Development Level and Dynamic Analysis of the Integration of Three Rural Industries in the Context of Rural Revitalization

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Abstract As a key measure to comprehensively promote the strategy of rural revitalization, especially in the field of industrial prosperity, the integration of rural three industries is of great strategic significance. In this study, entropy method and TOPSIS method were employed to calculate the comprehensive evaluation index of integration of three industries and the ideal development value respectively. The development status of integration of three rural industries was systematically evaluated, and the development trend of different regions was compared and analyzed. The results indicate that the development index of integration of three industries showed a steady growth trend, among which the development level of Jiangsu Province ranked first, followed by Hubei Province, while the development level of Shaanxi Province was relatively low. When analyzing the Level I indicators of integration of three rural industries, the contribution of industrial integration behavior exceeded the performance of industrial integration. Among the behavioral indicators of industrial integration, the weight of agricultural multi-functionality and service integration was relatively large, which plays a significant role in promoting the development of integration of three rural industries. The scores and growth rates of Jiangsu Province in increasing farmers' income, increasing agricultural production and rural economic development were higher than those of other regions, while Shaanxi Province still had a certain gap in rural industrial integration indicators compared with Jiangsu Province and Hubei Province. In view of this, we came up with some strategic recommendations for further promoting the development of integration of three rural industries.

Key words Integration of three industries, Entropy method, TOPSIS method, Rural revitalization

1 Introduction

In 2023, the No. 1 Central Document pointed out that it is necessary to promote industrial integration, build a whole industrial chain based on agriculture, and promote the deep integration of primary, secondary and tertiary industries. Since 2015, No. 1 Central Document has proposed to promote the development of integration of three rural industries for nine consecutive years. The development of integration of three rural industries is an important starting point for comprehensively promoting rural revitalization, especially industrial prosperity, and has become a key channel to increase farmers' income, and it is also a major measure to improve the structure of modern agricultural industry. In the 1960s and 1970s, western scholars put forward the idea of industrial integration, which gradually formed a more systematic theory of industrial integration with the development of industrial integration. In the 1990s, Japanese scholar Nara Imamura first put forward the theory of "six industries", and the integration of agriculture and secondary and tertiary industries has gradually attracted wide attention. In recent years, the integration of three rural industries has made a lot of achievements. First, the existing studies mainly focus on the connotation of the integration of three rural industries. Ma Xiaohe[1] believed that integration of three rural industries is the cross-border allocation of different factors of production in agriculture, and farmers participate in the value-added process of integration of three industries. Zhao Xia *et al.* [2] held that the development of integration of three rural industries is based on the primary industry, with farmers as the main body, with the help of high-tech penetration in agriculture, to achieve the organic integration of rural primary, secondary and tertiary industries. Su Yiqing[3] proposed that the integration of three rural industries is a gradual process from technology integration to business integration, and finally to market integration. Jin Lifu[4] stated that the essence of integration of three rural industries is the integration of primary, secondary and tertiary industries in technologies, products, services and markets, highlighting the efficacy of agricultural production factors and creating new forms of value. Tan Yanzhi[5] thought that the integration of three rural industries is the core element of integrating the industrial chain and value chain into the primary industry by using modern organizational methods. Zhou Fang and Zhu Chaozhi[6] contended that the integration of three rural industries is the division of interests among stakeholders based on the industrial chain. On the other hand, some scholars have studied how to measure the level of integration of three rural industries. Li Zhi[7] used the entropy method to set up comprehensive evaluation indicators and measure the level of integration of three rural industries. Chen Shengwei *et al.* [8] defined the level of integration of three rural industries through integration of three rural industries behavior and performance. Yu Tao[9] measured the level of integration of three rural industries from the four dimensions of industrial restructuring, industrial extension, industrial penetration and industrial intersection. Chen Hongxia[10] not only

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examined the integration behavior and benefits, but also made a comprehensive analysis of the overall environment to measure the level of integration of three rural industries. Zhu Changming[11] focused on the breadth and depth of integration of three rural industries and the economic and social benefits brought about by integrated development. Shi Xiuyi[12] measured the level of integration of three rural industries from three aspects: vertical industrial extension, horizontal multi-functional expansion and new business training.

