Research Article

Research Rural Ecological Stress Based on Farmers’ Livelihood Strategy in Three Gorges Reservoir Area

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The paper uses the AHP-DEA model to evaluate and analyze the current situation and influencing factors of rural ecological environment of farmers with different livelihood strategies in 9 administrative villages in 3 districts and counties of the Three Gorges Reservoir area. The conclusions are as follows: (1) The deeper the nonagricultural level, the worse the impact on the rural ecological environment, and the worse its ecological status. However, the degree of nonagricultural employment of farmers is not the only determinant of the quality of rural ecological environment. (2) The intensity of chemical fertilizer use, agricultural output value, pesticide use intensity, per capita net income, agricultural investment, and agricultural film use intensity are the key factors affecting the rural ecological environment of different part-time farmers in the Three Gorges reservoir area. The government should increase agricultural investment, introduce economically efficient agricultural projects, and vigorously develop low-carbon agriculture. (3) The rural ecological environment of farmers has not improved with the rapid development of the economy but instead has the opposite development trend; that is, the more developed the economy, the worse the rural ecology.

1. Introduction

The Three Gorges reservoir area is the most special ecological function area in China and the world; it is also one of the main ecologically vulnerable areas in the upper reaches of the Yangtze River. In recent years, scholars have carried out a series of studies on rural ecological problems in the Three Gorges reservoir area. Studies have shown that the rural ecological problems in the Three Gorges reservoir area are mainly reflected in the following aspects: frequent natural disasters and serious environmental pollution [1], destruction of biodiversity and serious soil erosion, and serious agricultural nonpoint source pollution [2, 3]. Focusing on how to solve the dilemma faced by the rural ecological environment in the Three Gorges reservoir area, the researchers separately constructed the development model of rural ecological agriculture [4], the establishment of rural ecological protection incentive mechanism [5], adjustment of agricultural industrial structure [6, 7], and ecological landscape design [8], and other aspects were analyzed and demonstrated.

The farmers in ecological protection play an important role. Especially for rural areas where most of China’s ecology is relatively fragile, farmers are the main players in the local ecosystem [9, 10]. Farmers directly or indirectly relate to ecological factors such as grassland, forest, land, water source through the production, consumption, and investment of the production and management models and consumer demand is closely related to their ecological behavior decision-making and has a strong impact on the rural ecological environment [13–15]. But what are the impacts of different livelihood strategies of farmers on the rural ecological environment and how they affect them? There is currently no relevant quantitative research. Therefore, it is very urgent to reveal the impact of changes in livelihoods on the rural ecological environment...
environment from the perspective of farmers in the Three Gorges reservoir area. This study uses the AHP-DEA model for assessing the impact of different farmer strategies on rural ecological environment. Select a typical sample village in the Three Gorges reservoir area, and compare and evaluate the impact of different livelihood strategies on rural ecological environment. In order to ensure the rural ecological security and the sustainable livelihood of farmers in Three Gorges reservoir area, provide reference for promoting the healthy development of regional social economy.

2. Materials and Methods

2.1. Data Collection. In July-August 2018, the research team conducted household surveys in Zhenxi Town of Fuling District, Yanshan Town of Wanzhou District, and Pingan Township of Fengjie District to obtain relevant data. Randomly select 15-25 households in each village, for a total of 192 households. The survey was completed in the form of a household interview. The survey sample farmers are divided into five types of livelihood strategies: traditional agriculture type, professional agriculture type, agricultural part-time type, nonagricultural part-time type, and nonagricultural type. From the basic situation of the sample, the survey sample has a certain representativeness (Table 1).

2.2. Study Methods

2.2.1. Construction and Descriptive Analysis of Evaluation Indicators. When establishing an indicator system for the evaluation of the impact of different livelihood strategies of farmers on rural ecological environment, mainly consider the impact of different livelihood strategies of farmers on rural resources and environment, rural production environment, and rural living environment. Through the construction of the rural ecological environment evaluation index system. In this study, 17 indicators including per capita arable land area were selected to evaluate the rural ecological environment of different farmers. Descriptive statistics for each variable is shown in Table 2.

2.2.2. Evaluation Model Construction. Comprehensively use the Analytic Hierarchy Process and Data Envelopment Analysis (AHP-DEA) to evaluate the impact of different livelihood strategies of farmers on rural ecological environment [16, 17]. Its model integration is as follows:

\[ P = \alpha R + (1 - \alpha) \theta^*, \quad \alpha \in [0, 1]. \]

In the formula, \( P \) is a comprehensive evaluation value. \( R \) is the AHP model evaluation value. \( \alpha \) is the subjective preference coefficient of the decision maker, and its specific value is given by the decision maker according to its preference, and \( \alpha \) is 0.5. \( 1 - \alpha \) is the objective preference coefficient.

