



# Sustainable Rural Ecological Environments: An Investigation of Agricultural Tourism Integration in Hunan Province, China

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. Author JL designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors BZC, MCA and FL managed the analyses of the study. Author FL managed the literature searches. All authors read and approved the final manuscript.*

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## **ABSTRACT**

**Aims:** The integration of agriculture and tourism represents a pivotal breakthrough point in realizing rural revitalization. To ensure sustainable development and attain ecological livability, there is a pressing need to investigate the impact mechanism of agricultural tourism integration on rural ecological environments.

**Study Design:** This study examines the current state of agricultural tourism integration and ecological livability in Hunan Province, China. The research constructs an influence mechanism to

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assess the impact of agricultural tourism integration on the rural ecological environment, utilizing empirical data covering the cities and prefectures of Hunan Province from 2015 to 2021.

**Results:** Our findings indicate a significant correlation between agricultural tourism integration and the rural ecological environment. However, whether such integration has a positive effect on the environment depends on the availability of scientific and reasonable development plans.

**Conclusion:** The results of this research offer critical insight into the impacts of agricultural tourism integration on rural ecological environments. In particular, the data demonstrate the importance of eco-friendly practices and biodiversity conservation when engaging in agricultural tourism integration as a way of promoting ecological sustainability in rural areas. Such evidence is essential to understanding the relation between agricultural tourism integration and rural ecological sustainability.

*Keywords: Rural revitalization; agriculture-tourism integration; ecological environment; ecological livable; Hunan Province.*

## 1. INTRODUCTION

The ecological environment is a fundamental element for human survival [1]. The ecological environment is a fundamental element for human survival. To achieve the harmonious coexistence of man and nature, it is essential to adhere to the concept of ecological and environmental protection during industrial integration and development processes [2]. Ecological livability constitutes the cornerstone for rural revitalization [3]. The integration of agriculture and tourism has important practical significance for promoting new industries and new formats in rural areas, realizing ecological livability and increasing farmers' income [4]. While agricultural tourism integration serves as a critical means to facilitate rural revitalization, its significant role in enhancing the ecological environment of rural areas has yet to receive sufficient attention from academia. Currently, most scholarly research on this subject has focused on examining the impact of agricultural tourism integration on rural industrial structure, thereby overlooking its potential contributions to promoting environmental sustainability in these regions.

In recent years, China has demonstrated an increased focus on rural development due to the sustained progression of the rural revitalization strategy. To address the "three rural" issues and promote the modernization of agriculture and rural areas, China is developing leisure agriculture and rural tourism boutique routes, optimizing rural leisure tourism, and promoting the integration of agriculture and tourism. New forms of leisure agriculture such as pastoral health preservation, research and science popularization, farming experience, leisure fishing, and home stay health care have been developed [5]. In addition, China has implemented a five-year action to improve the

rural living environment, including the demonstration and creation of beautiful livable villages and beautiful courtyards [6]. Hunan Province has also committed itself to promoting the modernization of agriculture and rural areas by taking the integration of tourism and agriculture as a breakthrough point to address the "three rural" issues. The rapid development of leisure agriculture in Hunan Province has transformed it from high-speed development to high-quality development [7,8]. It has become an important driver for promoting high-quality and efficient agriculture, livable rural areas, and prosperous farmers, as well as an essential starting point for promoting the integration of the three industries. Empirical research conducted by Wang et al. (2022) analyzed the impact of the integration of agriculture and tourism on the quality of the rural ecological environment based on the three dimensions of agricultural production and rural living environments. The study found a significant positive correlation between the integration of agriculture and tourism and the quality of the rural ecological environment. Therefore, the integration of agriculture and tourism has a positive effect on improving the quality of the rural ecological environment [9].

This paper examines the effects of the integration of agriculture and tourism on the rural ecological environment in Hunan Province, taking into account the government's support for the development of ecological livability in various regions. The second part explores the relationship between agricultural tourism, rural tourism, and agricultural tourism integration, drawing on relevant literature research by various scholars. In the third part, the paper outlines the influence mechanism of the integration of agriculture and tourism on the rural ecological environment. The fourth part adopts a

perspective of modern sustainable development, combined with the current situation of agricultural tourism integration and ecological livability in Hunan Province, to analyze the various elements of rural environmental investment and establish an empirical model. Finally, the paper concludes with suggestions for future research and policy, based on the findings of this study.

## 2. LITERATURE REVIEW

The integration of agriculture and tourism can be traced back to Germany's "citizen paradise" in 1850 and began to take root in China in the 1980s [10]. While Phillip et al. (2010) have summarized the characteristics of the integration of agriculture and tourism, there is no strict definition of this concept in academia [11]. However, there is no strict definition of the integration of agriculture and tourism in academia. Therefore, based on a comprehensive understanding of the integration of agriculture and tourism, this paper posits that it involves the rational development and utilization of agricultural tourism and land resources while fully respecting the functions of the agricultural industry. This includes the development of agricultural tourism and leisure projects, agricultural supporting commercial projects, and agricultural tourism real estate projects as the core functional structure, resulting in higher overall service quality [12].

The integration of agriculture and tourism is different from the traditional mode of agricultural Eco-tourism and the traditional mode of agricultural Eco-tourism pays more attention to the protection of the ecological environment [13]. The new agricultural ecological model of agricultural tourism integration focuses more on the running-in and sustainability of economic and ecological benefits [14]. The new format formed by the integration of agriculture and tourism has many expressions, such as rural tourism, agricultural tourism and so on. In short, it is a new model for the development of rural tourism and leisure agriculture. Leisure agriculture is an important part of the rural industry. It is an important carrier for the multi-functional expansion of agriculture, the integrated development of rural primary, secondary and tertiary industries, and the superposition of the whole industrial chain [15].

