is as follows.

$$W_j^* = \frac{W_j V_j}{\sum W_j V_j}$$

Where: Wj is the weight determined by the Analytic Hierarchy Process (AHP), and V_j is the weight determined by the entropy weight method.

3.4. Data Sources

Apart from a small amount of data collected from field surveys, expert opinions, and authoritative literature, the remaining raw data used in this paper are derived from publicly released information by the People's Government of Gaochun District and the People's Government of Nanjing City. These data include the Annual Bulletin of National Economy and Social Development of Gaochun District, the Publicity of Main Economic Indicators of Gaochun District, the Annual Environmental Quality Report, and other related publications. The data cover various aspects, including statistics from the Bureau of Statistics, the Department of Ecology and Environment, the Culture and Tourism Bureau, and other relevant departments.

4. Results and Discussion

4.1. Combined Weight

This paper uses a combined weight method of AHP and entropy weight, based on data from Gaochun District during 2019–2023, to derive the comprehensive weight results (see Table 4)

Table 4. Combined Weights of Evaluation Indicators for the Realization of the Value of Rural Ecological Products in Gaochun under the AHP - Entropy Weight Method

Primary Indicator	Secondary Indicator	AHP Weight Wj	Entropy Weight Vj	Combined Weight Wj	Sort
Economic Benefits	Agricultural product output	0.08020	0.070577	0.060538	10
	Gross Regional Product (GRP)	0.09367	0.070781	0.07091	7
	Total grain sown area in the whole district	0.07714	0.080136	0.066114	8
	Per capital disposable income of rural residents	0.08837	0.08145	0.076981	5
Social Benefits	Urban and rural subsistence allowance standards	0.08001	0.074553	0.063797	9
	Urbanization rate of permanent residents	0.08073	0.112199	0.096875	2
	General public service expenditure	0.08016	0.062561	0.053635	11
	Number of newly - added jobs	0.08034	0.086811	0.074592	6
Ecological Benefits	Coverage area of important ecological function protection areas	0.11307	0.221329	0.267654	1
	Compliance rate of water quality sections of major water bodies	0.11207	0.071751	0.086001	3
	Ratio of days with good air quality	0.11424	0.067852	0.082903	4

4.2. Comprehensive Score

This paper uses a combined weight method of AHP and entropy weight, based on data from Gaochun District during 2019–2023, to derive the comprehensive score results (see Table 5).

Table 5. Comprehensive Evaluation Score Table of the Benefits of Realizing the Value of Rural Ecological Products in Gaochun

Age	Economic benefit	Social benefit	Ecological benefit	Comprehensive benefit
2019	0	0.166558	0	0.166558
2020	0.076481	0.153781	0.150253	0.380515
2021	0.171125	0.153781	0.145801	0.470707
2022	0.225683	0.139372	0.325491	0.690546
2023	0.274543	0.201872	0.405853	0.882268

To make the Comprehensive scoring more visual, this paper has created the Figure 3 for date analysis.

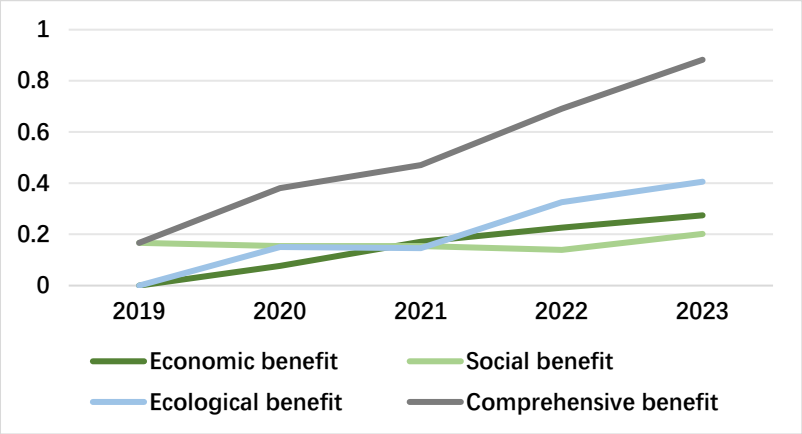


Figure 3. Line Chart of Comprehensive Evaluation Scores for the Realization of Rural Ecological Product Value in Gaochun

4.3. Mechanism Diagram

The value realization Mechanism Diagram for rural ecological products has been established based on their actual situation, considering ecological quality, economic output, social impact, and residents' needs, while ensuring data availability. This Mechanism Diagram (see Figure 4), comprising ecological, economic, and social benefits, supports the analysis of comprehensive evaluation results.

