



The Realization Mechanism of Rural Multi-Value Comes from Rural Living Environment Improvement in Mountainous Areas of Western China

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Abstract

In solving the rural decay problem, exploring rural values, promoting rural economic development, and improving the rural living environment have become popular in many countries worldwide. However, few studies show how improving the rural living environment affects realizing rural multi-value. Therefore, this study investigated the actual problems villages faced in most countries and built an evaluation index system for the effectiveness of rural living environment improvement and the degree of realization of rural multi-value from the commonality + individuality dimension. The model was based on a clear theoretical logic of improving the rural living environment and realizing rural multi-value. A typical town in Gansu Province of China was selected as the case study to reveal the realistic correlation and action process and to design a differentiated path for improving the rural living environment to help realize rural multi-value. The results showed that enhancing the rural living environment had a basic supporting effect on rural multi-value. The effectiveness of rural living environment improvement and the degree of realization of rural multi-value had a spatial convergence. Also, improving the environment toward realizing rural multi-value involved the following: toilet renovation and household waste management were the core factors; improving the village outlook was crucial; focusing on the domestic sewage treatment; and constructing infrastructures was the link. Overall, this study deepened the understanding of the impact of the rural living environment on the rural multi-value. The findings provided new insights for rural policymakers to understand better the impact of living environment improvement on rural development. Also, the results provided practical guidance for developing countries to solve rural decay problems and promote

sustainable development.

Subject Areas

Human Geography

Keywords

Rural Multi-Value, Rural Living Environment Improvement, Realization Mechanism, Dahonggou Town

1. Introduction

Rural decay has become a global problem, (being) experienced by every country globally [1] [2]. It manifests mainly as a lack of industry, a backward economy, a deteriorated ecological environment, abandoned land, a reduced rural population, and so on [3] [4] [5] [6]. However, these traits are against some of the United Nations (UN) Sustainable Development Goals (SDGs) (such as poverty eradication, good health and well-being, clean water and sanitation, industry, and innovation and infrastructure) aimed to be achieved by 2030. Therefore, countries worldwide actively explore viable solutions to solve rural decay problems and achieve the SDGs. Typical cases mainly include the new town construction in the United States [7], the new rural movement in South Korea [8], the gradual rural transformation in Germany [9], and the “one village, one product” movement in Japan [4]. Of course, China is also constantly exploring options while gradually improving the backward situation in rural areas to provide the Chinese experience for all countries globally. Therefore, it has implemented a rural revitalization strategy [10].

Several cases have shown that promoting rural development is a complex systematic project that chooses different development models based on varied economic levels and natural resources available in various countries. However, improving the quality of the rural living environment seems the primary choice for global governance of rural decay [11]. It involves first improving the essential needs of farmers and promoting the development of rural industries, thereby improving rural economic development. This development model is particularly evident in China, the world’s largest developing country. Since implementing the rural revitalization strategy, especially after introducing the “Rural Living Environment Improvement Three-year Action Plan” in 2018, China has focused on rural living environment improvement given specific problems (such as poor village appearance, poor environmental sanitation, unavailable toilet facilities, and backward infrastructure) to build beautiful and livable villages, help realize rural multi-value, and promote rural economic development. Presently, the quality of the rural living environment in China has improved substantially. However, there is still a gap between the long-term management and care of the

human settlements and the supporting facilities for industrial development and the aspirations of the masses of farmers for a better life [12] [13].

In 2021, China issued the “Rural Living Environment Improvement Five-year Action Plan (2021-2025)” to help promote the rural living environment improvement, digging deeper into rural multi-value. Realizing the rural multi-value based on continuously improving the quality of the rural living environment, China has adopted attracting many enterprises to enter the rural development and construction, attracting many tourists to experience rural life to drive economic growth, and constantly stimulating the endogenous power of rural development. In addition, realizing rural multi-value is a complex process, accompanied by diversifying rural industries, rural subjects, rural products, and rural land use.

So far, the academic research on rural multi-value mainly focuses on cognition, connotation analysis, realization path exploration, and other aspects [14]-[19]. Some rural areas dig deeper into pastoral resources to realize the multi-value therein. However, some shortcomings still exist, such as the below-par supporting facilities for rural agricultural production and effectively sustaining (managing and protecting) the rural environment for the long term. These problems need a systematic solution to improve the rural living environment comprehensively. The relevant available academic research only focused on the rural living environment improvement and its effect evaluation [20] [21], the governance mode and path of rural living environment [22] [23], and the relationship between the rural living environment improvement and rural revitalization [24] [25].

In a word, at present, the academic circles do not have a unified definition of the related concepts of the realization of rural multi-value and the rural living environment improvement. There are few studies on the relationship between the rural living environment improvement and the realization of rural multi-value and how the former helps the latter. Clarifying the conceptual connotation of rural living environment improvement and rural multi-value realization is helpful to clarify the logical relationship between the two and provide the basis for constructing the evaluation index system. Rural living environment improvement is a process in which rural multi-subjects, in order to realize the products and services they need, consider the current situation of regional living environment and take a series of initiatives to improve the hard environment, including living conditions, infrastructure and environmental sanitation, as well as the soft environment, including the comfort of life, the level of social services and the spirit of the farmers, in order to enhance the quality of the rural living environment. The realization of rural multi-value is a process in which farmers, village committees, the Government, rural enterprises and other rural subjects, in line with the overall goal of common prosperity and based on the actual situation of rural development, develop the forest economy, modern agriculture, rural tourism and other industries embodying a unique rural lifestyle by means of

strengthening ecological environmental protection, optimizing the structure of the agricultural industry, improving rural infrastructure, enhancing the quality of the rural habitat, and tapping into the traditional culture of the countryside, so as to fully tap and make use of the rural resources and raise the incomes of the peasants. The rural living environment improvement and the realization of rural multi-value are the process of using, transforming and updating rural regional space by rural multiple subjects. The result of the rural living environment improvement is characterized by the change of rural background conditions, and all rural development is inseparable from the rural background environment. It can be seen that the rural living environment improvement has a supporting role in the realization of rural multi-value (Figure 1).

