International Journal for Housing Science and Its Applications
Publish August 10, 2025. Volume 46, Issue 4 Pages 2291-2301

https://doi.org/10.70517/ijhsa464195

Research on the Implementation Pathways for the Revitalization of Rural Areas in Jiujiang City through the Deep Integration of Agriculture, Culture, and Tourism Based on the Xunongyuan Model

Jun Cai[1,*] and Shengmi Zhang[2]
[1] Institue of Engineering and Technology, Gongqing College of Nanchang University, Jiujiang, Jiangxi, 332020, China
[2] College of Economics and Management, Gongqing College of Nanchang University, Jiujiang, Jiangxi, 332020, China
Corresponding authors: (e-mail: 18146724899@163.com).

Abstract At present, Jiujiang Xunongyuan Beekeepers Professional Cooperative presents the characteristics of stable improvement of production scale and production capacity, and continuous improvement of industrial chain. This paper takes Jiujiang Xunongyuan Beekeepers Professional Cooperative as a research sample to explore the realization path of rural revitalization under the trend of integration of agriculture, culture and tourism. On the assessment of the development of the agricultural, cultural and tourism industry, a set of agricultural, cultural and tourism industry indicator system containing a total of 16 indicator systems is systematically, dynamically and scientifically constructed. Based on the development data of the agricultural, cultural and tourism industry in Jiujiang City from 2011 to 2020, the correlation data of agriculture and tourism are calculated, and the entropy weight method is used to determine the weights of the indicators. Using the comprehensive evaluation model and the coupling coordination degree model method, the interactive coupling mechanism of agriculture, culture and tourism in Jiujiang City is built. Combined with its dynamic evolution characteristics, the analysis concludes that a total of four indicators, namely, gross agricultural product (billion yuan), domestic tourism revenue (billion yuan), the number of employees in the cultural industry (10,000 people), and the operating profit of the cultural industry (billion yuan), are the important influencing factors of the coupling and coordination degree of the integration of agriculture, culture, and tourism and the revitalization of the countryside. In the three time nodes of 2011, 2015 and 2020, the gray correlation between the two systems is greater than 0.500.

Index Terms integration of agriculture, culture and tourism, comprehensive evaluation model, coupled coordination degree model, rural revitalization

I. Introduction

Agricultural-cultural-tourism is based on agriculture, centered on culture, and manifested through tourism, forming a new model of industrial development. It promotes the diversified development of the rural economy and increases farmers' income [1], [2]. By integrating agriculture, culture, and tourism, agri-cultural-tourism integration can create unique tourism experiences and offer visitors a wide range of leisure and vacation options [3], [4]. Currently, China's agri-cultural-tourism integration development exhibits a large market scale and robust supply and demand in rural cultural tourism, increasingly becoming a key driver for tourism market recovery, county-level economic development, and expanded urban-rural consumption [5]-[7].

In practice, the development of agri-cultural-tourism integration still faces numerous challenges that hinder its healthy growth. Many regions possess the necessary conditions for deep integration of agriculture, culture, and tourism, but due to constraints such as technology, funding, and talent, high-quality agricultural resources and cultural advantages have not been fully developed and utilized, and the agri-cultural-tourism sector has yet to form a complete and well-developed industrial chain [8]-[11]. Moreover, existing models exhibit severe homogenization, with insufficient reflection of value creation tailored to local conditions [12]. Second, there is insufficient motivation for product innovation. Current agri-cultural-tourism integration models primarily operate through top-down, multi-stakeholder collaboration, with relatively fixed forms, leading to a certain degree of lag in understanding market demand, which in turn results in insufficient product innovation [13], [14]. Third, the supporting service system is inadequate. Although business models such as homestays and rural tourism have attracted some young people to return to their hometowns to start businesses, many areas are still operated by elderly residents, and service quality needs to be improved [15], [16]. The above issues reflect that there are still imperfections in the

supervision and management of agri-cultural-tourism integration under different operational models. Therefore, further research on the pathways for rural revitalization enabled by deep agri-cultural-tourism integration is of great significance for enhancing rural cultural value and promoting farmers' income growth.