To sum up, the existing literature has done a lot of research on the measurement of the level of integration of three rural industries, but most of the research only focuses on a certain province. Few studies have compared and analyzed the integration of three industries in different regions with different levels of economic development. Due to the different bases for the development of integration of three rural industries in different regions, the focus and intensity of policies and measures are different, and the degree of integration of three rural industries is also different. Therefore, we selected the eastern Jiangsu Province, the central Hubei Province and the western Shaanxi Province as the research objects, and used the entropy method and the TOPSIS method to calculate the integration of three industries comprehensive evaluation index and the ideal development value respectively. We comprehensively evaluated the development level of integration of three rural industries, and compared and analyzed the development differences of integration of three industries in different regions.

2 Evaluation system construction and level measurement for development index of integration of three rural industries

2.1 Selection of evaluation system indicators According to the principles of scientificity, development, relevance and guidance, we constructed the development index evaluation system for integration of three rural industries. The index system includes two Level I indicators, six Level II indicators and 38 Level III indicators, covering three dimensions of agriculture, rural areas and farmers. The integration of three rural industries was measured by three Level II indicators, namely, the extension of agricultural industry chain, the multi-functionality of agriculture and the integration of rural services. The performance of integration of three rural industries was measured by three Level II indicators, namely, increase of farmers' income, increase of agricultural production and rural economic development.

2.2 Determination of evaluation system weight Firstly, we conducted dimensionless processing for all the indicators, and the specific normalization process was to divide different indicators into positive gain indicators and negative gain indicators. The processing method for the positive gain indicators was as follows:

$$Y_{ij} = \frac{X_{ij} - \min X_{ij}}{\max X_{ij} - \min X_{ij}} \tag{1}$$

For the negative gain indicators, the processing method was as follows:

$$Y_{ij} = \frac{\max X_{ij} - X_{ij}}{\max X_{ij} - \min X_{ij}} \tag{2}$$

where X_{ij} and Y_{ij} separately denote the meaning of the initial value and the dimensionless value of the $j^{th}(j=1, 2, 3, \cdots, m)$ indicator in the $i^{th}(i=1, 2, 3, \cdots, n)$ year; $\max X_{ij}$ and $\min X_{ij}$ separately denote the maximum value and minimum value in the j^{th} column indicators.

Secondly, we calculated the proportion of each indicator according to the dimensionless data:

$$P_{ij} = \frac{X_{ij}}{\sum_{i=1}^{n} X_{ij}} \tag{3}$$

Then, we calculated the information entropy:

$$E_j = -\frac{1}{\ln(n)} \sum_{i=1}^{n} P_{ij} \times \ln P_{ij} \tag{4}$$

Next, we calculated the corresponding information utility value:

$$D_j = 1 - E_j \tag{5}$$

We calculated the weight of each indicator:

$$W_j = \frac{D_{ij}}{\sum_{i=1}^{n} D_{ij}} \tag{6}$$

Finally, the product of the weight of each indicator and its dimensionless result is the comprehensive evaluation coefficient corresponding to each indicator:

$$C_j = Y_{ij} \times W_j \tag{7}$$

We used TOPSIS method to calculate the relative closeness of the corresponding indicators, and analyzed the idealization degree of integration of three rural industries by comparing the comprehensive evaluation coefficient of the indicators with the relative closeness. The specific operation process of the TOPSIS method was as follows: first, we determined the positive and negative ideal solutions, then obtained the distance from the object to be evaluated to the positive ideal solution and the negative ideal solution according to the Euclidean calculation formula, and finally determined the relative closeness of the object to be evaluated as a reference value. The closer the comprehensive evaluation coefficient to the relative closeness, the better the evaluation result.

2.3 Analysis of calculation results of integration level of three rural industries As shown in Table 1, the extension of the agricultural industry chain had a high contribution to the development of the integration of three rural industries. The proportion of the output value of the primary industry in the GDP of the region generally showed a downward trend, while the proportion of the output value of the tertiary industry and the proportion of employees showed an increasing trend. Among them, the output value of the tertiary industry in Hubei Province accounted for the highest proportion of GDP and had the largest growth rate, with an increase of 17.21% from 2015 to 2021. Hubei Province promoted the deep integration of real economy and digital economy around the "three highlands and two bases", and realized the rapid development of the tertiary industry in the central region. In response to the national employment priority policy, Shaanxi Province has increased the matching degree of employment supply and demand of key groups, and the proportion of employed persons in the tertiary industry has increased most significantly, with an average annual growth rate of 3.31%. The contribution of agricultural

