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A Study on the Comprehensive Effects of Rural Ecological Industry Development: A Case Study of Rural Areas in Xinyang, Henan Province

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Abstract: This study examines the multifaceted impacts of eco-industry development in rural regions, aiming to assess its influence on the ecological environment, human settlements, quality of life, economic level, and green awareness. Employing field surveys and in-depth interviews, this research gathered 228 valid datasets from six villages across three counties in Xinyang City. It systematically analyzed the impact of eco-industry development on these variables through multiple regression analysis. The findings reveal that eco-industry significantly enhances the rural ecological environment and human settlements, improves residents' quality of life and economic status, and bolsters farmers' green awareness. Additionally, the study identifies a strong positive correlation between the ecological environment and human settlements, illustrating the dual benefits of eco-industry in fostering both environmental and economic advancements. Consequently, the paper recommends that policies should further support eco-industries to foster the harmonious development of ecological, economic, and social benefits in rural areas.

1. Introduction

As the global environmental crisis intensifies, promoting ecological civilization has become essential, particularly in rural areas where environmental challenges hinder sustainable development. In China, protecting the rural ecological environment is crucial for national security and socio-economic progress, making it necessary to balance rural economic growth with ecological preservation [1].Eco-industries, including agriculture, forestry, eco-tourism, and eco-agriculture, present a viable solution by optimizing natural resource use and generating economic and social benefits [2]. However, the comprehensive effects of these industries on rural ecology, quality of life, economic development, human habitat, and green awareness still require thorough investigation [3]. Research shows that eco-industries enhance rural ecosystems by reducing pollution and improving resource efficiency, benefiting air quality, water resources, and land sustainability [4]. Additionally, they improve rural infrastructure, raise living standards, and expand employment opportunities through eco-tourism and eco-agriculture [5,6]. Moreover, eco-industries foster environmental awareness among residents, encouraging sustainable practices and contributing to broader green transformations [7]. This study explores the impact of eco-industry development on Xinyang City's rural areas, examining its effects on the ecological environment, human habitat, quality of life, economic level, and green awareness through field surveys and data analysis. The goal is to identify key impact mechanisms and propose policies for achieving coordinated ecological and economic development.

2. Literature Review and Research Hypotheses

Eco-industry development plays a crucial role in enhancing the rural ecological environment. Wei et al. demonstrated a significant positive interaction between agroecosystems and the rural ecological environment, showing that eco-agriculture improves environmental quality [8]. Similarly, Chen's study in the loess hill regions emphasized the synergy between rural economic development and ecological management, particularly in addressing soil erosion [9]. Peng further argued that eco-industrial advancement creates a win-win scenario for environmental protection and economic development [10]. Therefore, Hypothesis 1: Eco-industry development significantly improves the rural ecological environment.

The development of eco-industries also enhances rural human habitats. Tang et al. found that optimizing rural settlement organization positively affects human habitat quality and sustainability [11]. Wang's research supports this by highlighting the role of coordinated ecological and agricultural development in improving living conditions [12]. Additionally, Chen et al. noted that rural ecotourism boosts both ecological quality and residents' living standards [13]. Thus, Hypothesis 2: Eco-industry development significantly improves rural human habitat quality.

Eco-industry development is linked to better quality of life for rural residents. Bosshaq et al. identified a positive correlation between sustainable agriculture and residents' well-being, driven by employment opportunities and environmental improvements [14]. Sun et al. found that eco-agriculture and ecotourism directly raise living standards [15], while Ren et al. highlighted eco-agriculture's role in enhancing farmers' awareness and production methods [16]. Hence, Hypothesis 3: Eco-industry development significantly improves rural residents' quality of life.

In terms of economic growth, Zhu et al. showed that eco-industry facilitates economic and ecological objectives by optimizing resource utilization [17]. Li observed that in underdeveloped regions, eco-industry resolves conflicts between growth and environmental protection, thereby boosting regional economies [18]. Sun also reported that eco-agriculture and ecotourism significantly contribute to rural economic upgrades [15]. Therefore, Hypothesis 4: Eco-industry development significantly enhances the rural economy level.

Lastly, eco-industry boosts green awareness among farmers. Ren et al. found that eco-agriculture motivates sustainable agricultural practices, fostering greater ecological awareness [16]. Tan and Qi noted that promoting green development increases income and environmental awareness [7]. Gibbs and Qing et al. believed that a higher level of environmental problem cognition could promote farmers' environmental awarenessr [19, 20]. Thus, Hypothesis 5: Eco-industry development significantly enhances farmers' green awareness.

3. Research Design

3.1 Variable Enactment

The core explanatory variable of this study is eco-industrial development. This variable was quantified on a scale ranging from 1 to 10, where higher scores indicate greater levels of eco-industrial development. Eco-industrial development encompasses not only the effective use and protection of ecological resources but also the enhancement of economic growth and social progress. In this study, the mean score for eco-industrial development is 7, with a standard deviation of 2.376, which suggests that while the level of eco-industrial development in the sample is high, there remains considerable variability among the subjects.