The integration of agriculture, culture, and tourism not only promotes the development of agriculture and tourism but also drives the expansion and upgrading of related industries, making it a widely studied topic. Literature [17] established an evaluation indicator system for the integrated development of agriculture, culture, and tourism in a certain province of China, which can effectively analyze the level of agricultural integration and the stage of coupled coordination evolution in a region, providing valuable suggestions for upgrading rural revitalization pathways. Literature [18] examined the tea culture tourism model in a certain ancient village, indicating that talent effects, regional spatial types, and media network marketing have profound impacts on the agri-cultural-tourism model. Rural revitalization guided by cultural landscapes is an important form of achieving sustainable development in rural areas. Literature [19] explores the connotations and interactive feedback mechanisms of cultural and tourism integration and rural revitalization. Cultural and tourism integration in rural areas promotes rural revitalization through functional pathways such as cultural excavation and tourism utilization, while rural revitalization also provides demand and momentum for the development of cultural and tourism integration. Literature [20] indicates that developing rural tourism in traditional Chinese villages with historical and cultural significance is a key pathway for rural development and poverty alleviation. Therefore, it proposes a rural revitalization pathway based on the overall sustainable development of agri-cultural-tourism, aiming to protect traditional Chinese villages while leveraging their value. Literature [21] introduces the livelihood sustainability index to assess the sustainable performance of rural cultural-tourism integration. Literature [22] utilized the Participatory Rural Appraisal (PRA) method to evaluate rural cultural tourism development models, aiming at rural sustainable development and economic growth, thereby transforming rural tourism toward professional economic activities and the commercialization of natural and cultural content. Literature [23] discusses the impact of rural cultural tourism models on the sustainable livelihoods of local farmers, emphasizing that traditional culture within villages is an indispensable livelihood asset for farmers. Therefore, developing rural tourism using tangible cultural resources and intangible cultural heritage can effectively alter farmers' livelihood strategies. Given the differences in agricultural resources, cultural traditions, and natural landscapes across regions, the process of leveraging agri-cultural-tourism integration projects to empower ecological farms in Jiujiang City should prioritize the exploration and utilization of regional characteristics to create tourism products with distinct local identities.

This paper takes Xunongyuan Beekeepers Professional Cooperative as the research sample, carries out the connotation interpretation of agriculture, cultural industry and tourism, and constructs the index system of agriculture, culture and tourism industry in Jiujiang City. At the same time, the operation process of comprehensive evaluation model, coupling coordination model and the calculation method of coefficient of variation are elaborated respectively. Subsequently, based on the designed index system of Jiujiang agriculture, culture and tourism industry, the data on the development of agriculture, culture and tourism in Jiujiang City from 2011 to 2020 are sorted out, and the standardized data series of the correlation analysis of agriculture and tourism are calculated. And the entropy weight method is used to determine the final weight value of the three-level indicators of the designed indicator system. Thus, the research preparation for the analysis of the interactive coupling mechanism of agriculture, culture and tourism is completed. Then build the coupling system of Jiujiang City's cultural and tourism industry and rural revitalization from 2011 to 2020, analyze the dynamic evolution characteristics of the coupling coordination degree, and explore the influencing factors of the coupling coordination degree of agricultural, cultural and tourism integration and rural revitalization.

II. The current situation of professional beekeepers' cooperatives in Jiujiang City

Comprehensive multi-faceted research information that Jiujiang City, Jiujiang City, beekeepers professional cooperatives and Shangrao City, Yichun City and other advanced areas of honey production compared to the late start, but after a period of time, there is also a certain foundation, is now showing a good development trend. At present, the beekeepers' professional cooperatives in Jiujiang City are usually about 10 households, which are relatively small in scale and the degree of industrialization is not high. However, the production capacity of beekeepers' professional cooperatives in different regions of Jiangxi varies greatly, with the highest production in Yichun and Shangrao, and lower in Pingxiang and Xinyu.

Since beekeeping is significantly different from other general farming industries in terms of farming methods, beekeepers' professional cooperatives are quite different from other specialized cooperatives. Mainly because of the different flowering periods in different regions, beekeepers need to go to different places to harvest raw honey according to the type of honey source, the bee industry is not as centralized as other industries, which leads to a lot

of problems in Jiujiang Beekeepers' Specialized Cooperative Society, from the internal management to the sale of bee products.

The area of Jiangxi Province with developed bee product production and the area with the highest honey production are not the same area. Nanchang City is the capital city of Jiangxi Province, the economy is more developed than other regions, although the honey production in Nanchang City is not high, only a quarter of Jiujiang City, but Nanchang City Beekeepers Professional Cooperative has a high degree of industrialization of bee products, the product processing technology as well as sales channels, etc. are much higher than in Jiujiang City. And Nanchang has a leading honey enterprise, from the technical level and sales channels can help the neighboring beekeepers professional cooperatives to enhance competitiveness, but also in a timely manner to cash in their honey, so that farmers can get profits in a timely manner to improve their own income level, so that the local cooperative members of the enthusiasm is a very good to improve and promote.

II. A.Progress towards standardization, normalization and scaling up

In order to meet people's pursuit of commodity quality, high standard bee products such as additive-free honey and green honey are becoming more and more popular. At present, Jiujiang Beekeepers' Professional Cooperative, with the help of the government, has seen the emergence of a series of well-known honey brands, which are mainly supplied to large supermarkets in Wuhan and Hangzhou. Larger-scale beekeepers' professional cooperatives are also able to test bee products at any time to see if they meet production standards.

II. B.Increasing yield capacity

Excellent bee varieties is not only to ensure the production of the basis is the key, the strength of the honey swarm is directly related to the total output of beekeepers professional cooperatives, but also directly related to the economic benefits of beekeepers. In modern beekeeping production, the key to promoting its stable development and improving the corresponding economic benefits of beekeeping is to ensure excellent bee varieties. The research found that from 2013-2016, Jiujiang City gradually implemented a matching program for high-yielding honey bee varieties in promoting artificial mating, bee splitting and technical modifications to beehives. Through the gradual improvement of local traditional and backward Chinese bee breeding methods, the unit production of bee products in Jiujiang City is gradually increasing and the quality is gradually improving.