"Ecological livability" has been identified as a key component of rural revitalization efforts following the proposal made by the 19th National Congress of the Communist Party of China.

Furthermore, it has been recognized as a new requirement for the development of beautiful villages. In the context of rural construction, ecological livability encompasses not only the natural environment but also the quality of life of rural residents through enhanced village appearance and infrastructure. Thus, ecological livability can be defined as an environment that is both suitable for working and living, with emphasis on the protection and management of the natural environment, and improvement of the overall living standard [16].

Honarpisheh [17] found that rural tourism development can effectively reduce damage to the local environment and promote a more sustainable ecological structure in surrounding rural areas. Tong [18] conducted a comprehensive study of farmers' environmental management in relation to rural tourism by conducting literature reviews and experimental research. Deng [19] explained how to address the main ecological problems that arise as a result of rural tourism development and protect the rural ecological environment. Ma (2017) emphasized that effectively reconciling the tensions between rural tourism and the environment is critical for achieving sustainable tourism development. Although rural tourism development and construction may have certain impacts on the environment, subsequent tourism development can effectively promote ecological sustainability. Thus, the relationship between tourism and environmental construction should be complementary [20]. A recent investigation and analysis by Weyland et al. [21] indicated that farmers engaged in rural tourism are more willing to safeguard the uncultivated environment than those who are not involved in such tourism activities.

Privitera [22] analyzed the ecological characteristics that influence the integration of agriculture and tourism and concluded that this integration has positive effects on economic benefits, employment opportunities, and rural landscape protection. Wu [23] argued that environmental issues are closely linked to tourism development, with protecting the environment being capable of attracting more tourists and tourism contributing to the economy to build environmental sustainability. Based on the concept of ecological civilization construction, Tang et al. [24] constructed rural ecological agricultural tourism mode, rural ecological cultural tourism mode, and rural ecological food tourism mode using Cherry Valley Village, Great

Wall International Cultural Village, and Liugou Village as typical cases. Li et al. [25] believed that integrating agriculture and tourism was conducive to promoting the green transformation of rural industries, enhancing governance over rural resources, ecology, and human settlements, and improving rural ecological livability. Raftopoulos [26] proposed that rural community tourism can reshape the relationship between human beings and the environment, reevaluate environmental values and significance, and promote ecological environment protection. Chen et al. [27] applied the analytic hierarchy process to identify core evaluation indicators of rural ecotourism, finding that both human and natural conditions are critical elements of rural ecotourism resources, and the ecological environment plays a crucial role in rural ecotourism.

### 3 Theoretical Analysis

#### 3.1 Analysis on the development of agricultural tourism integration in Hunan province

The integration of agriculture and tourism in Hunan Province is a new format produced by the integration of leisure agriculture and rural tourism. It is one of the regions with earlier integration of rural tourism and leisure agriculture and more mature products and markets. The

overall development of rural tourism in Hunan Province is strong, and has basically formed four distinctive rural tourism areas: Changsha - Zhuzhou - Xiangtan economic development zone, Dong Ting Lake area, central and southern Hunan and western Hunan mountainous area [28]. It can be seen that the development momentum is good and the effect is remarkable.

Fig. 1 present the temporal distribution of Five-Star Rural Tourism Areas (Spots) in Hunan Province. From the perspective of the development scale of five-star rural tourism areas (spots) in Hunan Province, there were only 61 five-star rural tourism spots in Hunan Province in 2010, and the number has increased to 626 by 2022, which is about ten times the number in 2010. The number of leisure agriculture business entities in Hunan increased from 1860 in 2006 to 17,244 in 2021. The number of tourists received per year increased from 48 million to 206 million, and the total annual operating income increased from 2.65 billion to 47.04 billion. By 2020, Hunan has created 9 'Hunan leisure agriculture and rural tourism demonstration counties', 180 'Hunan leisure agriculture demonstration sites', and 100 'Hunan leisure agriculture agglomeration development demonstration villages'. These efforts have greatly facilitated the transformation and upgrading of leisure agriculture in Hunan Province.