Therefore, this study chooses the administrative villages of typical agricultural counties in China as the research unit. On the basis of clarifying the logical relationship between the realization of rural multi-value and the rural living environment improvement, this study constructs the evaluation index system of the effectiveness of rural living environment improvement and the realization degree of rural multi-value from the two dimensions of “commonness + individuality”, and explores the realistic relationship between the two. The fuzzy set qualitative comparative analysis method was used to analyze the influence mechanism of rural living environment improvement on the realization of rural multi-value, and to design the differentiated promotion path, so as to provide practical basis for promoting rural revitalization and providing Chinese experience for promoting sustainable rural development in the world.

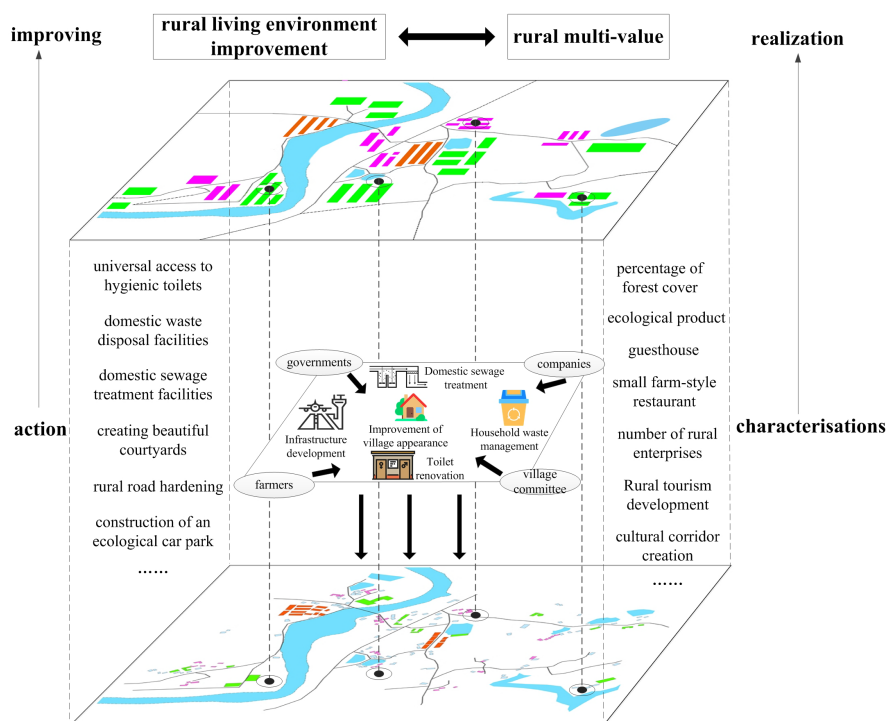


Figure 1. Framework diagram of the research idea.

2. Data and Methods

2.1. Study Area

This research selected Dahonggou Town in Gansu Province, China (**Figure 2**), as the empirical study area. Dahonggou Town has a land area of 260 km², nine administrative villages, and 53 villagers' groups. Dahonggou Town consistently implements developing “green water and green mountains are gold and silver mountains” concepts, promotes constructing ecological civilization in the area, and improves the rural living environment. As a result, it achieved the full coverage of infrastructure service facilities (such as piped water, transportation, electricity, Internet, villagers' fitness square, village comprehensive cultural service center, health institutions, etc.) by 2022.

Selecting Dahonggou Town for this empirical research was driven by two considerations. 1) Dahonggou Town is located at the intersection of the Tibetan Plateau, Loess Plateau, and Inner Mongolia Plateau. It has a fragile, diverse, and vital ecological environment, for which detailed and reliable research data have been obtained in a previous study. 2) Dahonggou Town is a typical town in mountainous poverty-eradication county. In combating poverty and implementing a rural revitalization strategy, Dahonggou Town combines the development of each village and the farmers' interest, thereby adopting the development mode of “adapting to local conditions and classifying policies” for nine administrative villages. There are differences in the degree of realizing the rural multi-value relevant to the research theme of this paper. In short, improving the