III. Jiujiang Agriculture, Culture and Tourism Industry Indicator System

III. A. Construction of the indicator system

III. A. 1) Principles for the design of the evaluation indicator system

To study the coupling and coordination between the development of agricultural, cultural and tourism industries and the growth of rural residents' income in Jiujiang City, Jiangxi Province, the establishment of a scientific and reasonable indicator system is an important premise to ensure the smooth progress of the study, so the following principles should be followed:

(1) Systematic principle

The construction of the indicator system should cover a wide range of assessment of the object of assessment, reflecting the systematic characteristics of the object of study, and the indicators have a logical relationship between the relative independence of each other and constitute a whole, from the macro to the micro, from the deep to the shallow hierarchy.

(2) Dynamic principle

Jiujiang City, Jiangxi Province, the coordinated development of agricultural, cultural and tourism industry development and rural residents' income growth needs to be reflected intuitively through a certain time series of data indicators, so the selection of indicators should fully take into account the dynamic changes, and consecutively select a number of years of data to describe the research object over time to change the state and degree of change.

(3) Scientific principle

The establishment of the average indicator system for the development of agricultural, cultural and tourism industries and the growth of rural residents' income in Jiujiang City, Jiangxi Province, the selected data should be obtained from official channels such as the statistical yearbook or by using calculation formulas, which can ensure the scientific nature of the data. At the same time, according to the development status quo of Jiujiang City, Jiangxi Province, the development of agriculture, culture and tourism industry and the growth of rural residents' income, and combined with the relevant theories and References targeted selection of the evaluation index system, to ensure that the research is scientific and reasonable.

III. A. 2) Construction of the indicator system for the agricultural, cultural and tourism industry

According to the connotation of the target layer Jiujiang City, Jiangxi Province, the development of agriculture, culture and tourism industry and the growth of rural residents' income, in accordance with the principles of systematic, dynamic and scientific design of the evaluation index system, and combining the availability of data and reference to the relevant literature, from the current actual situation in Jiujiang City, Jiangxi Province, a comprehensive evaluation index system of the development of the agricultural, culture and tourism industry in Jiujiang City, Jiangxi Province, and the growth of the income of the rural residents was constructed.

(1) Agriculture.

Agriculture is the foundation of the country, is the lifeblood of the national economy, is the basic industry for the development of agriculture, culture and tourism industry, rural industry should be surnamed “agriculture”, to do a good job of strengthening the planting and raising industry on the basis of actively expanding the multiple functions of agriculture. Therefore, this paper will assess the agricultural development from the aspects of gross agricultural product, grain production per unit area and so on.

(2) Cultural industry.

Culture is the spiritual pillar for the nation to be inherited and the country to be maintained, and the rise and fall of the national economy is closely related to the rise and fall of the culture. Indicators of cultural industry should be selected from the perspective of reflecting economic development, cultural prosperity and infrastructure construction, and this paper selects indicators from the two levels of cultural industry input and cultural industry output for measurement and evaluation.

(3) Tourism.

Tourism is a strategic pillar industry of the national economy, which is a comprehensive industry engaged in recruiting and receiving tourists by virtue of natural and humanistic tourism resources and infrastructures, and it is an important industry that deeply integrates with multiple industries such as culture, agriculture, science and technology, education, commerce, transportation, industry, agriculture, etc., and it is an important industry that promotes the reduction of the development gap between urban and rural areas, and promotes coordinated development of the region. Therefore, the tourism industry is evaluated by selecting indicators from the two levels of tourism industry input and tourism industry output.

To summarize, this paper constructs the evaluation index system for the development of Jiujiang's agricultural, cultural and tourism industry from three perspectives: agriculture, cultural industry and tourism, as shown in Table 1.

Table 1: Indicator system of agriculture, culture and tourism industry

Destination layer	Criterion layer	Index layer
(A) Agriculture	(A1) Agricultural development	(A11) Gross farm production (100 million yuan)
		(A12) Grain yield per unit area (Kilograms per mu)
(B) Cultural industry	(B1) Cultural industry investment	(B11) Number of libraries
		(B12) Number of cultural centers
		(B13) The proportion of the cultural industry in fiscal expenditure (%)
	(B2) Cultural industry output	(B21) The number of cultural market operation institutions
		(B22) The number of employees in the cultural industry (Ten thousand people)
		(B23) Operating profit of the cultural industry (100 million yuan)
(C) Tourism industry	(C1) Tourism industry investment	(C11) The number of travel agencies
		(C12) The number of star-rated hotels
		(C13) The number of A-level scenic spots
	(C2) Tourism industry output	(C21) The number of tourism industry practitioners (Ten thousand people)
		(C22) The number of domestic tourists (Ten thousand people)
		(C23) The number of international tourists (Ten thousand people)
		(C24) Domestic tourism revenue (100 million yuan)
		(C25) International tourism earnings