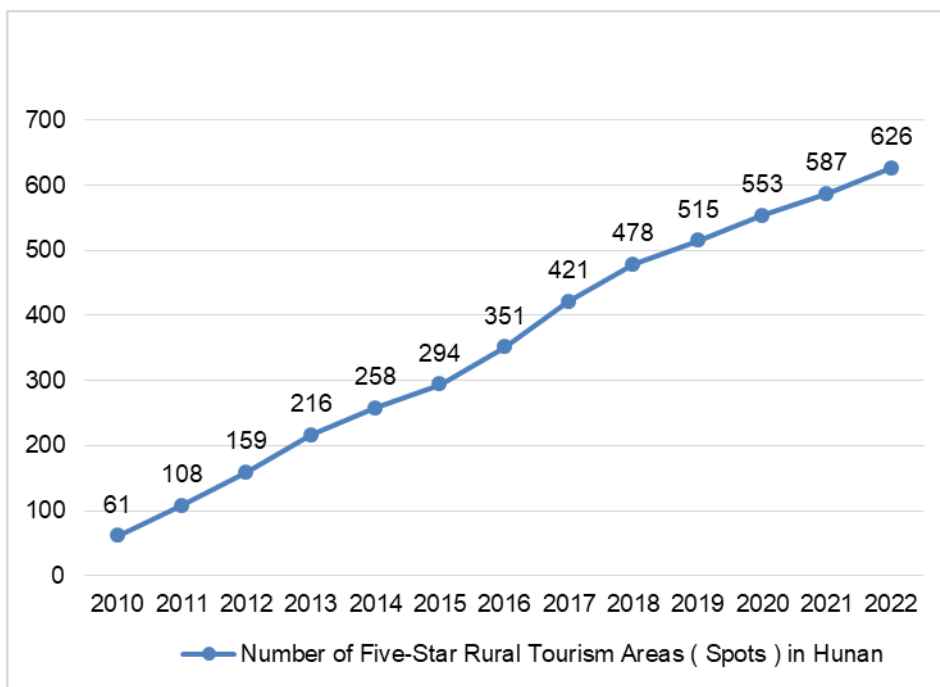


Fig. 1. Number of five-star rural tourism areas (spots) in Hunan

From the above data, it can be seen that leisure agriculture and rural tourism play an irreplaceable role in realizing strong agriculture, rural beauty and rich farmers. In addition, cities and prefectures in Hunan Province attach importance to tourism development. With the support of the government, the speed of industrial development has been significantly accelerated, and the quality has been continuously improved, which has promoted the development of rural economy.

Regional disparities and imbalanced development are apparent in Hunan Province. The province spans a vast territory, and each region has its distinct resource characteristics and human environment, which give rise to their unique regional advantages. Based on these differences and local conditions, different regions have created personalized rural tourism destinations that cater to their tourist offerings. From a spatial distribution perspective, Xiang Xi area focuses on ethnic culture and characteristic villages and towns; the eastern Hunan area features agricultural experience and leisure sightseeing types, while health sports are predominantly concentrated in southern Hunan. By capitalizing on each region's strengths, the integration of agriculture and tourism can avoid the problems associated with a duplication of product types. Nevertheless, due to rapid development, it is challenging to prevent the occurrence of identical products. Therefore, in subsequent tourism development, it is imperative to explore the rural characteristics from local historical heritage and folk customs and form a distinct brand that highlights the region's uniqueness.

### **3.2 Analysis of ecological livable development in Hunan province**

While developing leisure agriculture and rural tourism, Hunan Province adheres to the implementation of national policies, actively promotes the governance of rural ecological environment in development, and is guided by the construction of beautiful and livable villages. The year 2019 was a critical year for the "three-year action plan" aimed at combating pollution in Hunan Province. By prioritizing the implementation of environmental governance measures, the air and surface water quality in Hunan Province have seen continuous improvements, leading to effective protection of the natural ecological environment. However, the environmental problems in many cities are still

prominent, and the situation of urban environmental governance is still severe.

Upon conducting a thorough search for relevant research data, the ecological livability changes of various provinces and cities in Hunan Province from 2008 to 2018 were examined, and use ArcGIS to draw maps. The results are presented in Fig. 2.

From a temporal perspective, the construction of ecological livability in Hunan Province has witnessed steady growth. Generally, the level of ecological livability is lower in the central and western regions but higher in the eastern region. In 2008, Changsha City was the only region with high ecological livability, while the ecological livability level was moderate in the eastern region and substantially lower in the western region. By 2013, there was significant improvement throughout the province, particularly in Zhuzhou City, where the level of ecological livability had reached that of Changsha. By 2018, Hunan Province's ecological livability had made a qualitative leap, especially in the eastern region where it was relatively high.

From 2017 to 2022, the construction of beautiful rural demonstration villages in Hunan Province has been steadily promoted. In 2021, the list of beautiful rural demonstration villages has reached 301, and the rural living environment has been greatly improved.

### **3.3 Analysis of the influence mechanism of the integration of agriculture and tourism in Hunan Province on the rural ecological environment**

#### *3.3.1 Positive influence*

The integrated development of agriculture and tourism and the construction of beautiful villages complement each other. The integration of the two not only promotes the construction of beautiful villages, but also improves the level of rural ecological livability [30]. This paper divides the rural ecological environment into rural natural ecological environment and rural humanistic ecological environment. and analyzes the positive impact of the integration of agriculture and tourism from these two aspects (see Fig. 3).

The integrated development of agriculture and tourism is intrinsically linked to the utilization of local resources. In order to create tourism attractions, it is crucial to preserve the region's

natural beauty. In the development process, a series of protective measures need to be implemented to safeguard local biodiversity and ecological balance [31], conduct ecological restoration projects, and make rural environments more visually appealing and livable.

The integration of agriculture and tourism can effectively promote local agricultural product development, encourage the growth of organic, green, and pollution-free agricultural products, reduce the use of pesticides, fertilizers, and other harmful environmental factors, increase the ecological value of agricultural resources [32], and enhance the income of local farmers while

promoting their understanding of environmental protection.

The development of rural environmental construction necessitates that villagers have a deep appreciation for environmental protection. The economic benefits arising from the integration of agriculture and tourism can enable residents to realize the importance of independent ecological environmental protection, encouraging them to be more attentive to the environment, enhancing their awareness of environmental protection, translating economic benefits into ecological ones, and making sustainable environmental protection a fundamental aspect of everyday life [33].