multi-functionality to the development of integration of three rural industries is general. The development of rural leisure agriculture, agriculture, forestry, animal husbandry and fishery and auxiliary activities is good, and the ratio of its output value to the added value of the primary industry is in a steady upward trend. At the same time, the carrying capacity of rural industrial development has increased, the intensity of pesticide and fertilizer application has decreased year by year, and the area of comprehensive control of soil erosion has increased year by year. Hubei Province, located on the bank of Dongting Lake, has good agricultural production conditions, vigorously develops ecological agriculture, establishes and improves the system and long-term system of agricultural ecological protection and green development, and implements the development concept of "clear waters and green mountains are as valuable as mountains of gold and silver". The degree of integration of rural services has contributed a lot to the development of integration of three industries, and the output value of agriculture, forestry, animal husbandry and fishery services has steadily increased, with the highest output value in Hubei Province. Shaanxi Province had the highest expenditure on agriculture, forestry and water affairs, reaching 11.44% in 2021. In terms of the construction of Taobao villages, Jiangsu Province was far ahead of the other two provinces, with the proportion of Taobao villages in administrative villages in Jiangsu Province reaching 5.35% by the end of 2021. Favorable economic conditions and convenient transportation and other location advantages made the service industry and e-commerce industry in Jiangsu Province develop rapidly. The Jiangsu Provincial Government has vigorously promoted the construction of Taobao Villages, and encouraged the development of new forms of consumption such as the live-streaming economy, so as to achieve the coordinated development of the real economy and the digital economy.

Table 1 Comprehensive evaluation system for behavior of integration of three rural industries

Level I indicators (weight)	Level II indicators (weight)		Level III indicators	Attribute	Weight		
					Jiangsu	Hubei	Shaanxi
Behavior of integration of three rural industries	Jiangsu 0.526 4	Extension of agricultural industry chain	Output value of primary industry/Regional GDP//%	+	0.027 8	0.027 8	0.028 3
			Tertiary industry output value/Regional GDP//%	+	0.016 9	0.023 3	0.017 6
			Employees in the primary industry/Social employees//%	+	0.023 7	0.025 1	0.021 0
			Employees in the tertiary industry/Social employees//%	+	0.024 9	0.024 0	0.028 8
			Investment in fixed assets of primary industry/Investment in fixed assets of the whole society//%	+	0.024 3	0.022 3	0.014 6
			Investment in fixed assets of the tertiary industry/Investment in fixed assets of the whole society//%	+	0.037 6	0.048 9	0.012 9
			Main business income of agricultural products processing industry/Added value of primary industry//%	+	0.029 4	0.030 2	0.019 5
			Business income of leisure agriculture and rural tourism/added value of first output value//%	+	0.032 5	0.019 6	0.065 8
			Output value of agriculture, forestry, animal husbandry and fishery and auxiliary activities/Added value of primary industry//%	+	0.019 4	0.021 3	0.018 9
	Hubei 0.538 8	Multi-functionality of agriculture	Agricultural chemical fertilizer application intensity//t/ha	−	0.027 8	0.033 0	0.031 0
			Pesticide application intensity//t/ha	−	0.029 5	0.026 8	0.020 5
			Agricultural water consumption//10^8 m^3	−	0.017 0	0.015 7	0.032 2
			Comprehensive control of soil erosion area//10^4 ha	+	0.021 2	0.021 4	0.017 4
			Output value of agriculture, forestry, animal husbandry and fishery services//10^8 yuan	+	0.023 2	0.034 2	0.023 3
	Shaanxi 0.577 6	Integration of rural services	Output value of agriculture, forestry, animal husbandry and fishery services/Total output value of agriculture, forestry, animal husbandry and fishery//%	+	0.020 2	0.018 8	0.020 2
			Length of highway open to traffic//km	+	0.020 7	0.023 0	0.021 1
			Total power of agricultural machinery//10^4 kW	+	0.020 6	0.019 1	0.024 5
			Expenditure on agriculture, forestry and water affairs//10^8 yuan	+	0.018 8	0.018 3	0.029 6
			Expenditure on agriculture, forestry and water affairs//%	+	0.029 6	0.020 3	0.021 9
			Area of facility agriculture/Farmland area//%	+	0.033 5	0.013 4	0.036 4
			Number of Taobao villages/Number of administrative villages//%	+	0.027 6	0.052 4	0.072 3

Data source: the data were calculated according to the relevant data in *China Statistical Yearbook*, *Jiangsu Statistical Yearbook*, *Hubei Statistical Yearbook* and *Shaanxi Statistical Yearbook* from 2016 to 2022. In the table, A agricultural chemical fertilizer application intensity of = Agricultural chemical fertilizer used (t)/Total sown area of crops (ha); Pesticide application intensity = Pesticide application amount (t)/Total sown area of crops (ha).