III. B. Comprehensive evaluation model and calculation method

III. B. 1) Integrated evaluation model

(1) Dimensionless processing

Culture, tourism and sports three industries coupled evaluation and coordination system contains a large number of indicators, the meaning of the indicators, units and levels are different, so in order to eliminate the

impact of the differences due to the indicators of the unit of the data outline, to ensure the reliability and accuracy of the results of the analysis, this paper applies the method of the polar deviation of the data processing, in order to effectively avoid the phenomenon of the individual indicators in the processing of the dimensionless function may appear negative values or zero, in the equation after the overall plus 0.01, as in equation (1):

$$x' = \frac{x_{ij} - \min x_{ij}}{\max x_{ij} - \min x_{ij}} \tag{1}$$

(2) Data standardization

The entropy value method is used for objective weighting as in equation (2)-(5):

$$p_{ij} = x'_{ij} \Big/ \sum_{i=1}^{n} x'_{ij} \tag{2}$$

$$e_j = -\frac{1}{\ln n} \sum_{i=1}^{n} p_{ij} \ln p_{ij}, \ln \text{ is the natural logarithm}, e_j \geq 0 \tag{3}$$

$$g_j = 1 - e_j \tag{4}$$

$$w_j = g_j \Big/ \sum_{j=1}^{m} g_j \tag{5}$$

p_{ij} indicates the weight of the j nd indicator in the i rd year, and e_j, g_j and w_j indicate the entropy value, coefficient of variation and weight of the j th indicator respectively.

(3) The comprehensive evaluation of each subsystem is shown in equation (6):

$$u_{ik=1=2=3} = \sum_{j=1}^{r} w_{ij} x'_{ij} \tag{6}$$

u_{ik} indicates the composite evaluation index for year i of subsystem k, and r indicates the number of indicators.

III. B. 2) Coupling harmonization model

With the help of the coupling theory in physics, the measurement describes the interaction of the cultural industry, tourism industry and agricultural industry. The formula of n system of interaction is as equation (7)-(9):

$$C = n \times \left\{ \frac{U_1 \times U_2 \times \ldots \times U_n}{\left(U_1 + U_2 + \ldots + U_n\right)^n} \right\}^{\frac{1}{n}} \tag{7}$$

$$D = \sqrt{C \times T} \tag{8}$$

$$T = \sum a_i U_i \tag{9}$$

Where C is the degree of coupling, U_i represents the comprehensive evaluation index of cultural industry, tourism industry and agricultural industry, calculated by entropy value method and linear weighting method, D is the degree of coupling coordination, T is the comprehensive coordination index of the three major industries, a_i is the coefficient to be determined, with reference to the relevant research results of the coupling and coordination of the tourism industry and other industries, and combined with the analysis of this paper, it is taken as $a_1 = a_2 = a_3 = \frac{1}{3}$, and in the study of the coupling of two and two industries, it is taken as $a_1 = a_2 = \frac{1}{2}$.

The value range of U_i, C and D is $[0,1]$, and they are divided into levels according to the size of the values.

III. B. 3) Coefficient of variation

The standard deviation coefficient St indicates the magnitude of change of regional differences at t time points, but it is influenced by the mean value, while the coefficient of variation CVt can effectively avoid the influence

produced by the mean value, and more objectively compare the industries of provinces in the study area, as in equation (10):

$$St = \sqrt{\sum_{i=1}^{N} (D - \bar{D})^2 / N}, CVt = \frac{St}{\bar{D}} \tag{10}$$

IV. Determination of the weights of the indicators of the agricultural, cultural and tourism industry index system

IV. A. Data sources and collection and organization

The statistical data of agriculture, cultural industry and tourism in this paper come from local government statistical yearbooks and local macroeconomic databases, with a timeframe of 10 years from 2011 to 2020. For the indicator data that cannot be obtained directly, the weighted average method is adopted to calculate and assign values. The results of the correlation between the statistical data and values for 2011-2015 are shown in Table 2, and the results of the correlation between the statistical data and values for 2016-2020 are shown in Table 3.

Table 2: Statistics on agriculture, cultural industry and tourism (2011-2015)

Destination layer	Criterion layer	Index layer	2011	2012	2013	2014	2015
A	A1	A11	224.78	257.38	272.74	283.16	288.08
		A12	384.279	384.053	386.778	375.683	405.004
B	B1	B11	6	8	10	11	13
		B12	12	15	18	23	27
		B13	30.39	34.75	33.38	28.95	25.09
	B2	B21	987	1082	1171	1186	1484
		B22	4.01	4.57	4.34	5.17	5.09
		B23	364.10	372.82	399.71	427.77	475.24
C	C1	C11	15	23	36	50	58
		C12	25	36	44	52	56
		C13	26	33	37	40	44
	C2	C21	9.87	18.24	26.09	30.55	34.54
		C22	4488.17	5739.96	6354.35	6863.51	7030.43
		C23	2.25	2.63	3.56	4.56	4.79
		C24	510.9	544.18	593.8	660.05	692.23
		C25	228.1	260.19	310.15	372.34	426

Table 3: Statistics on agriculture, cultural industry and tourism (2016-2020)