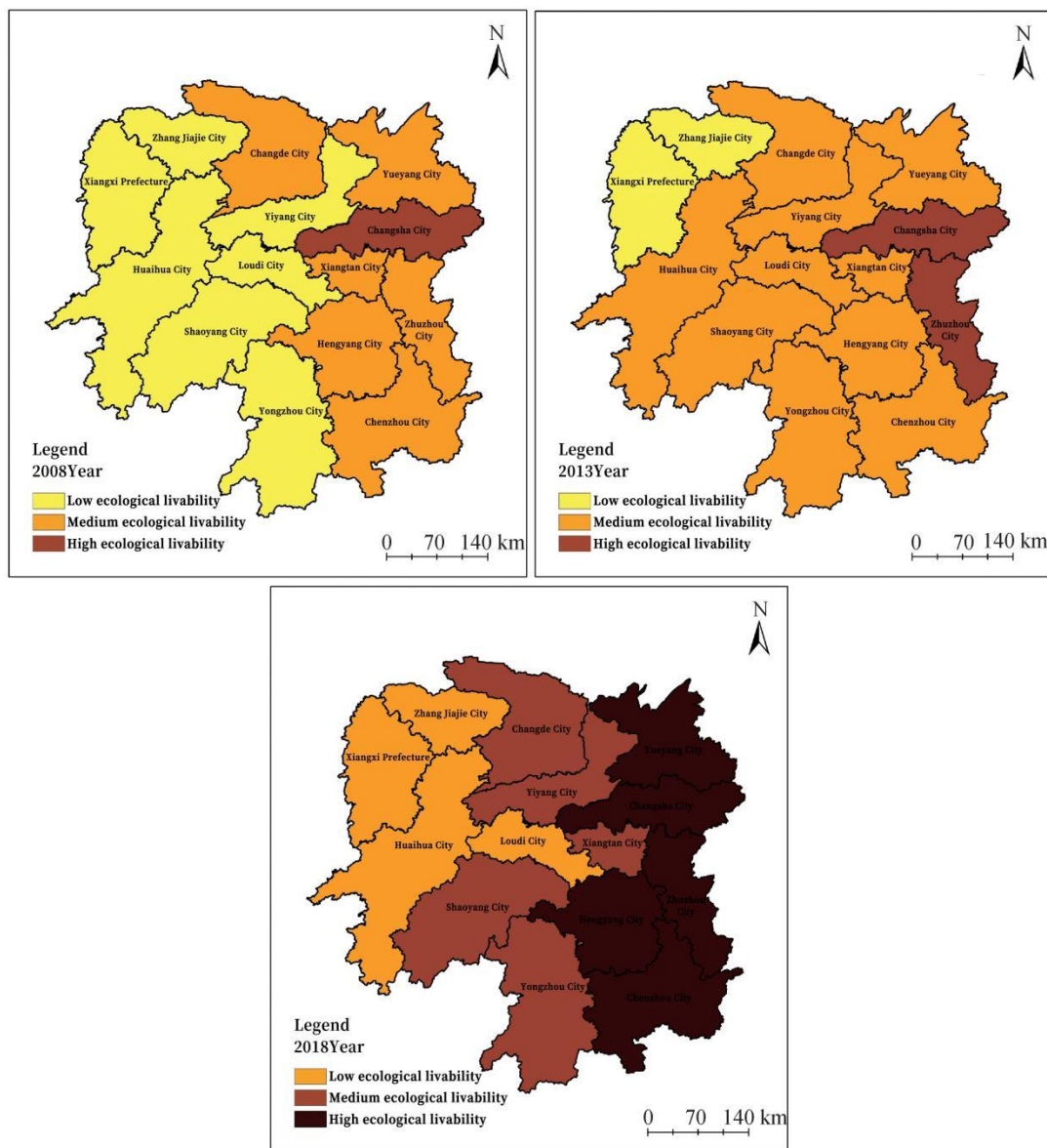


Fig. 2. Ecological livability trend of Hunan province [29]

The integration of agriculture and tourism can also support ecotourism, cultivate ecological tourists, and foster low-carbon and environmentally friendly approaches to travel, including cycling and hiking, which can minimize automobile exhaust emissions and land resource waste, reducing damage to the local ecological environment. Moreover, merging primary and tertiary industries can diminish the construction of polluting industries to some degree, reducing air pollution generated by industries, and significantly boost the natural ecological environment of rural areas.

The integrated development of agriculture and tourism necessitates maintaining a pristine natural landscape in rural areas. In order to enhance tourist satisfaction, many villages have improved their roadways, sewage treatment systems, garbage receptacles, public restrooms, and other infrastructure, renovated the rural environment, revitalized the appearance of the village, and enhanced the overall rural living environment. Meanwhile, efforts are made to strengthen the safeguarding of rural traditional folk customs to enhance the appeal of rural tourism. Tourist influx can bring about significant ideological impacts, and advanced ideologies and cultures can transform existing bad habits of rural communities to some extent. To become the foundation of leisure agriculture and tourism, some villagers actively learn Mandarin, improve their skillsets, and alter the collective spiritual outlook of the countryside.

### 3.3.2 Negative influence

As a novel business model under industrial integration, the integration of agriculture and tourism often prioritizes economic benefits at the early stage of integration, resulting in improper resource utilization. In addition, uncivilized tourist behavior and poor tourism operator management may also undermine the ecological environment.