As shown in Table 2, the contribution of farmers' income increase to the development of integration of three rural industries was general, and the per capita disposable income and consumption expenditure of farmers were increasing year by year, with the largest increase in Jiangsu Province. The proportion of non-agricultural income of farmers in Hubei Province grew fastest, accounting for 62.44% at the end of 2021, with an average annual growth of 2.94%. Hubei Province actively explored the production and operation mode of "enterprise + cooperative + base + farmer household", created characteristic industries in each county, and continuously extended the industrial chain on this basis. In terms of grain yield, Jiangsu Province had the highest total grain yield. In recent years, Jiangsu Province had attached great importance to food security, and included grain production in the assessment system of comprehensive assessment of high-quality development, assessment of food security responsibility system, and performance assessment of rural revitalization strategy. The contribution of rural economic development to the development of integration of three rural industries is high, and the retail sale of rural consumer goods in Jiangsu Province was the highest and the growth rate was the fastest. The number of rural minimum living security declined steadily, with Jiangsu Province being the most significant, with an average annual decrease of 87 300. Jiangsu Province vigorously promoted poverty alleviation through consumption, through the guidance and improvement of the government, focusing on promoting the sales of poverty alleviation products, and promoting the "vegetable basket" and "rice bag" in the counterpart support areas to connect the urban market and government agencies, enterprises and universities at all levels.

Table 2 Comprehensive evaluation system for performance of integration of three rural industries

Level I indicators (weight)		Level II indicators (weight)		Level III indicators	Attribute	Weight		
						Jiangsu	Hubei	Shaanxi
Performance of integration of three rural industries	Jiangsu 0.473 6	Increase of farmers' income	Jiangsu 0.126 9	Per capita disposable income of farmers//yuan	+	0.026 0	0.024 3	0.024 9
				Per capita consumption expenditure of farmers//yuan	+	0.022 5	0.025 3	0.024 1
			Hubei 0.1260	Engel coefficient of rural residents	−	0.031 1	0.014 8	0.023 0
				Proportion of farmers' non-agricultural income//%	+	0.022 6	0.027 2	0.024 3
			Shaanxi 0.132 3	Producer price index of agricultural products	+	0.024 7	0.034 4	0.036 1
				Total output value of agriculture, forestry, animal husbandry and fishery//10^8 yuan	+	0.032 4	0.027 1	0.030 1
	Hubei 0.461 2	Increase of agricultural output	Jiangsu 0.130 8	Total grain yield//10^4 t	+	0.021 1	0.035 2	0.023 1
				Grain yield per unit area//kg/ha	+	0.020 5	0.030 3	0.027 1
			Hubei 0.142 7	Cotton yield per unit area//kg/ha	+	0.021 3	0.030 0	0.016 7
				Oil crop yield per unit area//kg/ha	+	0.035 3	0.020 1	0.021 2
			Shaanxi 0.118 1	Retail sales of rural consumer goods//10^{12} yuan	+	0.024 1	0.020 8	0.019 1
				Proportion of rural areas in total retail sales of social consumer goods//%	+	0.040 0	0.012 8	0.022 7
	Shaanxi 0.422 4	Rural economic development	Jiangsu 0.216 0	Average number of cars owned per 100 rural households at the end of the year//unit	+	0.017 4	0.026 2	0.018 3
				Average Internet access at the end of the year//100 rural households	+	0.045 8	0.030 3	0.037 2
			Hubei 0.192 6	Number of people receiving rural minimum living security 10^4 people	−	0.026 0	0.013 6	0.015 4
				Income ratio of urban and rural residents//%	−	0.048 2	0.054 4	0.035 6
			Shaanxi 0.171 9	Ratio of living expenditure of urban and rural residents//%	−	0.014 6	0.034 5	0.023 4

Data source: the data were calculated according to the relevant data in *China Statistical Yearbook*, *Jiangsu Statistical Yearbook*, *Hubei Statistical Yearbook* and *Shaanxi Statistical Yearbook* from 2016 to 2022. In the table, Proportion of farmers' non-agricultural income (%) = 1 − Net income of primary industry from agricultural operation/Per capita disposable income of farmers.