The explanatory variables of this study encompass ecological environment, human settlements, quality of life, economic level, and green awareness. Firstly, the ecological environment, assessed mainly to gauge ecosystem health within the study area, was quantified through farmers' subjective evaluations of air quality, water cleanliness, soil health, and biodiversity on a scale from 1 to 10. A higher score indicates a healthier ecological environment, with a sample mean of 7.211 and a standard deviation of 1.935, suggesting overall favorable ecological conditions. Next, the human settlements, reflecting the comfort and living conditions of residents, included indicators such as housing quality, infrastructure, and public services. It scored an average of 7.487 with a standard deviation of 1.613 on the same scale, indicating general satisfaction among residents. The third variable, quality of life, measures overall satisfaction with living conditions, covering aspects like income, health, education, and social relations. It had a mean of 6.697 and a standard deviation of 2.093, showing variability in residents' quality of life. The fourth variable, economic level, assessed the economic status through income levels, employment opportunities, and growth rates, with a mean score of 2.684 and a standard deviation of 1.105 on a scale from 1 to 10, reflecting a relatively low economic level in the region. Lastly, green awareness was measured by residents' environmental protection behaviors and support for green policies, with a mean of 6.531 and a standard deviation of 2.220, indicating substantial environmental awareness among the majority of residents. Additionally, six demographic characteristics were selected as control variables in this study: age, gender, education, political profile, marital status, and return to home, all detailed in Table 1. The descriptive statistics for all variables in this study are presented in the same table.

Table 1: Descriptive statistics of variables.

Category	Variable Name	Mean	Standard Deviation	Range
Explanatory Variable	Ecological Industry Development	7	2.376	[1,10]
Dependent Variables	Ecological Environment	7.211	1.935	[1,10]
	Human Settlements	7.487	1.613	[1,10]
	Quality of Life	6.697	2.093	[1,10]
	Economic Level	2.684	1.105	[1,10]
	Green Awareness	6.531	2.22	[1,10]
Control Variables	Age	3.969	1.096	[18,60]
	Gender	1.465	0.50	1=Male; 2=Female
	Education Level	1.943	1.18	[Primary or less; Master's or above]
	Political Affiliation	3.509	0.978	1=Youth League member; 2=CPC member (including preparatory); 3=Democratic parties; 4=Non-affiliated
	Marital Status	1.829	0.411	1=Single; 2=Married; 3=Divorced
	Return to Hometown	1.237	0.426	1=No; 2=Yes

3.2 Data Sources

To collect first-hand data, the research team conducted field surveys in six villages across three counties of Xinyang City. Using questionnaires, interviews, and on-site observations, the team gathered rural residents' perspectives and feedback on eco-industry development, human habitat, quality of life, economic levels, and green awareness. (1) Questionnaire Survey: The team designed a questionnaire that encompassed a broad array of questions related to eco-industry development, environmental protection, and quality of life. This questionnaire was administered to randomly selected rural residents from the specified regions. Responses were recorded on a 10-point scale adapted from a five-point Likert scale. A total of 260 questionnaires were distributed, with 245 successfully recovered. After discarding responses that were either too brief or lengthy, or had incomplete information, 228 questionnaires were deemed valid, resulting in an 87.69% validity rate. (2) In-depth Interviews: In alignment with the directives of the General Secretary, the team selected six representative villages for in-depth interviews with village cadres, farmer representatives, and leaders of eco-agricultural enterprises. Each interview lasted between 30 to 60 minutes, yielding six valid records after thorough recording and documentation. These interviews provided detailed qualitative data, facilitating a deeper understanding of the rural residents' genuine opinions on the aforementioned topics.

3.3 Sample Characteristic

This study included 228 valid samples, capturing various demographic and socio-economic variables such as age, gender, education, political affiliation, marital status, return status, household headship, children's education, and household size (Table 2). The mean age was 3.97 (SD = 1.10), indicating most respondents were young to middle-aged adults (31-59). Gender distribution slightly favored males (mean = 1.46, SD = 0.50). Education levels were generally low, with most respondents having only primary to junior high school education (mean = 1.94, SD = 1.18). Politically, the majority were classified as general public (mean = 3.51, SD = 0.98). Most participants were married (mean = 1.83, SD = 0.41) and had not returned to their hometowns (mean = 1.24, SD = 0.43). Household headship was balanced (mean = 1.51, SD = 0.50), while children's schooling showed diverse participation (mean = 1.58, SD = 0.66). Household size varied significantly, with an average of 5.36 members (SD = 2.09), and 50% of households having four to six members.