3. Research Result and Next Research Plan

3.1. Research Result

3.1.1. Evaluation Results of Rural Ecological Environment for Different Subsistence Types of Farmers. From the evaluation results of the AHP-DEA model (Table 3), the ranking of AHP-DEA comprehensive evaluation values of rural ecological environment of different livelihood strategies in Zhenxi Town of Fuling District is professional agriculture type > traditional agriculture type > agricultural part-time type...
Table 2: Descriptive statistical analysis of the variables.

| Variable                                    | Unit       | Code | Mean    | Standard deviation | Max    | Min    |
|---------------------------------------------|------------|------|---------|--------------------|--------|--------|
| Per capita cultivated area                  | Hectare    | C1   | 0.04    | 0.06               | 0.08   | 0.02   |
| Per capita effective irrigated area         | Hectare    | C2   | 0.03    | 0.02               | 0.05   | 0.01   |
| Fertilizer use intensity                    | kg/hectare | C3   | 315.44  | 134.51             | 533.42 | 154.11 |
| Pesticide use intensity                     | kg/hectare | C4   | 3.04    | 1.52               | 5.13   | 1.48   |
| Agricultural film strength                  | kg/hectare | C5   | 4.61    | 1.42               | 8.01   | 3.51   |
| Diesel usage                                | kg         | C6   | 2.92    | 1.35               | 5.74   | 1.04   |
| Straw comprehensive utilization rate        | %          | C7   | 30.2    | 10.14              | 47.8   | 16.5   |
| Returning farmland to forests               | %          | C8   | 22.81   | 7.61               | 31.41  | 9.54   |
| Annual output value of family farming       | Ten thousand yuan | C9 | 10.95 | 3.48 | 15.33 | 6.25 |
| Household agriculture power consume         | Kilowatt/hour | C10 | 218.21 | 57.72 | 315.23 | 131.15 |
| Annual investment in family farming         | Ten thousand yuan | C11 | 6.83 | 3.76 | 12.33 | 2.31 |
| Family agricultural population ratio        | %          | C12  | 32.13   | 19.67              | 80.3   | 12.5   |
| Per capita annual net income                | Yuan       | C13  | 6875.35 | 2864.42           | 11356.55 | 3535.81 |
| Per capita living area                      | m²         | C14  | 87.9    | 16.19             | 124.3  | 76.34  |
| Per capita annual consumption level         | Yuan       | C15  | 4813.45 | 1989.21           | 7694.03 | 2871.18 |
| Rural medical insurance participation rate  | %          | C16  | 67.15   | 12.67            | 81.22  | 37.32  |
| Rural pension insurance participation rate  | %          | C17  | 35.08   | 13.19            | 52.44  | 16.12  |

Table 3: Evaluation of rural ecological environment models of farmers with different livelihood strategy types.

| Research area                        | Livelihood strategy type | AHP value | Θ value | Comprehensive evaluation value | In-region sorting | Sort within total area |
|--------------------------------------|--------------------------|-----------|---------|--------------------------------|-------------------|-----------------------|
| Zhenxi Town of Fuling District       | Traditional agriculture type | 0.8356 | 1       | 0.9178                        | 2                 | 4                     |
|                                     | Professional agriculture type | 0.9359 | 1       | 0.9680                        | 1                 | 1                     |
|                                     | Agricultural part-time type | 0.7791 | 0.9231 | 0.8511                        | 3                 | 7                     |
|                                     | Nonagricultural part-time type | 0.7246 | 0.8842 | 0.8044                        | 4                 | 10                    |
|                                     | Nonagricultural type | 0.6427 | 0.8111 | 0.7269                        | 5                 | 14                    |
|                                     | Traditional agriculture type | 0.8251 | 1       | 0.9126                        | 2                 | 5                     |
|                                     | Professional agriculture type | 0.8764 | 1       | 0.9382                        | 1                 | 2                     |
| Yanshan township of Wanzhou District | Agricultural part-time type | 0.7138 | 0.8621 | 0.7880                        | 4                 | 11                    |
|                                     | Nonagricultural part-time type | 0.7376 | 0.9013 | 0.8195                        | 3                 | 9                     |
|                                     | Nonagricultural type | 0.6895 | 0.8364 | 0.7630                        | 5                 | 12                    |
|                                     | Traditional agriculture type | 0.8381 | 1       | 0.9191                        | 1                 | 3                     |
|                                     | Professional agriculture type | 0.7875 | 1       | 0.8938                        | 2                 | 6                     |
| Pingan Township of Fengjie District   | Agricultural part-time type | 0.7452 | 0.8975 | 0.8214                        | 3                 | 8                     |
|                                     | Nonagricultural part-time type | 0.6742 | 0.8243 | 0.7493                        | 4                 | 13                    |
|                                     | Nonagricultural type | 0.6421 | 0.8056 | 0.7239                        | 5                 | 15                    |
type > nonagricultural part-time type > nonagricultural type. The ranking of AHP-DEA comprehensive evaluation values of rural ecological environment of different livelihood strategies in Yanshan Township of Wanzhou District is professional agriculture type > traditional agriculture type > nonagricultural part-time type > agricultural part-time type > nonagricultural type. The ranking of AHP-DEA comprehensive evaluation values of rural ecological environment of different livelihood strategies in Pingan Township of Fengjie District is traditional agriculture type > professional agriculture type > agricultural part-time type > nonagricultural part-time type > nonagricultural type.