3 Analysis of development index of integration of three rural industries in the three provinces

3.1 Analysis of Level II indicators As shown in Table 3, in general, the comprehensive evaluation index of the six Level II indicators showed a growth trend. The growth rate of rural industrial chain extension indicator was slow, and the score of agricultural industrial integration indicator was high before 2018, but with the deepening of the integration of three industries and the transformation of agricultural production mode. The indicator scores of agricultural multi-functionality and integration of agricultural services have gradually increased and the growth rate has accelerated. Among them, the rural industry chain extension indicator in Hubei Province developed well, the agricultural multi-functionality indicator in Jiangsu Province had the highest score in 2022, and the integration of three rural industries in Shaanxi Province developed rapidly, although it started late.

The indicator scores of increasing farmers' income, increasing agricultural production and rural economic development increased

rapidly, and the integration of three rural industries achieved remarkable results. In terms of the indicator of increasing farmers' income, the comprehensive score of Hubei Province was the highest, reaching 0.08, and the growth of indicator score of Jiangsu Province was the fastest, with an average annual growth of 91.5%. In terms of indicator of increasing agricultural production, Jiangsu Province had the fastest growth rate, with an average annual growth rate of 84%. In terms of rural economic development indicator, the integration of three rural industries in Jiangsu Province achieved good results, with an indicator score of 0.17 and an average annual growth rate of 60%.

Table 3 Comparison of Level II indicators for development evaluation system of the integration of three rural industries in three provinces from 2015 to 2021

Province	Level II indicator	Year						
		2015	2016	2017	2018	2019	2020	2021
Jiangsu	Extension of agricultural industry chain	0.092 9	0.097 5	0.088 2	0.059 0	0.074 7	0.113 5	0.060 9
	Multi-functionality of agriculture	0.007 2	0.025 1	0.045 7	0.076 1	0.087 9	0.120 0	0.147 5
	Integration of rural services	0.050 4	0.049 5	0.065 9	0.085 5	0.128 8	0.133 8	0.146 2
	Increase of farmers' income	0.011 8	0.039 3	0.039 4	0.069 1	0.100 0	0.079 9	0.076 3
	Increase of agricultural output	0.021 0	0.004 0	0.031 7	0.070 1	0.107 3	0.111 4	0.126 7
	Rural economic development	0.036 9	0.068 7	0.090 0	0.082 9	0.082 1	0.101 5	0.170 2
Hubei	Extension of agricultural industry chain	0.106 5	0.105 8	0.085 8	0.062 5	0.091 4	0.115 5	0.116 4
	Multi-functionality of agriculture	0.007 6	0.031 4	0.053 4	0.081 0	0.098 4	0.120 4	0.122 1
	Integration of rural services	0.028 4	0.042 1	0.057 0	0.086 6	0.119 0	0.150 5	0.189 5
	Increase of farmers' income	0.017 7	0.035 5	0.034 0	0.062 7	0.098 6	0.096 5	0.080 8
	Increase of agricultural output	0.095 5	0.031 9	0.051 6	0.057 0	0.044 5	0.045 3	0.069 5
	Rural economic development	0.026 0	0.037 8	0.047 4	0.101 4	0.115 3	0.144 9	0.148 0
Shaanxi	Extension of agricultural industry chain	0.065 0	0.089 2	0.089 2	0.080 6	0.090 9	0.092 2	0.070 0
	Multi-functionality of agriculture	0.025 9	0.087 4	0.026 5	0.061 4	0.099 6	0.095 2	0.115 1
	Integration of rural services	0.035 7	0.034 9	0.041 5	0.082 8	0.120 5	0.180 9	0.202 3
	Increase of farmers' income	0.011 6	0.032 3	0.055 5	0.071 1	0.082 1	0.076 2	0.066 6
	Increase of agricultural output	0.022 1	0.048 5	0.031 4	0.056 0	0.072 0	0.096 3	0.101 9
	Rural economic development	0.046 9	0.075 2	0.094 6	0.074 2	0.066 3	0.085 1	0.143 0

3.2 Analysis of Level I indicators After calculating the weight of each indicator, we calculated the corresponding comprehensive evaluation coefficient and TOPSIS ideal point closeness according to the weight. Because the closer the year, the more convincing the indicator score, the different weights were given to different years (1/28 in 2015, 2/28 in 2016, …, 7/28 in 2021), and calculated the composite score of this indicator in the statistical period. It should be noted that the evaluation coefficient of the second-level indicators was equal to the sum of the evaluation coefficients of the third-level indicators covered by the Level II indicators. Similarly, the evaluation coefficients of the Level I indicators and the overall industrial integration development can be obtained, as shown in Table 4.