Destination layer	Criterion layer	Index layer	2016	2017	2018	2019	2020
A	A1	A11	296.74	300.38	298.09	301.32	319.87
		A12	366.604	436.648	408.381	440.003	385.539
B	B1	B11	15	15	15	15	15
		B12	30	32	33	33	33
		B13	28.17	25.15	34.79	25.69	34.41
	B2	B21	1565	1805	2044	2131	2182
		B22	6.86	6.19	6.90	6.42	4.26
		B23	498.03	525.16	543.02	429.73	404.21
C	C1	C11	64	69	75	79	54
		C12	61	65	68	70	63
		C13	47	51	56	58	60
	C2	C21	37.28	41.96	48.16	52.93	41.75
		C22	7811.02	8300.01	8646.52	8878.11	5997.84
		C23	5.84	6.19	7.2	8.58	3.17
		C24	751.39	791.61	876.41	941.54	651.93
		C25	461.01	496.45	539.63	574.5	296.56

Between 2011 and 2020, Jiujiang's agricultural development showed a slow upward trend, with (A11) gross agricultural product rising from 22.478 billion yuan in 2011 to 31.987 billion yuan in 2020. The development of tourism industry also showed a booming trend before the epidemic, with the highest domestic tourism revenue of 94.154 billion yuan (C24) in 2019.

IV. B. Calculation of the gray correlation

Combining Table 2 and Table 3, the standardized data series for the analysis of the correlation between agriculture and tourism in Jiujiang City during the period of 2011-2020 was calculated as shown in Table 4.

Table 4: Grey relational degree analysis standardized data sequence

Index	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
A11	1.000	0.29	0.56	0.98	1.39	1.67	1.87	1.78	2.27	1.86
A12	1.000	0.28	0.37	0.39	0.59	0.95	0.96	1.43	1.51	1.75
B11	1.000	0.39	0.53	1.13	1.39	1.62	1.98	2.1	2.14	2.57
B12	1.000	0.14	0.22	0.51	1.32	1.6	2.1	2.18	2.44	2.46
B13	1.000	0.48	0.66	0.85	0.97	1.25	2.21	2.36	2.88	2.9
B21	1.000	0.49	1.45	1.5	1.98	2	2.07	2.31	2.32	2.82
B22	1.000	1.2	1.48	1.52	1.57	1.58	1.9	2.38	2.61	2.64
B23	1.000	0.08	0.73	1.09	1.14	1.26	1.65	1.67	2.01	2.07
C11	1.000	0.25	0.55	0.84	1.06	1.22	1.31	2	2.36	2.86
C12	1.000	0.6	0.66	0.66	0.91	1.22	1.27	2.33	2.72	2.77
C13	1.000	0.11	0.31	0.56	1.34	1.44	1.63	1.66	2.1	2.23
C21	1.000	0.18	0.27	0.35	0.51	0.89	1.05	1.08	1.1	1.75
C22	1.000	0.2	0.26	0.91	0.95	1.03	1.16	1.53	2.46	2.55
C23	1.000	0.02	0.56	0.57	0.68	0.85	1.04	1.37	1.6	2.61
C24	1.000	0.03	0.07	0.12	0.79	1.03	1.19	1.44	1.79	1.93
C25	1.000	0.13	0.2	0.65	1.01	1.33	1.52	1.99	2.42	2.49

Based on Table 4, the statistical data of 2019 before the epidemic was selected as the gray correlation analysis of agriculture, culture and tourism in Jiujiang City, and the calculation of the correlation between agriculture and tourism indicators in the three levels of indicators in 2019 is shown in Table 5. It can be seen that there are four cultural industry indicators as a whole:(B11) the number of libraries, (B13) the proportion of the cultural industry in the financial expenditures (%), (B22) the number of employees in the cultural industry ((10,000 people), (B23) operating profit of cultural industry (billion yuan), and six tourism indicators: (C11) number of travel agencies, (C12) number of star-rated hotels, (C13) number of A-grade scenic spots, (C21) number of employees in the tourism industry (10,000 people), (C22) number of domestic tourists (10,000 people), and (C24) domestic tourism revenue (billion yuan) have correlations with the agricultural indicators that are 0.7 and above ..

Table 5: The correlation degree between agricultural and tourism indicators (2019)

	A11	A12
B11	0.996	0.867
B12	0.676	0.175
B13	0.262	0.806
B21	0.231	0.434
B22	0.98	0.962
B23	0.457	0.928
C11	0.608	0.949
C12	0.807	0.78
C13	0.842	0.926
C21	0.823	0.64
C22	0.613	0.793
C23	0.651	0.645
C24	0.669	0.871
C25	0.549	0.676

IV. C. Calculation and determination of indicator weights

Using the entropy weight method to calculate the weights of the proposed indicator system, the final weights of the three-level indicators are shown in Table 6. The overall distribution of the indicator weight values is relatively uniform, mostly concentrated in the range of 0.04 ~ 0.09. Among them, (C24) domestic tourism revenue (100 million yuan) has the highest weight of 0.097, which can be preliminarily inferred that in the integrated development of agriculture, culture and tourism in Jiujiang City, the revenue of tourism industry plays an indispensable role.