Table 2: Sample feature description.

Statistic	Age	Gender	Education Level	Political Affiliation	Marital Status	Return to Hometown	Household Head	Child Education	Total Population
Count	228	228	228	228	228	228	228	228	228
Mean	3.97	1.46	1.94	3.51	1.83	1.24	1.51	1.58	5.36
Standard Deviation	1.10	0.50	1.18	0.98	0.41	0.43	0.50	0.66	2.09

4. Result

4.1 Reliability and Validity Test

The variables in this study underwent factor analysis, followed by tests for reliability and validity. Reliability was assessed using Cronbach's alpha to evaluate the internal consistency of the main variables, which included eco-industrial development, ecological environment, human settlements, quality of life, economic level, and green awareness. For validity, principal component analysis tested the structural validity. Reliability testing involved internal consistency coefficients, split-half reliability, and retest reliability. As shown in Table 3, the internal consistency coefficients ranged from 0.593 to 0.887, with the total scale achieving 0.901, indicating robust internal consistency. Specifically, the dimensions of ecological environment and green awareness exhibited high consistency with coefficients of 0.880 and 0.887, respectively. The split-half reliabilities for all dimensions exceeded 0.569, and the total scale demonstrated a split-half reliability of 0.797 and a retest reliability of 0.903, suggesting substantial stability and consistency across measurements. Consequently, the scale used in this study is reliable, effectively measures the targeted constructs, and provides reliable data support for subsequent analyses.

Table 3: Reliability analysis of the scale.

Dimension	Cronbach's Alpha	Split-Half Reliability	Total Scale Split-Half Reliability	Total Scale Test-Retest Reliability
Ecological Industry Development	0.621	0.652	0.797	0.903
Ecological Environment	0.880	0.842		
Human Settlements	0.787	0.737		
Quality of Life	0.677	0.641		
Economic Level	0.593	0.569		
Green Awareness	0.887	0.863		

The next step involved the validity testing of the scale using Principal Component Analysis (PCA), starting with the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity. The KMO value, which assesses the suitability of factor analysis, ranges as follows: values closer to 1 indicate higher suitability, with values over 0.9 being very suitable, 0.8-0.9 more suitable, 0.7-0.8 moderately suitable, and below 0.6 unsuitable. Typically, KMO values above 0.7 are considered effective for factor analysis. Bartlett's test, which checks for the independence among variables, requires a p-value less than 0.05 to confirm that the data distribution is adequately spherical and the variables are sufficiently independent. According to Table 4, each scale displayed varying degrees of validity. Notably, the scales for ecological environment, green awareness, and human settlements showed high interpretation rates, indicating rigorous design and consistent data. Despite lower KMO values in some scales, such as ecological industry development and economic level, their cumulative explanatory rates remained within acceptable limits. Together with the reliability tests and factor analysis results, the main predictor variable scales in this study have demonstrated sufficient reliability and validity, enabling further analysis.

Table 4: Principal component analysis of the scale.

Dimension	KMO	Significance	Total Variance Explained	Total Scale Validity Value
Ecological Industry Development	0.690	<0.001	0.620	0.890 (P=.000)
Ecological Environment	0.826	<0.001	0.687	
Human Settlements	0.761	<0.001	0.614	
Quality of Life	0.722	<0.001	0.516	
Economic Level	0.668	<0.001	0.731	
Green Awareness	0.741	<0.001	0.817	

4.2 Relevance Analysis

The correlation coefficient analyses of the scale dimensions (Table 5) revealed multiple significant correlations, further affirming the structural validity of the scale. Among the six dimensions evaluated, correlation coefficients ranged from 0.251 to 0.676, indicating a low to moderate level of interrelation. This suggests that while the dimensions exhibit directional consistency, they also maintain a degree of independence and are not interchangeable. Notably, the correlation between ecological environment and human habitat was the highest at 0.629, reflecting shared ecological factors or interactive influences in environmental assessments. This high correlation likely arises from the interdependent enhancement of the ecological environment and human habitat in green development, both contributing to the overall environmental quality. Overall, these statistically significant correlations validate the questionnaire design, demonstrating that the dimensions effectively capture and reflect the attributes of their respective domains, thereby providing a robust empirical foundation for the scale's scientific validity and reliability.

Table 5: Correlation coefficient test results.

	Eco-Industry	Eco-Environment	Human Settlements	Quality of Life	Economic Level	Green Awareness
Eco-Industry	1					
Eco-Environment	0.378**	1				
Human Settlements	0.471**	0.629**	1			
Quality of Life	0.429**	0.644**	0.676**	1		
Economic Level	0.346**	0.499**	0.528**	0.574**	1	
Green Awareness	0.310**	0.350**	0.276**	0.363**	0.251**	1

Note: Correlations marked with "**" are significant at the 0.01 level (two-tailed), while those marked with "*" are significant at the 0.05 level (two-tailed).