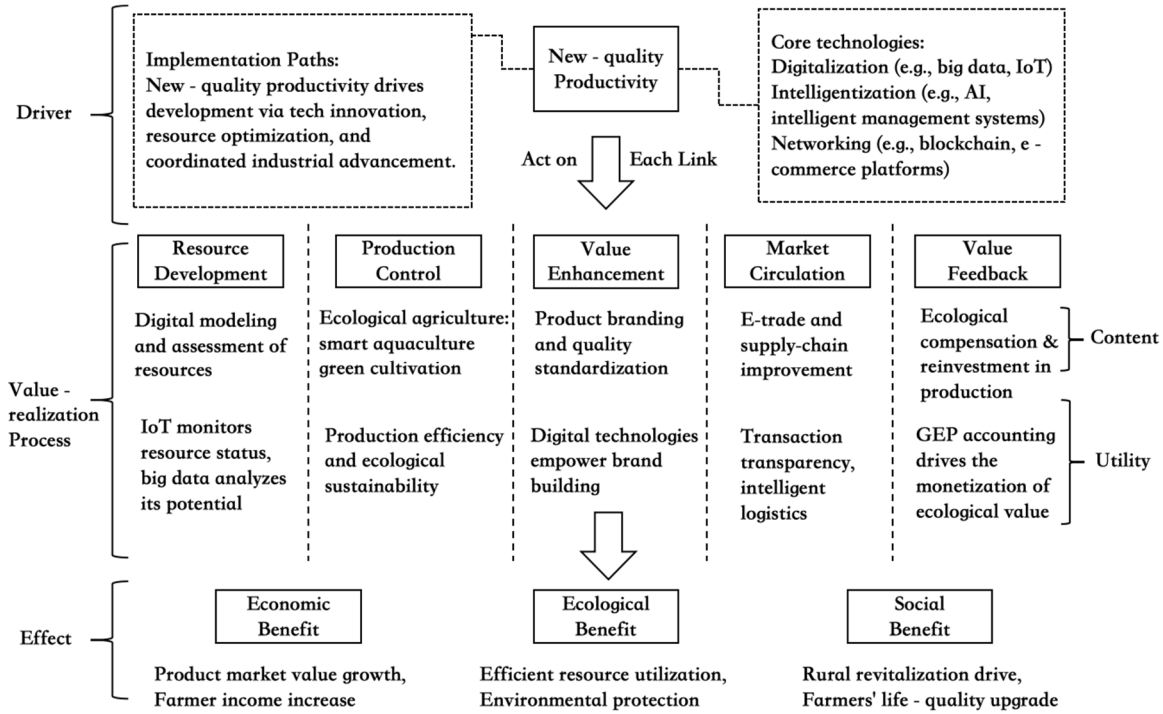


Figure 4. Mechanism Diagram for the Realization of the Value of Rural Ecological Products

4.4. Discussion

This paper, based on the background of new-quality productivity, innovatively employs the Analytic Hierarchy Process (AHP) combined with the entropy weight method to integrate statistical data and field survey data. It merges expert and resident evaluations to combine qualitative and quantitative analyses. This approach comprehensively evaluates and analyzes the reasons behind the realization of rural ecological product value in Gaochun District from 2019 to 2023:

(1) Economic Benefits Analysis

Since 2019, the economic benefits score in Gaochun District has steadily increased to 0.274543 by 2023, reflecting the effectiveness of its economic development measures. In agriculture, the district has introduced high-quality productivity and developed specialty agriculture. The Gucheng Lake crab breeding industry has expanded, with the completion of a 1.82 million square meter crab trading center and a 15,000-ton cold chain logistics base. These efforts boosted crab yields and output, while promoting related processing and sales industries. Additionally, the district promoted organic agriculture, expanded market channels, and increased agricultural output and GDP. Rural residents' per capita disposable income also rose, driving local economic growth and supporting ecological and social efficiency.

(2) Social Benefits Analysis

The social benefits score in Gaochun District was 0.170569 in 2019, declined in 2020, but then rose in 2021 and 2023.

The district increased investment in education, healthcare, and social security, raising the urban and rural subsistence allowance from 900 yuan to 1050 yuan per month. The urbanization rate remained around 60% and steadily increased as rural residents moved to urban areas for better public services. In 2021, a standardized intelligent gas distribution system was established to enhance public safety. However, during the COVID-19 pandemic, issues like unbalanced public service resource allocation and an unreasonable employment structure caused fluctuations in the social benefits score.

(3) Ecological Benefits Analysis

From 2019 to 2023, Gaochun District introduced efficient environmental governance systems and advanced agricultural technologies. The ecological benefits score increased by 0.405853 points, achieving significant progress in sustainability. Water quality compliance rates and air quality have improved, with a peak of 86.9% good air quality days. The coverage of important ecological function protection zones remained stable. Overall, Gaochun's ecological environment has been steadily improving, contributing to the goal of an environmentally friendly society.

(4)Comprehensive Benefits Summary

Since its inclusion in the national modern agricultural industrial park list in 2019, Gaochun District has seized opportunities in rural ecological industries, promoted quality and intellectual property rights, and advanced agricultural industrialization with high-tech. This includes using technology to enhance tea and livestock breeding. The Gaochun National Modern Agricultural Industrial Park has gained a strong reputation in Jiangsu Province for its ecological products. The district's economic, social, and ecological benefits have improved significantly, with the comprehensive benefits of ecological product value realization increasing from 0.166558 to 0.882268.

5. Conclusion

(1)The realization of the value of rural ecological products is essential for global sustainable development and plays a crucial role in China's rural revitalization. The comprehensive evaluation of Gaochun District shows that it can drive economic growth, improve the ecological environment, ensure ecological security, and enhance social well-being, contributing to harmonious rural development.

(2)Gaochun District has achieved significant progress driven by new-quality productivity . It has leveraged its ecological advantages to develop crab breeding, organic agriculture, and eco-tourism, creating a complete industrial chain for diversified rural economic development. With a focus on ecological protection, it has improved resource use efficiency and environmental quality through advanced technologies and management practices. The emphasis on new-quality productivity has further propelled high-quality rural economic development.

(3)To better promote the realization of rural ecological product value and ensure sustainable rural development, we propose three strategies. First, formulate supportive policies that integrate high-tech solutions into ecological industries, such as strengthening the protection of local resources, organizing industrial technology promotion events and fostering industry-university-research cooperation. Second, optimize ecological compensation policies by setting standards and methods based on resource protection and product supply, and establishing an adjustment mechanism. Third, implement inter-departmental coordination policies to enhance communication and cooperation for collective progress. The adoption of these strategies is expected to further improve the value realization process and achieve coordinated economic, social, and ecological development in rural areas.

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