Table 6: The final weights of the third-level indicators

Destination layer	Criterion layer	Index layer	Weight
A	A1	A11	0.062
		A12	0.054
B	B1	B11	0.044
		B12	0.055
		B13	0.076
	B2	B21	0.074
		B22	0.051
		B23	0.053
C	C1	C11	0.062
		C12	0.087
		C13	0.053
	C2	C21	0.048
		C22	0.057
		C23	0.075
		C24	0.097
		C25	0.051

V. Path to rural revitalization

V. A. Mechanisms for interactive coupling of agriculture, culture and tourism

The efficacy coefficient Uij of the coupled system of cultural tourism industry and rural revitalization can be calculated through the efficacy function formula, and after the completion of the step of calculating the weights λij of each index of the coupled system, these weights can be used to calculate the comprehensive evaluation value of the two evaluation systems of cultural tourism industry and rural revitalization, which are recorded as U1 and U2 respectively.Under this step, the coupled system of cultural tourism industry and rural revitalization is derived. coupling coordination degree value and coupling degree. Table 7 shows an overview of the relevant data of the coupled system of agricultural, cultural and tourism industry and rural revitalization in Jiujiang City from 2011 to 2020. In 2011-2012, the coordination grade of agriculture, culture and tourism in Jiujiang City was on the verge of being out of tune, with the coupling coordination degree (D) below 0.46. In 2013-2014, the coordination grade of agriculture, culture and tourism was barely out of tune, and in 2015-2018, the coordination grade of agriculture, culture and tourism was firstly changed to “coordinated”, which belonged to the primary coordination stage. In 2019-2020, the coordination grade of agriculture, culture and tourism in Jiujiang City develops into a well-coordinated stage, and the coupling coordination degree (D) reaches 0.800 and above. It is also in the two years of 2019-2020 that Jiujiang City's agriculture, culture and tourism will be transformed from “tourism lagging type” to “rural lagging type”.

Table 7: Interactive coupling mechanism

Year	U1	U2	C	D	Coordination level	Contrast type
2011	0.1390	0.3245	0.9180	0.4577	On the verge of disorder	Tourism lag type
2012	0.0847	0.4585	0.7373	0.4497	On the verge of disorder	Tourism lag type
2013	0.3031	0.4156	0.9983	0.5969	Forced imbalance	Tourism lag type
2014	0.2127	0.6086	0.8795	0.5997	Forced imbalance	Tourism lag type
2015	0.3672	0.5189	0.9959	0.6629	Primary coordination	Tourism lag type
2016	0.2894	0.5199	0.9675	0.6241	Primary coordination	Tourism lag type
2017	0.3158	0.4790	0.9889	0.6251	Primary coordination	Tourism lag type
2018	0.3699	0.4470	0.9968	0.6396	Primary coordination	Tourism lag type
2019	0.7124	0.6280	0.9995	0.8219	Good coordination	Rural lagging type

2020	0.8458	0.7613	0.9999	0.9006	Good coordination	Rural lagging type

V. B. Characterization of the dynamic evolution of the coupling coordination degree

First, the traditional Markov chain probability transfer matrix is calculated, which is divided into four adjacent but not intersecting perfect intervals according to the high and low differences in coupling coordination degree: (S1) severe dysfunction, (S2) basic dysfunction, (S3) basic coordination, and (S4) advanced coordination, and the specific results of the calculation are shown in Fig. 1. The diagonal color blocks in the figure reflect the probability of maintaining the original state, while the color blocks on the non-diagonal line represent the probability that the coupling coordination level changes.

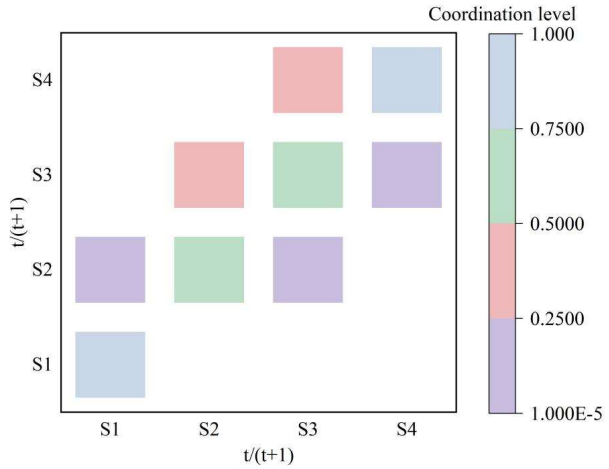

Figure 1: Traditional Markov transition probability matrix

Combined with Figure 1, it can be inferred that without considering the geospatial pattern, the evolution of the coupling coordination degree is characterized by:

(1) The probability that the coupling coordination type of agricultural, cultural and tourism integration and rural revitalization is stable and unchanged is greater than 67.78%, indicating that there is a possibility that the coupling coordination degree of the two will converge to the advanced level of coordination, and that cities need to rely on the regional resources to realize the upward development of the coupling coordination degree.

(2) The probability of transferring the coupling coordination level is on both sides of the diagonal line, and the maximum value on both sides of the diagonal line is 32.38%. Therefore, the coupling coordination grade is difficult to achieve a leapfrog development change in a short period of time.