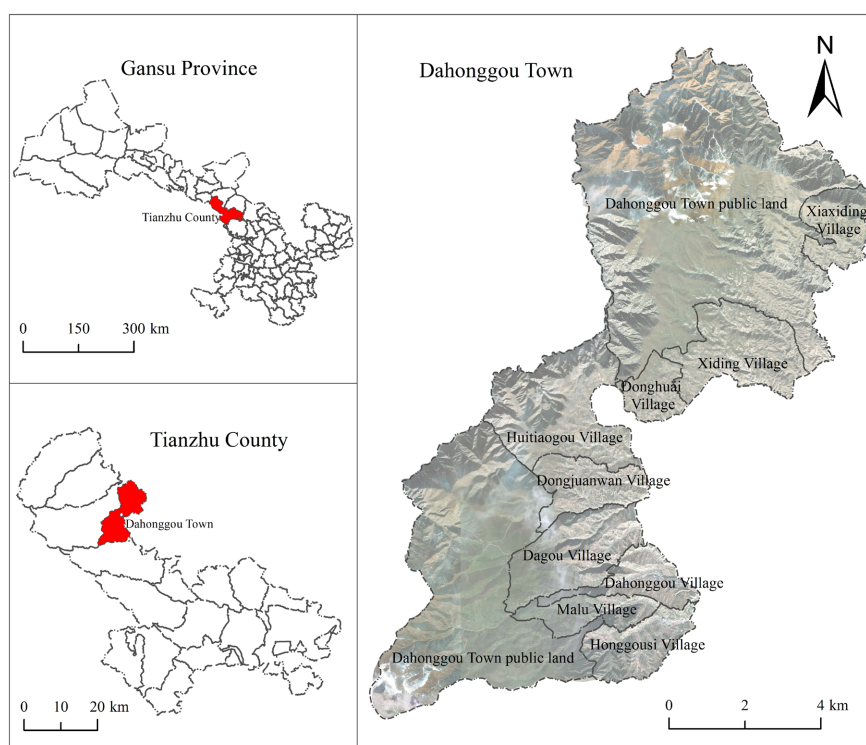


Figure 2. Study area.

rural living environment in Dahonggou Town has become a typical example of realizing rural multi-value.

2.2. Data Sources

The data of this study mainly include spatial data and attribute data. In the spatial data, the boundary of each administrative village in Dahonggou Town comes from the download of BIGEMAP map. In the attribute data: 1) The data of forest coverage, medical security level and rural tourism income are derived from the “Statistical Bulletin of National Economic and Social Development of Tianzhu Tibetan Autonomous County (2022)”; 2) The data of village road hardening, the popularity of sanitary toilets, the number of public toilets, sewage treatment facilities, the number of street lights installed, and the construction of ecological parking lots are from the “Tianzhu Tibetan Autonomous County Rural Grassroots Infrastructure”; 3) The output value of ecological products, the amount of pesticides and fertilizers, the total value of agriculture, the number of rural enterprises and other data are derived from the “Tianzhu Tibetan Autonomous County Animal Husbandry Production Table” and the “Tianzhu Tibetan Autonomous County Planting Production Table” and the 2022 annual summary report of Dahonggou Town; 4) The data of the number of farmhouses, the number of homestays, the compilation of village regulations, the number of households selected by civilized families, the construction of cultural corridors, the coverage of farmers trash cans, the number of garbage collection boxes, the number of households built by beautiful courtyards and the number of households transformed by rural houses are mainly obtained from the field visits to various administrative villages in Dahonggou Town from December 15 to December 25, 2022.

2.3. Methods

2.3.1. Evaluation Indicator System for the Degree of Realization of Rural Multi-Value

The construction of index system generally selects indexes from two dimensions of commonality and individuality [26]. Based on the perspective of multidisciplinary integration, the common indicators select the high-frequency indicators related to the research topic in the index system of each discipline. The selection of personality indicators focuses on the particularity of the research topic, the uniqueness of the research area and the requirements of relevant policy documents. Based on the evaluation index system of rural multi-value realization degree in different disciplines, this paper analyzes the connotation of rural multi-value realization, the logical relationship between rural multi-value realization and rural living environment improvement, combines the actual situation of rural development in the study area, and selects 12 indicators from the four dimensions of ecological value, production value, life value and cultural value to construct the evaluation index system of rural multi-value realization degree. The reliability and validity of the original data of each index are tested by SPSS

software, and the entropy weight method is adopted to empower each index (Table 1).

The entropy weight method can effectively solve the problem of information overlap between index variables, overcome the assumption and randomness of subjective weighting method, and objectively reflect the utility value of index information entropy. The specific calculation process is as follows:

1) Data standardization:

When X_{ij} is a positive indicator:

$$Z_{ij} = \frac{X_{ij} - \min X_{ij}}{\max X_{ij} - \min X_{ij}} \quad (1)$$

Table 1. Evaluation indicator system for the degree of realization of rural multi-value.

System layer	Indicator layer	Explanations and units of indicators	Attribute	Weight
Ecological value	percentage of forest cover	The proportion of the total area of forest land in the total area of the region (%)	+	0.073
	output value of ecological products	The output value of ecological products including vegetables, fruits, wild fungi, Chinese herbal medicine and so on in each village (ten thousand yuan)	+	0.036
	application amount of pesticide and chemical fertilizer	The total consumption of agricultural fertilizers and pesticides in each village (t)	-	0.077
Life value	number of rural farmhouses and homestays	The number of farmers operating farmhouses and homestays in the village (number)	+	0.272
	health insurance level	Number of health care workers in village clinics (number)	+	0.050
	village road hardening rate	The proportion of natural villages that have completed road hardening in each village (%)	+	0.052
Productive value	gross agricultural production	The total production of the primary industry (ten thousand yuan)	+	0.129
	number of rural enterprises	The total number of villages, including enterprises, cooperatives, large farming households, etc. (number)	+	0.170
	rural tourism income	The total income obtained through rural tourism in the village every year. (ten thousand yuan)	+	0.036
Cultural value	village regulations	Whether the village has compiled village regulations (compiled as 1, not compiled as 0)	+	0.025
	number of civilized families	Number of civilized families selected by villages (number)	+	0.054
	the construction of cultural corridor	Does the village create a cultural corridor that highlights the traditional culture of the village (if there is a Fu 1, no Fu 0)?	+	0.026

When X_{ij} is a negative indicator:

$$Z_{ij} = \frac{\max X_{ij} - X_{ij}}{\max X_{ij} - \min X_{ij}} \quad (2)$$

In the formula, Z_{ij} is the standardized value of the index, X_{ij} is the original value of the index, i is the i^{th} research unit, and j is the j^{th} evaluation index.