Table 4 Comparison of development index of integration of three rural industries in three provinces from 2015 to 2021

Province	Level II indicator	Year							Weight
		2015	2016	2017	2018	2019	2020	2021	
Jiangsu	Behavior index of industrial integration	0.150 4	0.172 1	0.199 8	0.220 7	0.291 5	0.367 3	0.354 6	0.290 1
	Performance index of industrial integration	0.069 8	0.112 0	0.161 1	0.222 1	0.289 4	0.292 8	0.373 2	0.267 2
	Development index of integration of three industries	0.220 2	0.284 1	0.360 9	0.442 8	0.580 9	0.660 1	0.727 8	0.557 3
	TOPSIS ideal point closeness	0.460 3	0.460 2	0.464 7	0.425 6	0.507 0	0.538 7	0.526 6	0.497 5
Hubei	Behavior index of industrial integration	0.142 5	0.179 3	0.196 2	0.230 0	0.308 9	0.386 4	0.428 0	0.316 7
	Performance index of industrial integration	0.139 2	0.105 2	0.133 0	0.221 1	0.258 4	0.286 7	0.298 2	0.240 5
	Development index of integration of three industries	0.281 7	0.284 5	0.329 2	0.451 2	0.567 2	0.673 1	0.726 2	0.557 2
	TOPSIS ideal point closeness	0.452 6	0.440 0	0.442 3	0.465 7	0.543 6	0.543 8	0.543 1	0.510 9
Shaanxi	Behavior index of industrial integration	0.126 6	0.211 6	0.157 3	0.224 8	0.310 9	0.368 2	0.387 4	0.299 9
	Performance index of industrial integration	0.080 6	0.156 0	0.181 5	0.201 4	0.220 3	0.257 6	0.311 5	0.234 7
	Development index of integration of three industries	0.207 2	0.367 5	0.338 8	0.426 2	0.531 3	0.625 8	0.698 8	0.534 5
	TOPSIS ideal point closeness	0.380 4	0.486 5	0.413 8	0.409 0	0.400 7	0.513 0	0.531 3	0.465 4

From the evaluation of behavior index of integration of three rural industries, the overall growth trend was stable, and the development gap between provinces was small. The behavior index of integration of three rural industries can be obtained by combining the evaluation index after the weighted average of the behavior of integration of three rural industries from 2015 to 2021. The results showed that Hubei (0.317) > Shaanxi (0.300) > Jiangsu (0.290). It can be seen that Hubei Province had the highest behavior index of integration of three rural industries, increasing from 0.143 in 2015 to 0.428 in 2021, with an average annual growth rate of 20.4%. The behavior index of integration of three rural industries in Shaanxi Province took the second, with an average annual growth rate of 34.3%, showing the fastest growth rate. The behavior index of Jiangsu Province was the lowest, with an average annual growth rate of 22.6%, which was faster.

According to the performance evaluation index of integration of three rural industries, the overall trend was fluctuating and rising. The development of Jiangsu Province was the most remarkable. In 2021, the performance index of rural triple integration in Jiangsu Province reached 0.373, with an average annual growth rate of 72.3%. Followed by Hubei Province, the performance weighted score of integration of three rural industries was 0.241, with an average annual growth rate of 19.1%, which was relatively slow. The development performance of integration of three rural industries in Shaanxi Province was relatively poor, with an indicator evaluation index of 0.312 in 2021 and an average annual growth rate of 47.7%.

The comprehensive evaluation index of the development of integration of three rural industries showed a steady upward trend, indicating that the development of integration of three rural industries was stable and good. Before 2018, the comprehensive evaluation index of the three provinces was lower than 0.5 and lower than ideal closeness, and the development of integration of three rural industries was in the initial stage of exploration. After 2018, the integration of three rural industries in the three provinces tended to be mature, and the comprehensive evaluation index was greater than 0.5, which was gradually higher than ideal closeness. The development of integration of three rural industries was generally well realized. The comprehensive evaluation index of each year was weighted to obtain the final comprehensive evaluation index. The results show that the development level of Jiangsu Province and Hubei Province was close, and higher than overall development level of Shaanxi Province. The development achievement of integration of three rural industries in Jiangsu Province was the most remarkable, and its comprehensive evaluation index increased from 0.220 to 0.728, with an average annual growth rate of 0.085 and a growth rate of 38.5%. The comprehensive evaluation index of Hubei Province increased from 0.282 to 0.726, with an average annual growth rate of 26.3%. However, the development level of integration of three rural industries in Shaanxi Province was poor, with the evaluation index rising from 0.207 to 0.699, but the average annual growth rate was 39.6%, which was the fastest among the three provinces and had certain development potential.