While relying on the endogenous development power of the system, the coupling coordination degree of agricultural, cultural and tourism integration and rural revitalization has a certain correlation with the surrounding cities. Therefore, on the basis of the traditional Markov model, the spatial Markov probability matrix is constructed as shown in Table 8.

Table 8: Spatial Markov transition probability matrix

Spatial lag	t/(t+1)	S1	S2	S3	S4
S1	S1	0.77964	0.22036	0	0
	S2	0	0.825	0.175	0
	S3	0	0	0	0
	S4	0	0	0	0
S2	S1	0.84765	0.15235	0	0
	S2	0	0.55	0.45	0
	S3	0	0.33333	0.33333	0.33334
	S4	0	0	0	1
S3	S1	0.5	0.5	0	0
	S2	0	0.4	0.6	0
	S3	0	0.56871	0.24653	0.18476
	S4	0	0	0.435	0.565
S4	S1	0	0	0	0

	S2	0	0.35	0.65	0
	S3	0	0	0.5	0.5
	S4	0	0	0	1

By comparing Figure 1 and Table 8, it can be found that the transfer of the coupled coordination level of agricultural, cultural and tourism integration and rural revitalization shows a certain correlation in geospatial terms. It indicates that the resources owned by neighboring regions play an important role in promoting the development of agro-cultural tourism integration and rural revitalization, i.e., cities in the state of high-level coordination will have positive spatial spillover effects on neighboring cities. It also implies that regions with higher coupling coordination can, to a certain extent, promote the coupling coordination of neighboring cities, i.e., the geospatial pattern contributes to the upward change of the two systems.

V. C. Analysis of Impact Factors

To further explore the intrinsic influencing factors of the coupling coordination degree between agricultural-cultural-tourism integration and rural revitalization, based on previous research and the analysis in the preceding section, it is hypothesized that factors such as (A11) agricultural gross output value (in billions of yuan), (C24) domestic tourism revenue (in billions of yuan), (B22) number of employees in the cultural industry (in ten thousand people), and (B23) operating profit of the cultural industry (in billions of yuan) within the indicator system will exert significant influence on the coupling coordination degree between the two. Therefore, based on the relationship between these four influencing factors and the coupling coordination degree, we further analyze their impact effects. Combining previous research, we select the coupling coordination degree as the reference sequence and the influencing factors as the comparison sequence. Using the gray correlation model, we calculate the gray correlation degrees for 2011, 2015, and 2020, as shown in Table 9.

Table 9: Coupling coordination degree and influencing factors

Influence factor	2011		2015		2020	
	Degree of association	Sort	Degree of association	Sort	Degree of association	Sort
A11	0.957	1	0.951	1	0.878	3
B22	0.712	4	0.722	4	0.741	4
B23	0.817	3	0.811	3	0.889	2
C24	0.903	2	0.947	2	0.922	1

At three time points, the gray correlation of the two systems is greater than 0.700, indicating that there is indeed a correlation between the four selected influencing factors and the trend of the coupling coordination degree. Among them, (C24) domestic tourism revenue (billion yuan) factor correlation always reaches 0.900 and above and ranks the first in 2020, while (B22) the number of employees in the cultural industry (10,000 people) factor is always in the fourth place. (A11) Gross Agricultural Product (billions of dollars) is still in the first place in 2011 and 2015, and then backs down to the third place in 2020. As the level of economic development continues to rise, the industrial structure of Jiujiang City has begun to upgrade and optimize, forming a diversified industrial system, thus injecting new vitality into the development of rural revitalization. And the correlation degree of each influencing factor has not changed significantly at different time points, indicating that the selection of indicators is more accurate and the influencing factors have effectively promoted the coupling and coordination degree of the two.

VI. Conclusion

On the assessment of the development status of agricultural, cultural and tourism industry, this paper proposes a set of Jiujiang agricultural, cultural and tourism industry indicator system consisting of 16 third-level indicators in five dimensions: agricultural development, cultural industry input, cultural industry output, tourism industry input and tourism industry output. The entropy weighting method is used to assign the indicators, among which the third-level indicator “domestic tourism revenue (billion yuan)” has the highest weight value (0.097).

Taking the 2011-2020 Jiujiang City agriculture, culture and tourism development data as a research sample, the coupling system of agriculture, culture and tourism industry and rural revitalization is output. In 2019-2020, Jiujiang City's agricultural, cultural and tourism coordination level develops into a good coordination stage, with a coupling coordination degree of 0.800 and above. In the three time nodes of 2011, 2015 and 2020, there are four influencing factors, namely, gross agricultural product (billion yuan), domestic tourism revenue (billion yuan), the number of employees in the cultural industry (10,000 people) and the operating profit of the cultural industry (billion yuan), which have a gray correlation degree of 0.700 and above in the two systems.

The correlation of “domestic tourism revenue” is always above 0.900 and will be ranked first in 2020, indicating that the in-depth integration of agriculture, culture and tourism can effectively promote the improvement of the level and quality of economic development in Jiujiang City. The increase in economic output and the upgrading and optimization of the industrial structure not only expand the sources of agricultural income but also provide solid economic support for the development of agricultural production capacity, which inadvertently helps to achieve a high degree of rural revitalization in Jiujiang City.