2) Empowerment of evaluation indicators:

$$e_j = -\left(\frac{1}{\ln n}\right) \times \sum_{i=1}^n \frac{Z_{ij}}{\sum_{i=1}^n Z_{ij}} \ln \frac{Z_{ij}}{\sum_{i=1}^n Z_{ij}} \quad (3)$$

$$W_j = 1 - e_j / \sum_{j=1}^m (1 - e_j) \quad (4)$$

In the formula, e_j is the information entropy value of the j^{th} index, W_j is the index weight of the j^{th} index, where $i = 1, 2, \dots, n$, $j = 1, 2, \dots, m$.

2.3.2. Evaluation Indicator System for Improved Effectiveness of Rural Living Environment

By combining the common indicators of relevant research, strictly following the objectives and tasks of rural living environment improvement in policy documents, combined with the actual situation of rural living environment improvement in the study area, we selected 13 indicators from five dimensions of the system layer, viz. toilet renovation, household waste management, domestic sewage treatment, village appearance improvement, and infrastructural development to construct an evaluation index system for the effectiveness of rural living environment improvement. The reliability and validity of the original data of each index were tested and standardized by SPSS software. Based on the results of expert consultation in related fields and field research, we found that the relevant departments attached the same importance to the five dimensions in implementing rural living environment improvement. Therefore, the five dimensions were given the same weight and further averagely allocated to each indicator (Table 2).

2.3.3. Evaluation Model

Based on the weight of each index and the results of SPSS standardization, the evaluation value C_j of each index was calculated as follows:

$$C_j = X_{ij} W_j \quad (5)$$

where i denotes the i^{th} administrative village, j represents the j^{th} evaluation index, x_{ij} indicates the value of each index of each administrative village after SPSS standardized processing, w_j represents the weight of the j^{th} evaluation index, and the calculation result C_j represents the contribution value of each index of an administrative village to the realization degree of rural multi-value and the improvement effect of rural living environment.

2.3.4. Fuzzy Set Qualitative Comparative Analysis

In order to explore the impact of rural living environment improvement on the

Table 2. Evaluation indicator system for effectiveness of rural living environment improvement.

System layer	Indicator layer	Explanations and units of indicators	Attribute	Weight
Toilet renovation	prevalence rate of sanitary toilets	The proportion of the number of households that have completed toilet renovation in each administrative village to the total number of households in the village (%)	+	0.100
	number of public toilets	Number of public toilets built in administrative villages (number)	+	0.100
Household waste management	farmers' trash coverage rate	The proportion of the number of households equipped with garbage bins in the total number of administrative villages (%)	+	0.066
	number of garbage collection boxes	Number of garbage collection boxes in each administrative village (number)	+	0.067
	garbage collection and disposal rate	The proportion of garbage handled by each administrative village in the collection and transportation of garbage (%)	+	0.067
Domestic sewage treatment	number of sewage treatment facilities	Number of sewage treatment facilities in each administrative village (number)	+	0.100
	sewage treatment rate	The proportion of treated domestic sewage in total sewage discharge in each administrative village (%)	+	0.100
Improvement of village appearance	number of rural housing renovation households	The number of rural housing renovation households in each administrative village (number)	+	0.067
	beautiful courtyard to create the number of households	The number of beautiful courtyards in each administrative village (number)	+	0.067
	the number of rural house style transformation households	The number of rural housing style transformation in each administrative village (number)	+	0.066
Infrastructure development	road hardening length	Road hardening length of each administrative village (km)	+	0.067
	number of street lights installed	Number of street lamps installed in each administrative village (number)	+	0.067
	number of ecological parking lots	The number of ecological parking lots in each administrative village (number)	+	0.066

realization of rural multi-value, this paper chooses qualitative comparative analysis method for analysis. The qualitative comparative analysis method (QCA) was first proposed by the American sociologist Ragin, which is mainly a comparative analysis method for some small and mediumsized sample cases. This method combines the operation ideas of set and algebra, combines the advantages of qualitative analysis and quantitative analysis, and analyzes the key influencing factors and combined effects of various antecedent conditions on the

research object based on the comparison of a small number of research cases in the research topic [27] [28]. Fuzzy set qualitative comparative analysis (fsQCA) is a type of qualitative comparative analysis. Based on the existing research experience and related theoretical basis, this paper chooses this method mainly based on the following considerations: 1) It can explore the role of multi-configuration of rural living environment improvement measures in realizing rural multi-value from a holistic and systematic perspective. Realizing rural multi-value is complex; multiple factors promote or inhibit it. The rural living environment improvement provides better background conditions, actualizing rural multi-value. The villages with a higher degree of realization of rural multi-value are not the result of a specific improvement measure but the combined effect of multiple measures; 2) Measuring the effectiveness of rural living environment improvement cannot be assigned 0 or 1. This method allows arbitrary assignment of variables between 0 and 1, making the interpretation more reasonable and scientific. 3) It is suitable for exploratory research on causality with a relatively small sample size, such as the nine villages in this study.