From the perspective of the impact of different livelihood strategies of farmers in different regions on the rural ecological environment and the rural ecological environment of traditional agriculture type farmers, the first place is Pingan Township of Fengjie District. Traditional agriculture type farmers in Yanshan Township of Wanzhou District and Zhenxi Town of Fuling District are ranked second. It can be seen that professional agricultural farmers and traditional agricultural farmers have a relatively strong awareness of the rural ecological protection on which they depend, the manpower and material resources that are willing to invest in protection are more, and the rural ecological conditions of professional agricultural farmers and traditional agricultural farmers are better. The rural ecological environment of nonagricultural farmers in the three regions is at the bottom. It can be seen that the rural ecological environment of nonagricultural farmers in the region is generally poor. The main reason is that non-agricultural farmers’ agriculture is not the main source of their survival; their dependence on rural areas and their protection is reduced. Coupled with the ineffective supervision mechanism, rural areas often become the hardest hit areas for nonagricultural pollution.

The ecological environment of agricultural part-time households varies from region to region. Overall, the deeper the nonagricultural level, the worse the impact on the rural ecological environment; its ecological condition is also worse. The degree of nonagricultural is not the only determinant of the quality of the rural ecological environment. In addition to different policy guidance for farmers with different livelihood strategies, it is also possible to improve the rural ecological environment by improving other relevant factors.

3.1.2. Analysis of the Factors Affecting the Rural Ecological Environment by Different Livelihood Strategies of Farmers. The indicators with the top 6 weights are agricultural output value, fertilizer use intensity, pesticide use intensity, agricultural investment amount, agricultural film use intensity, and per capita net income. It is indicated that these six indicators are the decisive indicators for the status of rural ecological environment affected by different livelihood strategies of farmers. Therefore, improving the rural ecological environment from the perspective of adjusting farmers’ livelihood strategies, the main consideration should be given to improving the rural resource environment; the key measures are to reduce the intensity of chemical fertilizer use, the intensity of pesticide use, and the strength of agricultural film use and increase agricultural output value, per capita net income, and agricultural investment.

In further analysis, the use of pesticides, fertilizers, and agricultural films is the specific application of the achievements of the human industrial revolution in agriculture. Although it has a significant effect on agricultural production, it may also bring about the residual poison of agricultural products, agricultural nonpoint source pollution, and soil degradation, and the negative effects that affect the sustainable development of agriculture cannot be ignored. In this regard, improving the level of further agricultural production technology and vigorously developing low-carbon agriculture are effective ways to reduce and replace pesticides, fertilizers, and agricultural films.

3.1.3. Regional Differences in the Impact of Farmers’ Different Livelihood Strategies on Rural Ecological Environment. Judging from the results of the entire study area, the top five in rural ecological conditions are as follows: professional agricultural farmers in Zhenxi Town of Fuling District, professional agricultural farmers in Yanshan Township of Wanzhou District, traditional agricultural farmers in Pingan Township of Fengjie County, traditional agricultural farmers in Zhenxi Town of Fuling District, and traditional agricultural types in Yanshan Township of Wanzhou District Farmers.

On the whole, the comprehensive ecological environment value of the five types of farm households in Zhenxi Town of Fuling District averaged 6.6 th, the comprehensive ecological value of the five farmer types in Yanshan Township of Wanzhou District averaged 7.8 th, and that of Ping’an Township of Fengjie averaged 9 th.

The level of economic development has always been an important factor affecting the choice of farmers’ livelihood strategies. The study of regional economic development levels is as follows: Zhenxi Town of Fuling District has the highest level of economic development, followed by Ping’an County of Fengjie County and Yanshan Township of Wanzhou District. It can be seen that the ranking results of the rural ecological environment of the farmers in the study area are almost consistent with the economic development level of each region. The more developed the economy, the worse the rural ecological environment of the farmers, and the more backward the economy, the better the rural ecological environment of the farmers.

The main conclusions are as follows: (1) The deeper the nonagricultural level, the worse the impact on the rural ecological environment and the worse its ecological status. However, the degree of nonagricultural employment of farmers is not the only determinant of the quality of rural ecological environment. (2) The intensity of chemical fertilizer use, agricultural output value, pesticide use intensity, per capita net income, agricultural investment, and agricultural film use intensity are the key factors affecting the rural ecological environment of different part-time farmers in the Three Gorges reservoir area. The government should increase agricultural investment, introduce economically efficient agricultural projects, and vigorously develop low-carbon agriculture. (3) The rural ecological environment of Italian.
farmers has not improved with the rapid development of the economy but instead has the opposite development trend; that is, the more developed the economy, the worse the rural ecological.

3.2. Next Research Plan. According to the previous research results, the research group plans to put forward relevant countermeasures for the coordinated development of farmers' part-time employment and rural ecological environment in the next step, so as to provide reference for ensuring the rural ecological security and the sustainable development of farmers' livelihood in the Three Gorges Reservoir area and promoting the healthy development of regional social economy.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

It is declared by the authors that this article is free of conflict of interest.

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