Funding

This work was supported by Jiujiang City Social Science Fund.

References

[1] Sun, Y., Timothy, D. J., Wang, Y., Min, Q., & Su, Y. (2019). Reflections on agricultural heritage systems and tourism in China. Journal of China Tourism Research, 15(3), 359-378.
[2] Farsani, N. T., Ghotbabadi, S. S., & Altafi, M. (2019). Agricultural heritage as a creative tourism attraction. Asia Pacific Journal of Tourism Research, 24(6), 541-549.
[3] Su, M. M., Wall, G., & Wang, Y. (2019). Integrating tea and tourism: A sustainable livelihoods approach. Journal of Sustainable Tourism, 27(10), 1591-1608.
[4] Zhu, Y., Chai, S., Chen, J., & Phau, I. (2024). How was rural tourism developed in China? Examining the impact of China’s evolving rural tourism policies. Environment, Development and Sustainability, 26(11), 28945-28969.
[5] Ab Rahman, A., Zainol, N., Ramli, A., & Manzoor, H. (2020, December). Challenges in creating ecotourism in rural area: A case of RK eco farm business venturing. In IOP Conference Series: Earth and Environmental Science (Vol. 596, No. 1, p. 012050). IOP Publishing.
[6] Fusté-Forné, F. (2020). Farming travels: a note on cheese-based tourism. Matkailututkimus, 16(1), 120-127.
[7] Pato, L., & Kastenholz, E. (2017). Marketing of rural tourism–a study based on rural tourism lodgings in Portugal. Journal of Place Management and Development, 10(2), 121-139.
[8] Shen, S., Wang, H., Quan, Q., & Xu, J. (2019). Rurality and rural tourism development in China. Tourism Management Perspectives, 30, 98-106.
[9] Bi, G., & Yang, Q. (2023). The spatial production of rural settlements as rural homestays in the context of rural revitalization: Evidence from a rural tourism experiment in a Chinese village. Land use policy, 128, 106600.
[10] Chen, Y., & Liang, H. (2021). Research on the construction of rural complex in the context of rural revitalization based on FAHP. Journal of Intelligent & Fuzzy Systems, 41(3), 4669-4678.
[11] Einali, J., Mohammadi Yeganeh, B., & Ghasemlou, H. (2019). The role of creative tourism in sustainable development of rural areas (Case study: historic-cultural villages in north-west of Iran). Journal of Research and Rural Planning, 8(2), 19-39.
[12] Chen, X. (2020). The core of China’s rural revitalization: Exerting the functions of rural area. China Agricultural Economic Review, 12(1), 1-13.
[13] Li, B. (2023). The integration of cultural tourism and rural revitalization in big data and the internet of things. Journal of Computational Methods in Science and Engineering, 23(1), 51-62.
[14] Yanbing, H. E., Tong, Z. H. A. N. G., & Dongmei, X. I. O. N. G. (2020). Evaluation on cultural value of traditional villages and differential revitalization: A case study of Jiaozuo City, Henan Province. Economic geography, 40(10), 230-239.
[15] Maroto-Martos, J. C., Voth, A., & Pinos-Navarrete, A. (2020). The importance of tourism in rural development in Spain and Germany. Neoendogenous development in european rural areas: Results and lessons, 181-205.
[16] Zhu, J., Yuan, X., Yuan, X., Liu, S., Guan, B., Sun, J., & Chen, H. (2021). Evaluating the sustainability of rural complex ecosystems during the development of traditional farming villages into tourism destinations: A diachronic emergy approach. Journal of Rural Studies, 86, 473-484.
[17] Cheng, R., Wu, M., Liu, X., Song, X., & Zhang, Y. (2024). Research on the Measurement and Improvement Strategy of Integration of Agriculture, Culture and Tourism in Hebei Province Under the Strategy of Rural Revitalization. Advance in Sustainability, 4(1).
[18] Shen, J., & Chou, R. J. (2022). Rural revitalization of Xiamei: The development experiences of integrating tea tourism with ancient village preservation. Journal of Rural Studies, 90, 42-52.
[19] Jingran, L. O. N. G., & Shanshan, D. U. (2021). Mechanism and model of rural vitalization guided by culture-tourism integration. Economic geography, 41(7), 222-230.
[20] Gao, J., & Wu, B. (2017). Revitalizing traditional villages through rural tourism: A case study of Yuanjia Village, Shaanxi Province, China. Tourism management, 63, 223-233.
[21] Li, H., Nijkamp, P., Xie, X., & Liu, J. (2020). A new livelihood sustainability index for rural revitalization assessment—a modelling study on smart tourism specialization in China. Sustainability, 12(8), 3148.
[22] Ćurčić, N., Mirković Svitlica, A., Brankov, J., Bjeljac, Ž., Pavlović, S., & Jandžiković, B. (2021). The role of rural tourism in strengthening the sustainability of rural areas: The case of Zlakusa village. Sustainability, 13(12), 6747.
[23] Ma, X., Wang, R., Dai, M., & Ou, Y. (2021). The influence of culture on the sustainable livelihoods of households in rural tourism destinations. Journal of Sustainable Tourism, 29(8), 1235-1252.