3. Results and Analysis

3.1. Spatial Characteristics

Formula (5) is used to calculate the evaluation value of the improvement effect of rural living environment and the realization degree of rural multi-value in each village of Dahonggou Town. The evaluation value is spatially visualized by means of the natural discontinuity method in ArcGIS10.2 software, and the spatial pattern distribution map of the two is formed (Figure 3). Among them, the natural discontinuity method is based on the natural grouping inherent in the data, and the classification interval is identified. It can group the values of the phases and maximize the difference between the classes. The grouping method is to divide the original data into multiple categories, and set the boundary at the position where the difference of the specific value of the data is relatively large [29].

1) Spatial differentiation characteristics of rural living environment improvement effect

The overall effect of improving the rural living environment in Dahonggou Town shows a spatial distribution pattern of “high in the south and low in the north”. The middle and high value areas were Dahonggou, Honggousi, Malu, and Dagou Villages, while the low value areas included Dongquanwan, Donghuai, Huitiaogou, Xiding, and Xiaxiding Villages. Due to the relatively good resource endowment and economic development level of the four villages in the south, by implementing the rural revitalization strategy, Dahonggou Town has consistently focused on the economic development of the four villages in the south. Also, it has vigorously improved the village appearance and basic service facilities of the four villages in the south, improving the rural living environment more effectively in the four villages in the south. Under the rural revitalization

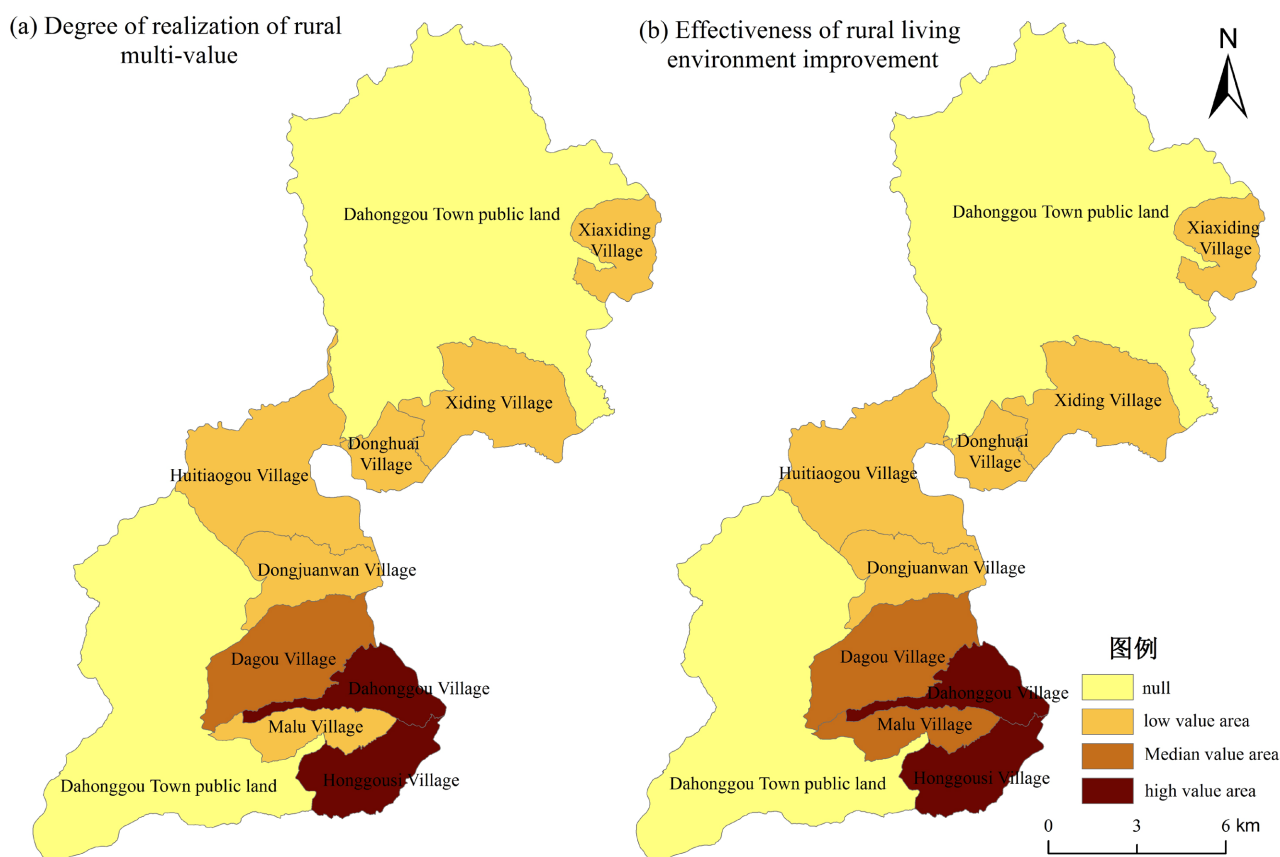


Figure 3. Spatial differentiation of the degree of realization of rural multi-value and rural living environment improvement.

strategy, the five northern villages adopted relocating ecological migrants as effective for rural development and moving-out some villagers' groups struggling to maintain their livelihood, resulting in a small number of rural and scattered households in the villages.