4 Conclusions and policy recommendations

4.1 Conclusions Generally, the development index of integration of three rural industries in Jiangsu, Hubei and Shaanxi provinces shows a steady growth trend, but due to the differences in human resources and natural endowments in different regions. As a result, the development effects of integration of three rural industries are different, among which the development level of integration of three rural industries in Jiangsu Province is the highest, followed by Hubei Province. The level of integration of three rural industries in Shaanxi Province is low, but the development is fast and the development prospect is broad.

From the Level I indicators of the development of integration of three rural industries, the contribution of industrial integration behavior is higher than that of industrial integration performance. Among the indicators of industrial integration behavior, the indicators of agricultural multi-functionality and service integration have a larger weight, and they play a stronger role in promoting the development of integration of three rural industries. Agricultural multi-functionality and service integration can not be separated from the development of superior industries, infrastructure construction and scientific and technological personnel training. Jiangsu and Hubei provinces have comparative advantages in these areas, with higher index scores and better overall development than Shaanxi. The indicator of industrial integration performance focused largely on how farmers can truly enjoy the benefits brought by the development of industrial integration in the process of the development of integration of three industries. Jiangsu Province is more perfect in the system guarantee and the coordination of industrial interests, which makes the transformation of the development of integration of three rural industries more effective. The empirical study results show that Jiangsu Province has higher scores and faster growth in the indicators of increase of farmers' income, increase of agricultural production and rural economic development, while Shaanxi Province has a certain gap in the level of rural industrial integration compared with Jiangsu Province and Hubei Province.

4.2 Policy recommendations (i) The development of integration of three industries should not only attach importance to diversification, but also grasp refinement. Different regions should pay attention to "developing respective strengths and avoiding weaknesses" and give full play to their comparative advantages according to local conditions. There is still a lot of room for development in the integration of three industries in the rural areas of the western region, making use of the unique natural environment and resource endowments to develop characteristic industries.

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4.5 Cultivating diverse ecological compensation mechanisms and policies for mutually beneficial livelihood and ecological advancement The execution of ecological compensation policies serves a dual purpose: it compensates for the economic disadvantages incurred by farmers due to their commitment to ecological initiatives[5], and it elevates their standard of living. This, in turn, fortifies the foundation for the evolution of agricultural livelihoods. As such, the formulation and application of ecological policies must be meticulously aligned with the interplay between ecological preservation and the sustenance of farmers' livelihoods.

It is imperative to adopt a farmer-centric approach, devising and refining a spectrum of ecological compensation mechanisms and supportive policies. These should be designed to foster both ecological conservation and the enduring prosperity of rural economies. Furthermore, it is essential to broaden the recipient base and the scope of ecological compensation to encompass a wider array of farmers engaged in ecological stewardship[6]. By doing so, we can reinforce the collective efforts in promoting, endorsing, and safeguarding ecological integrity, while concurrently ensuring that the livelihood transformation of farmers and the imperative of ecological protection are realized in a mutually advantageous manner.

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(ii) It is recommended to strengthen the infrastructure construction, improve transportation conditions, supplemented by supporting service facilities. The eastern region should take advantage of its own transportation and economic advantages, improve the corresponding industrial services, expand the scale of rural primary, secondary and tertiary industries, and enhance the ability of industry to resist risks and realize continuous development. The central and western regions should mainly focus on the construction of infrastructure and land transportation in order to attract foreign investment and further expand the market.

(iii) It is recommended to pay attention to the development of science and technology and the introduction of talents, vigorously develop smart agriculture and "Internet +" agriculture, and enhance the development momentum of industrial integration. In addition, it is necessary to implement a more active and open talent introduction policy, actively build cooperation platforms with universities and high-quality enterprises, provide incubation space for high-quality agricultural entrepreneurship projects, and promote high-quality development of integration of three rural industries.

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