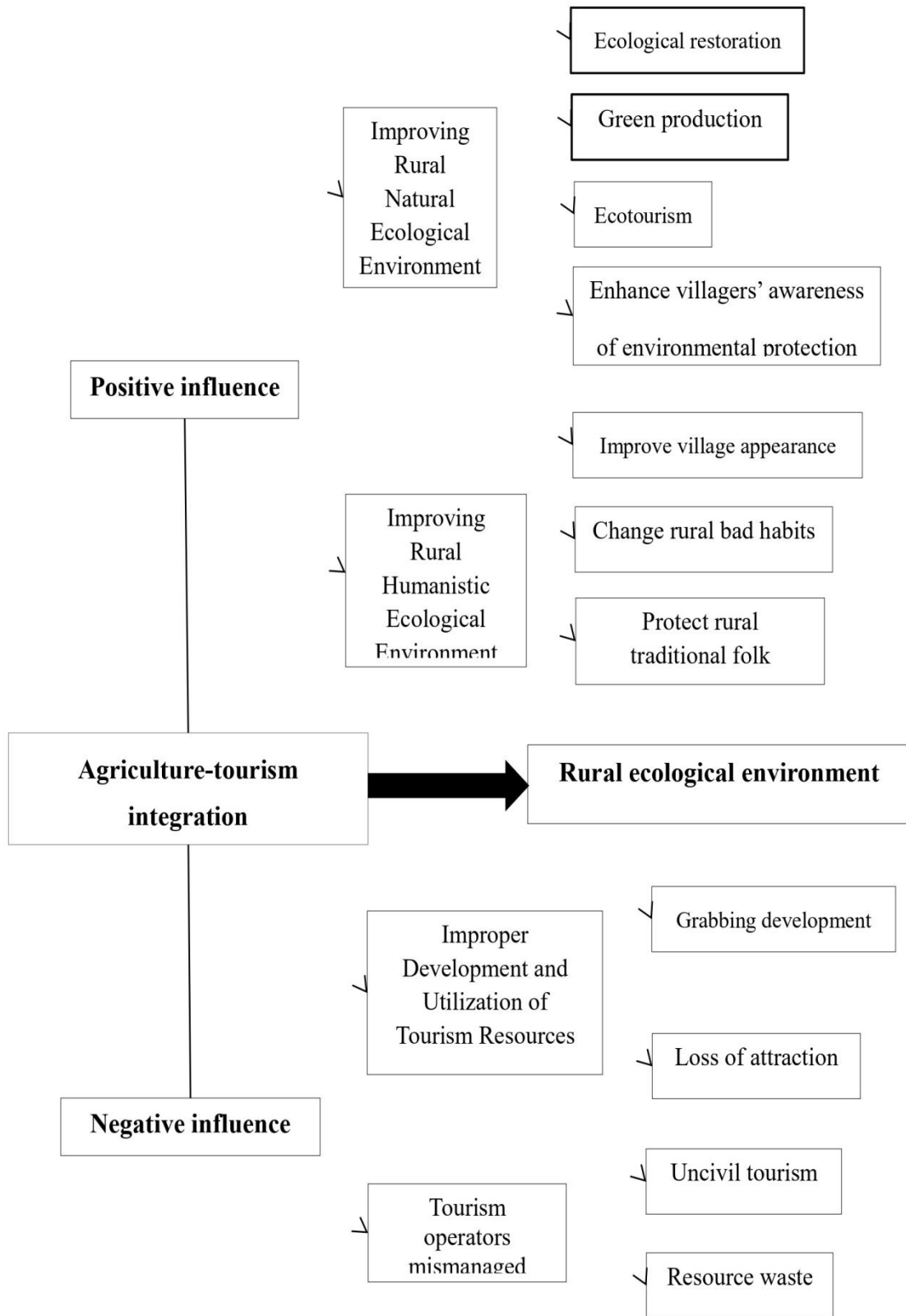
In the process of industrial integration of agriculture and tourism, the development of agricultural tourism resources has become one of the important measures for rural local governments to develop local economy. However, in some areas, when developing tourism resources, there is a lack of comprehensive feasibility investigation and scientific tourism project planning. Conformity and blind development ignore sustainable development, resulting in many tourism resources being snatched and developed, causing damage and waste of resources.

Because the integration of agriculture and tourism generally requires the use of land resources and water resources, if improperly developed, it may cause irreversible damage to the local ecological environment. For example, over-harvesting and hunting wildlife destroy the local ecological balance; large-scale construction of tourism facilities and hotels may lead to ecological problems such as soil erosion, waste of water resources and land desertification.

During rural tourism destination management, relevant departments often overlook the carrying capacity of the ecological environment and lack standardized management of scenic spots. Consequently, some rural tourism operators prioritize short-term profits and disregard sustainable development in their operations. They fail to effectively manage the garbage generated by tourists and improperly discharge wastewater and other pollutants in the scenic spot, leading to excessive accumulation of tourism debris and pollution of rural vegetation and rivers. Furthermore, inadequate rural tourism supporting facilities and infrastructure construction indirectly disrupts the ecological environment [34]. Repeated construction of artificial landscapes that do not align with natural landscapes or excessive pursuit of uniformity in rural houses lead to indistinguishable rural villages and the loss of character.

The rural ecological management approach in Hunan Province primarily focuses on pastoral health preservation, experiential observation, crop planting, and recreational fishing. In this mode, a large number of tourists can experience various sightseeing activities daily. However, if tourists behave uncivilized, it may pollute the farmland and rural surrounding environment.