By adhering to the principle of saving public resources during rural living environment improvement, the town government has taken measures to improve the infrastructure and livelihood of the residents of the five northern villages. At the same time, under the government's supervision and active farmers' participation, the original rural appearance of "dirty and messy" has improved. Still, the improvement was less than found in the four southern villages.

2) Spatial differentiation characteristics in the realization degree of rural multi-value

The realization degree of rural multi-value in Dahonggou Town showed a "high in the south and low in the north" spatial distribution pattern, ranging between 0.013 and 0.855. Among them, the high value areas were Dahonggou Village and Honggousi Village, the median area was Dagou Village, and the low value areas included Malu, Dongquanwan, Huitiaogou, Donghuai, Xiding, and Xiaxiding Villages. The two villages in the high value area relied on superior location conditions, population factors, natural resource endowments, production conditions, and complete public service facilities. They introduced rural enter-

prises, establish cooperatives, vigorously develop tourism, implement the government's support policy for farmers to establish industries in the rural revitalization strategy, and cultivate many large-scale farming households. With the help of rural tourism, farmers could develop agritainment and homestay, which provided tourists with fresh air, experience a unique life, feel the rural production mode, and broaden the channels for farmers to increase their income. Dagou Village, in the middle-value area, developed tourism, planting, and breeding industries according to local conditions. Only in 2022, it planted 50 mu of Chinese herbal medicine, 1000 mu of quinoa, 1000 mu of forage grass, 550 head of cattle, and 4600 head of sheep. It also had one registered tourism cooperative and three farmhouses, with a total village collective economy of 1,413,200 yuan. The evaluation value of the realization degree of rural multi-value in the six low-value villages was around 0.200. These six villages had relatively small populations and poor location conditions, hindering the development of rural tourism and planting industry. The current residential farmers rely on sufficient grass in the village to develop animal husbandry. It results in a single rural industry, few farmer income-generating channels, and a low degree of rural multi-value realization.

3.2. Action Mechanism

3.2.1. Core Influencing Factors and Configuration Analysis

1) Necessity analysis of univariate

The fuzzy set qualitative comparative analysis method must calibrate the antecedent variables and outcome variables involved in the study, converting the values into membership values between 0 - 1. Based on the existing research experience [29], this study selected 95%, 50%, and 5% of the evaluation value of the effectiveness of rural living environment improvement and degree of realization of rural multi-value as complete membership points, cross membership points, and incomplete membership points. All subsequent operations were based on calibrated data. Usually, before studying the configuration path of the antecedent variable, it was necessary to use consistency and coverage to test the necessity of a single antecedent variable (including its non-set). If the consistency index was greater than 0.8, it showed that the antecedent variable was a sufficient condition for the outcome variable. However, if the consistency index was greater than 0.9, the antecedent variable was necessary for the outcome variable. At the same time, if the value of the coverage index was larger, the explanatory power of the antecedent variable to the result variable was greater. Based on this condition, we studied the univariate necessity test of the impact of these measures on the rural living environment improvement on various dimensions of rural multi-value (Table 3).

2) Multivariate configuration analysis

Based on the results of univariate necessity analysis and the actual situation of the study area, along with previous research [30], we set-up the parameters to

Table 3. The consistency and coverage of individual factors in the process of realizing rural multi-value.

Variable	Ecological value		Life value		Productive value		Cultural value	
	consistency	coverage	consistency	coverage	consistency	coverage	consistency	coverage
Toilet renovation	0.990	0.637	1.000	0.125	0.993	0.653	0.994	0.794
~Toilet renovation	0.403	0.589	0.506	0.144	0.273	0.407	0.399	0.724
Household waste management	0.943	0.726	1.000	0.150	0.946	0.745	0.984	0.941
~Household waste management	0.428	0.455	0.490	0.101	0.333	0.362	0.449	0.593
Domestic sewage treatment	0.826	0.804	1.000	0.189	0.849	0.845	0.776	0.937
~Domestic sewage treatment	0.460	0.380	0.490	0.079	0.350	0.296	0.463	0.474
Improvement of village appearance	0.990	0.847	1.000	0.166	0.951	0.832	0.896	0.951
~Improvement of village appearance	0.498	0.465	0.490	0.089	0.428	0.409	0.527	0.612
Infrastructure development	0.806	0.640	1.000	0.156	0.813	0.660	0.888	0.875
~Infrastructure development	0.542	0.553	0.835	0.166	0.426	0.444	0.501	0.635

Note: ~means the non-set of each single factor.

analyze how the combination of rural living environment improvement measures affected the realization of rural multi-value. Here, we obtained four sets of composite schemes (Table 4). Through fsQCA, three solution types were obtained: complex solutions that did not include any logical remainders, simple solutions that included all logical remainders and intermediate solutions that only involved the expected logic of the theoretical direction. This study selected the intermediate solution for the analysis. The core and edge variables were distinguished by combining the simple solution; that is, the conditions that appeared simultaneously in the intermediate and simple solutions were the core conditions. In contrast, only edge conditions appeared in the intermediate solution. In addition, if the consistency index of the single factor variable is greater than 0.9 and the conditions that do not appear in the intermediate solution and the simple solution are the core conditions missing.