4.3 Multiple Regression Analysis

This study utilized multiple regression analysis to explore the impact of eco-industry development on various factors including the ecological environment, human habitat, quality of life, economic level, and green awareness. A stepwise regression model systematically analyzed the influence of each variable and their intrinsic associations, as detailed in Table 6. Model 1 incorporated basic demographic variables which had limited explanatory power ($R^2 = 0.031$), yet provided a foundation for subsequent analyses. Gender (Beta = 0.302) significantly positively influenced eco-industry development, possibly reflecting females' greater emphasis on environmental quality within the home. Marital status (Beta = 0.380) also had a significant positive effect, suggesting that married individuals prioritize eco-industry development due to family responsibilities and concerns for future generations. Additionally, the variable of returning home (Beta = 0.449) indicated that those returning to their hometowns support eco-industry development to enhance local economic and ecological conditions. Age (Beta = 0.035) and education (Beta = -0.011) showed no significant effects in this model but could interact differently in more complex models. Model 2 introduced the ecological environment as a key variable, which significantly positively affected the model (Beta = 0.5844***), increasing its explanatory power to $R^2 = 0.165$. This underscores the direct and substantial influence of eco-industry development on ecological improvement, particularly in sustainable resource use and ecological restoration. Model 3 included the habitat variable, showing a significant positive effect (Beta = 0.5826***), and raising the R^2 to 0.248. This model suggests that eco-industry development not only enhances the natural environment but also markedly improves living conditions through infrastructure and public service upgrades. Model 4 focused on quality of life, which had a significant positive impact (Beta = 0.2613*) and an R^2 of 0.259. Improvements in quality of life indicate eco-industry's role in bolstering economic support and social services, enhancing life satisfaction and well-being for rural residents, aligning with sustainable development goals. Model 5 added the economic level variable, showing a smaller yet significant positive effect (Beta = 0.161*), with an R^2 of 0.263. This reflects eco-industry's contribution to economic growth through industry chain extension, technological innovation, and market expansion, enhancing income and employment opportunities. Model 6 introduced green awareness, which had a significant positive effect (Beta = 0.1738**), reaching the highest explanatory power (R^2 = 0.283). This increase in green awareness highlights eco-industry's impact on boosting environmental awareness and fostering green cultural values.

Table 6: Stepwise regression analysis results.

Variable	Model 1 Beta	Model 2 Beta	Model 3 Beta	Model 4 Beta	Model 5 Beta	Model 6 Beta
Age	0.035	0.008	-0.033	-0.024	-0.026	-0.034
Gender	0.302	0.277	0.215	0.170	0.149	0.162
Education Level	-0.011	-0.089	-0.024	-0.038	-0.039	-0.072
Political Affiliation	-0.292	-0.2928*	-0.196	-0.187	-0.194	-0.161
Marital Status	0.380	0.260	0.320	0.308	0.28	0.337
Return to Hometown	0.449	0.355	0.251	0.250	0.287	0.250
Eco-Environment		0.5844***	0.2117*	0.1218*	0.102*	0.055
Human Settlements			0.5826***	0.4711***	0.4438**	0.4496***
Quality of Life				0.2613*	0.2157*	0.165*
Economic Level					0.161*	0.140
Green Awareness						0.1738**
R^2	0.031	0.165	0.248	0.259	0.263	0.283
F-value	1.751	16.224	19.011	18.475	17.756	17.757

Note: Statistical significance level is * $P < 0.05$, * * $P < 0.01$, * * * $P < 0.001$.

5. Conclusion

This study rigorously examines the comprehensive effects of eco-industry development on rural areas through multiple regression analyses of 228 valid samples from six villages in three counties of Xinyang City, Henan Province. Results indicate that eco-industry significantly enhances the ecological environment and human habitat, improves residents' quality of life and economic status, and effectively raises green awareness among farmers. The development of eco-industry not only boosts the natural environment but also enhances the human environment by upgrading infrastructure and public services, thereby substantially improving farmers' quality of life and economic conditions through increased employment opportunities and higher incomes, particularly in eco-agriculture and eco-tourism. Furthermore, eco-industry development has significantly elevated farmers' environmental protection awareness, with more adopting sustainable agricultural practices and engaging in eco-conservation activities, contributing to a socio-cultural green transformation. Consequently, it is recommended that government agencies enhance policy support for the eco-industry, particularly in financial investment, technical support, and market development. Additionally, strengthening eco-environmental education and technical training for farmers is crucial to increase their understanding of the eco-industry's significance, develop their green production capabilities, and further improve rural infrastructure to support eco-industry development. Future research should investigate the long-term impacts of eco-industry on rural social structures and cultural changes, and devise strategies to address emerging challenges and opportunities through innovative policies and technologies.

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