Agriculture and tourism are resource-dependent industries that rely on the resources of tourism destinations. Thus, effective attraction of tourists entails adequate protection and development of these resources. The impact of agricultural tourism integration on the rural ecological environment has both positive and negative aspects, depending on the development planning and execution. Therefore, only a scientific and reasonable approach to development planning that prioritizes sustainable development can ensure that the integration of agriculture and tourism plays a positive role in promoting the rural ecological environment.



**Fig. 3. Influence mechanism of agricultural and tourism integration on rural ecological environment**



#### 4. AN EMPIRICAL ANALYSIS OF THE IMPACT OF RURAL TOURISM INTEGRATION ON RURAL ECOLOGICAL ENVIRONMENT FACTORS

##### 4.1 Model Construction

In order to verify the impact of the integration of agriculture and tourism in Hunan Province on the rural ecological environment, this paper constructs the following panel model:

$$\ln Y_{it} = \alpha + \beta_1 \ln X_{it} + \beta_2 \ln Z_{it} + \varepsilon_{it} \quad (1)$$

In formula (1), *i* represents 14 prefecture-level cities in Hunan Province, and *t* represents time (2015-2021). *Y* is the dependent variable for the rural ecological environment (REN) of cities and prefectures in Hunan Province. The independent variables include core independent variables and control variables. The core variable is the level of integration of agriculture and tourism (RTUR) in various cities and states of Hunan Province; the control variables include local fiscal revenue level (LFIN), urbanization level (URB), labor force (LAB), rural science and technology development level (RTEC), rural infrastructure level (RINF) and foreign direct investment level (FDI).

##### 4.2 Sources of Data

This paper uses the panel data of cities and states in Hunan from 2015 to 2021. The original data of each variable are from the website of Hunan Provincial Bureau of Statistics and the website of Hunan Provincial Department of Culture and Tourism\*. Specific instructions:

Ecological livability (REN) variable: This paper uses the amount of chemical fertilizer applied in

various cities and prefectures in Hunan to measure\*. Excessive application of chemical fertilizer is an important factor affecting the rural soil environment and water environment, which has certain representative.

The level of integration of agriculture and tourism (RTUR) variables: The level of integration of agriculture and tourism is the core variable of this paper. This paper uses the ratio of the number (stock) of five-star rural tourism areas (points) in Hunan Province to the population size in each year of each city and state to measure; local fiscal revenue level (LFIN) variable: This paper uses the total fiscal revenue of each city and state in the year; urbanization level (URB) variable: This paper uses the annual urbanization rate index of each city and state; the number of labor force (LAB) variables: this paper uses the scale of rural employment to measure; rural science and technology development level (RTEC) variable: this paper uses the total power index of agricultural machinery to measure; the rural infrastructure level (RINF) variable: This paper uses the total mileage index of rural roads to measure [The total mileage of the four-level highway in Hunan Province is adopted.]; foreign direct investment level (FDI) variables: This paper uses the total foreign direct investment index to measure.

Descriptive statistical analysis of each indicator is shown in Table 1.

##### 4.3 Empirical Analysis

###### 4.3.1 Empirical analysis results

Model 1 is the regression result without control variables, and Model 2 is the regression result with control variables, as shown in Table 2.

**Table 1. Descriptive statistical analysis of variables**

Variables	N	Unit	Mean	SD	Min	Max
REN	98	Ten thousand tons	16.86	7.980	5.580	37.52
RTUR	98	-	0.174	0.112	0.0190	0.487
LFIN	98	Ten thousand yuan	1.740e+06	2.160e+06	315,761	1.188e+07
URB	98	proportion	54.40	9.573	41.13	83.16
LAB	98	Ten thousand people	223.7	79.91	79.70	395.6
RTEC	98	Ten thousand kilowatts	452.3	166.6	109.4	673.9
RINF	98	kilometer	13,900	4,508	4,341	20,136
FDI	98	Ten thousand yuan	98,568	137,378	219	728,165

\*The number of rural employees in 2020-2021 and the total power of agricultural machinery in 2020 are estimated from previous data

Fertilizers referred to herein, excluding organic fertilizers

**Table 2. Regression results of each model**

	(1)	(2)
<b>Variables</b>	<b>REN</b>	<b>REN</b>
RTUR	-0.102*** (-8.42)	-0.090*** (-3.08)
LFIN		0.125** (2.23)
URB		0.127 (0.59)
LAB		1.444*** (3.03)
RTEC		-0.007 (-0.05)
RINF		-0.174 (-1.12)
FDI		0.012*** (2.72)
Constant	2.499*** (101.86)	-5.873* (-1.75)
Observations	98	98
R-squared	0.461	0.558
Number of city	14	14
F test	0	0
r2_a	0.370	0.443
F	70.96	13.90

*z-statistics in parentheses*  
 \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$

### 4.3.2 Empirical analysis discussion

The quantitative analysis results indicate that there are notable variations in the integration of agriculture and tourism across different cities and states in Hunan Province. However, the impact on the rural ecological environment is generally consistent. There is a significant negative correlation between the level of integration of agriculture and tourism and ecological livable variables:

The integration of agriculture and tourism development, in order to attract tourists, in the development process will consider the local ecological environment, take a series of protection measures, ecological restoration; it will also promote the development of local agricultural products, promote organic, green, pollution-free and other agricultural ecological products, thereby reducing the use of chemical fertilizers or using organic chemical fertilizers, but there are villagers who over-fertilize to promote crop growth, resulting in land resources and water resources. At the same time, the increase of rural population flow will bring some pressure to the ecological environment. If it exceeds the local ecological carrying capacity, it will lead to

ecological imbalance. The level of integration of agriculture and tourism is significantly negatively correlated with the ecological livability variable at the 0.01 level, and the correlation coefficients are -0.102 and -0.090. It can be seen that the negative impact of the integration of agriculture and tourism on the rural ecological environment in Hunan Province from 2015 to 2021 is greater than the positive impact, but its correlation coefficient is not large. It reflects that the impact of the integration of agriculture and tourism on the rural ecological environment can be controlled by the scientific and rational development planning in the early stage of development and the implementation of relevant measures in the implementation process, which verifies the conclusion of the above impact mechanism analysis.