Among the various combinations of rural multi-value realization, toilet renovation, and household waste management appeared thrice as core condition variables and once as marginal condition variables. They were the most common core conditions among the measures. Second, the improvement of village appearance appeared twice each as a core condition variable and a marginal condition variable. Then, domestic sewage treatment was used once as a core condition variable and thrice as a marginal condition variable. Finally, infrastructural development as a core condition variable appeared once, and the core condition variable missing one time, twice can exist or not exist.

In summary, the series of state policies have not addressed the measures for improving the rural living environment. However, in the actual implementation,

Table 4. Configuration analysis of rural living environment improvement to realizing rural multi-value.

Conditional variable	Ecological value	Life value	Productive value	Cultural value
Toilet renovation	●	●	●	●
Household waste management	●	●	●	●
Domestic sewage treatment	●	●	●	●
Improvement of village appearance	●	●	●	●
Infrastructure development		⊗	●	
Consistency	0.876	0.989	0.866	0.992
Original coverage	0.811	0.785	0.679	0.739
Unique coverage	0.811	0.785	0.679	0.739
Consistency of solutions	0.876	0.989	0.866	0.992
The coverage of the solution	0.811	0.785	0.679	0.739

Note: ● means core conditions; ⊗ means the lack of core conditions; ● implies edge conditions; ⊙ means the lack of edge conditions; Blank means conditions can exist or not exist.

the village should focus on improving the rural living environment in combination with the background conditions. Also, they should endeavor to actualize developmental goals to create the most realistic background environment for rural development and maximize the rural multi-values.

3.2.2. Mechanism of Action Analysis

The background conditions required for realizing rural multi-value result from the comprehensive effect of various measures for the rural living environment improvement. However, due to the differences in rural resource endowment conditions, social and economic development level, government and enterprise cooperation degree, and farmers' participation degree, the effect of rural living environment improvement was different, causing varied realization degrees of rural multi-value. Aided by theoretical analysis and empirical research results, we found that the improvement measures of the rural living environment were the background conditions to ensure the realization of rural multi-value according to certain combinations and logical connections (Figure 4).

1) Toilet renovation and household waste management are core to realizing rural multi-value

As the core conditions, toilet renovation and household waste management have often appeared in the configuration scheme of rural multi-value realization, proving they are the core measures for promoting rural multi-value realization. Since the rural revitalization strategy was implemented, most rural toilets