There is a notable positive correlation between the ecological livable variables and the local fiscal revenue level, foreign direct investment level, and labor force level. Economic development is closely linked to industrial integration, and a more extensive labor force is fundamental to such development. The higher the level of economic development and labor force, the more positive is the impact of the integration of agriculture and tourism on the rural ecological environment, and the more prominent are the financial and human resource guarantees.

The level of urbanization, rural science and technology development, and rural infrastructure show no significant impact on ecological livability and have yet to reach an ideal level. This may be attributed to the fact that higher levels of urbanization imply that rural areas have already become urbanized, and the combination of agriculture and tourism cannot be carried out. Additionally, during urbanization, more attention is paid to urban environmental construction, and relatively insufficient investment is allocated to rural infrastructure and environmental protection. Ultimately, agricultural machinery indirectly affects the ecological environment by changing agricultural planting structures and affecting chemical input and waste treatment, but it also leads to substantial energy consumption and carbon emissions, thus having both positive and negative impacts.

## 5. CONCLUSIONS AND POLICY RECOMMENDATIONS

Based on the panel data of 14 cities and prefectures in Hunan from 2015 to 2021, this

paper uses the fixed effect model to empirically study the impact of factors such as the integration level of agriculture and tourism, local fiscal revenue level, urbanization level, labor force, rural science and technology development level, rural infrastructure level and foreign direct investment level on rural ecological environment. The results show that the development of agricultural tourism integration in Hunan Province under scientific and reasonable planning can effectively promote the construction of rural ecological environment.

The existence of a scientifically and reasonably designed development plan that takes into account sustainable development is directly related to the potential positive impact of agricultural tourism integration on the rural ecological environment. When implemented through scientific and reasonable planning, the development of agricultural tourism integration can enhance the natural ecological environment and humanistic ecological environment of rural areas. Additionally, the integration of agriculture and tourism has significantly reduced the amount of harmful substances produced during agricultural production processes, thereby promoting the development of the agricultural ecological environment. In terms of the impact on rural residents, promoting the integration of agriculture and tourism can raise awareness of environmental protection among residents and promote the sustainability of the rural ecological living environment. From the perspective of the tourism industry, the ecological construction of tourism destinations is necessary to attract tourists. By prioritizing ecological considerations during the development of tourism destinations, the integration of agriculture and tourism can have a positive impact on the rural ecological environment.

The economic support is the key to promote ecological livability in the integrated development of agriculture and tourism in Hunan Province. Promoting the organic combination of rural agriculture and tourism can improve the level of economic development. From the empirical results, promoting the integration of agriculture and tourism in areas with higher levels of local fiscal revenue and foreign direct investment can have a positive impact on the rural ecological environment. For example, the Chang-Zhu-Tan area is not only a region with rapid development of tourism, but also a region with high ecological livability. With the support of the economy, the ecological environment has been reasonably

protected in the development process, and the number of tourists has increased in an orderly manner without exceeding the ecological carrying capacity. The economy and the environment complement each other; Xiang Xi area is a gathering area of Tujia and Miao ethnic minorities, with prominent ethnic characteristics, ethnic architecture and folk culture with regional characteristics, and the natural resources of rural tourism in this area are very rich. In recent years, rural tourism has developed very rapidly. However, due to the slightly backward local economic development and relatively small investment in environmental protection, the ecological environment in this area has been damaged to a certain extent.

Based on literature research and empirical results analysis, it is evident that the integration of agriculture and tourism can greatly impact the development of rural ecological environment. Effective formulation of development plans and policies directly influences its positive impact, which ultimately leads to stimulated rural development. Further research could be conducted to identify the direct mode of action and impact mechanism more comprehensively. However, limited data collection has made it challenging to gather firsthand information from farmers, resulting in insufficient data standards on the real impact of the integration of agriculture and tourism on the rural ecological environment. Additionally, the current academic community lacks a clear measurement method for assessing the level of integration of agriculture and tourism. Thus, the author has provided their own understanding of this measurement, based on their reference materials. There is still ample research space for developing a comprehensive and universally accepted measurement method in the future.

Based on the above findings, we put forward the following policy suggestions.

1. In the process of integrated development of agriculture and tourism, Hunan Province combines different development progress and location characteristics of various regions, innovates planning concepts, and optimizes industrial function layout. Combined with the regional development status of 'Great Xiang Xi Poverty Alleviation and Critical Pilot Area' and 'Dong Ting Lake Eco-economic Circle', the comprehensive improvement of the rural environment around the drinking water source protection area

and the 'Dong Ting Lake Eco-economic Circle' is promoted as the focus of remediation.

To ensure effective implementation, the leading mechanism for promoting the county as a whole should be established. Relevant departments should integrate their strengths, invest multiple resources, and closely cooperate with each other. For instance, the environmental protection department should undertake comprehensive supervision of the environment, with a focus on the rural domestic waste treatment system and the formation of an environmental protection team. Meanwhile, the residential construction department should be responsible for establishing township sewage treatment facilities, while the water conservancy department should oversee rural drinking water safety projects. Additionally, the agriculture, animal husbandry, and aquaculture departments should work together to reduce non-point source pollution in agriculture and aquaculture. By setting up a leading mechanism and integrating the efforts of different departments, we can ensure the effective promotion and implementation of the county's development plans. In doing so, we can establish a sustainable and livable county that benefits everyone.

2. The government should formulate scientific development plans and promote the deep integration of agriculture and tourism. In the process of integrated development of agriculture and tourism, through systematic planning, organic integration of rural tourism resources, the development of agriculture, rural areas and farmers is highly integrated, so that leisure agriculture and rural tourism become the primary development industries in rural areas. According to the situation of each township, the feasibility analysis is carried out, and the relevant policies of the integration of agriculture and tourism are formulated in a differentiated way [35]. Strengthen the training of farmers' agricultural technology and business knowledge, improve the willingness of rural residents to develop leisure agriculture and rural tourism, improve their ability to run tourism, actively explore the local characteristics and historical culture of the countryside, enhance the economic benefits of tourism, and truly benefit the majority of farmers.

To formulate a scientific rural ecological environment protection plan, with the protection of the rural ecological environment as the core, focusing on increasing the employment opportunities and income of residents, maintaining the rural style and local humanistic characteristics, taking the road of standardization, scale, specialization and brand integration, promoting the development of rural tourism industrialization, and finally realizing the sustainable development of rural tourism and ecological livable construction.

3. The government should strengthen the improvement of rural ecological environment laws and regulations, improve the ecological environment benefits. We should firmly adhere to the concept of 'lucid waters and lush mountains are invaluable assets', adhere to the land use policy of 'developing in protection and protecting in development', and formulate relevant policy documents for implementing ecological environment protection and soil and water conservation. In the process of integrated development of agriculture and tourism, in addition to following the existing various protection laws related to land and water resources, it is also necessary to speed up the formulation of special protection laws and regulations for rural ecological environment, provide codes of conduct for all walks of life, and promote the sustainable development of agriculture and tourism integration. All kinds of tourism enterprises should also formulate relevant tourism environmental protection systems to ensure that tourism development activities are carried out within the ecological capacity.

Adhering to the principle of "who develops, who protects" and "who destroys, who restores" [36], the government should prioritize the development and construction projects of rural tourism across various departments. Additionally, we must reinforce the management of scenic operators, ensuring that they meet environmental standards. Hotel pollution control can be improved by implementing a pollution charge system, which encourages hotels to reduce their impact on the environment. We must also strengthen the construction of a punishment system for tourists who engage in uncivilized tourism behavior. At the same time, law enforcement departments should increase the

implementation of relevant systems to ensure that violators are held accountable.

By adopting a comprehensive approach to environmental protection and sustainable tourism development, we can promote the long-term development of rural tourism while protecting the natural environment. This will not only benefit tourists but also contribute to the well-being of locals and promote the overall development of rural areas.

4. Investment in Rural Construction and Supporting Ecological Environment Protection should be prioritized to push the integrated development. The level of economic support is the main influencing factor of the construction of ecological environment in the process of agricultural tourism integration in Hunan Province, and it is also an important basis for the construction of urban ecological livability. The level of economic development among 14 cities in Hunan Province is quite different. For areas with relatively low economic development levels such as Xiang Xi Autonomous Prefecture, Huai Hua City and Zhang Jiajie City, attention should be paid to economic development in the process of integration of agriculture and tourism. At the same time, we should adhere to improving the carrying capacity of the ecological environment. For the central and eastern regions with rapid tourism economic development and high environmental quality, residents' awareness of environmental protection should be continuously improved.

To promote the further in-depth development of the integration of agriculture and tourism, improve economic efficiency, make the achievements of economic development benefit more people, enhance the sense of gain of rural residents, and then feed back the protection of ecological environment. When the economic benefits brought by the development of rural tourism are comparable to the economic benefits brought by other heavy industries that pollute the ecological environment, more capital enterprises will take tourism as the focus of development, so as to increase the capital investment in the integration of agriculture and tourism industry and support the protection of ecological environment [37].

5. It's critical to strengthening the propaganda of rural ecological civilization and

improving the environmental protection consciousness of villagers and tourists.

Currently, urban residents have demonstrated a high level of moral quality, but some rural areas still lack awareness of environmental protection. Therefore, to better protect the ecological benefits of agricultural tourism integration, it is necessary to ensure that residents in rural areas share the same values of environmental protection. In promoting environmental protection efforts, increasing the participation of villagers in environmental governance and involving them in rural construction planning can enhance their sense of ownership and stimulate their potential for environmental protection. Additionally, this approach can generate employment opportunities for villagers. It is also crucial to focus on publicity efforts related to environmental protection during the development and construction phase. Local governments can use propaganda films and manuals to raise awareness of civilized tourism, and scenic spots should improve their interior signage promoting civilized tourism. Volunteers can be arranged to help maintain a civilized atmosphere within the scenic spot. By establishing a connection between residents and the ecological environment, we can foster a correct understanding of ecological civilization and create an atmosphere of environmental protection. In conclusion, promoting the participation of villagers in environmental governance and increasing public awareness of ecological protection can help to better protect the ecological benefits brought by the integration of agriculture and tourism while creating a sustainable environment for all stakeholders.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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