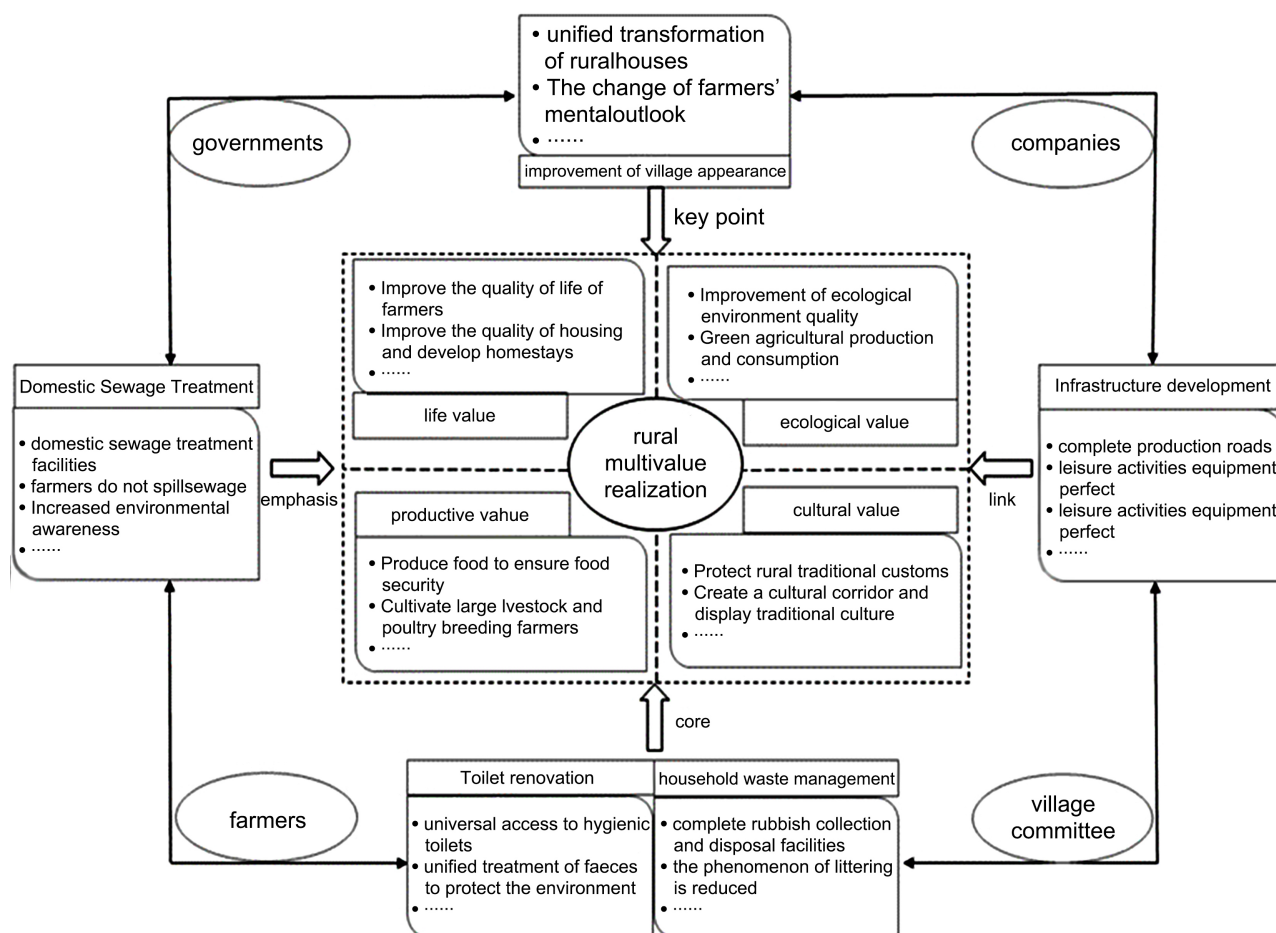


Figure 4. A schematic representation of the analysis mechanism of action.

have been transformed from traditional dry toilets to flush toilets. After treatment, the manure is collected uniformly and used as organic fertilizer for agricultural production, reducing the unpleasant smell in rural areas while improving the quality of green agricultural products. This approach is a foundation for realizing ecological value and production value. In addition, the toilet renovation scheme plans to install sanitary toilets in the house to improve the quality of life (especially for the farmers). Another key task of toilet renovation is to uniformly allocate public health toilets next to the village committee, in the fitness square, and in the concentrated farmers' residential areas, thereby serving the farmers and tourists, protecting the sanitation of the rural environment, enhancing agricultural civilization, and helping to realize ecological value and cultural value.

Furthermore, each household should be equipped with garbage cans, natural villages were equipped with garbage collection boxes, and administrative villages were built with garbage collection stations. Garbage trucks were regularly collected and transported to county-level garbage treatment plants for unified treatment. Villagers were organized periodically to clean up public environmental sanitation weekly or monthly to ameliorate environmental pollution caused by the unorganized disposal of rural domestic garbage.

The rural ecological environment continues to improve, and the living environment was safer and healthier. Through the implementation of garbage treatment in recent years, farmers have gradually regarded garbage treatment as a habit, ensuring that the residential and surrounding environment is always tidy. Also, the living environment of farmers has improved, ensuring less harm to human health. In addition, timely garbage removal has become a daily routine for farmers, encouraged by the implemented incentives for garbage treatment. As a result, environmental protection awareness, rural civilization, and rural multi-value have improved consistently.

2) Improved village appearance as crucial to realizing rural multi-value

The administrative villages with high economic development and rapid development of rural tourism in Dahonggou Town (such as Honggou and Dahonggou Villages) have improved village appearance and fully demonstrated the local characteristics of the village. In addition, the univariate necessity and multivariate configuration analyses showed that the consistency and coverage values of village appearance improvement were relatively high, appearing twice as the core conditions. It indicated that village appearance improvement was the key to improving the quality of the rural background environment and helped highlight rural multi-values.

Through the comprehensive rectification of disorderly construction and stacking of villages, the ruins of long-term uninhabited and dilapidated rural houses were cleansed to excavate and utilize the idle space and land in the village. As a result, it allowed for adequate development to realize the value of rural life and production. Vigorous rural greening and beautification exercises protected the original rural ecological resources, river wetlands, ancient and famous trees, and other rural background resources, stimulate farmers' enthusiasm, thereby promoting the greening of barren hills and wasteland within the village. In other words, planting seedlings and flowers to develop rural ecotourism and promote ecological health improved the quality of the ecological environment, creating a more ecologically valuable background environment. Farmers were guided and encouraged to beautify their courtyard building by planting fruits and vegetables, ornamental flowers and trees, and other decorative plants. This exercise helped to develop homestay and agritainment by decorating and transforming the original building area. Through the rural "four sides" (water, road, village, and house sides), planting trees to promote village greening comprehensively utilized wastelands and corner lands in the village to build a small rural park, strengthen the guidance of village architectural style, optimize the village life, increase production and ecological space, and lay the foundation for the development of rural tourism. Traditional rural cultural carriers (such as rural cultural corridors and village history museums) have been created to highlight local characteristics and regional features to coordinate the village's overall style. At the same time, it was necessary to develop leisure experience agriculture vigorously, ensure an excellent farming culture, and promote the realization of

rural cultural values.

3) Domestic sewage treatment as a focus to promoting rural multi-value

The random discharge of rural domestic sewage is an essential source of soil and water pollution. At the same time, the persistent black and odorous water in rural areas is also a major obstacle to improving rural ecological environment quality. Therefore, accelerating rural domestic sewage treatment is crucial to realizing the rural multi-value, mainly to fully utilize the rural ecological value. Honggousi and Dahonggou Villages, the high value areas of domestic sewage treatment in Dahonggou Town, were recognized by many tourists. One of the reasons was that the sewage treatment was efficient and the environmental (ecological and air) quality was high. Moreover, in the univariate necessity test and multivariate configuration analysis, domestic sewage treatment greatly impacted realizing rural multi-value, which focused on improving rural background environmental conditions and highlighting rural values in many ways.

According to local conditions, there was a need to choose domestic sewage treatment technology that aligns with the actual situation of the rural areas. It involved building domestic sewage discharge, having collection and treatment facilities, solving the pollution of soil and water from the source, and actively promoting resource utilization through treated sewage. These factors would improve the convenience of farmers' livelihood, protect the rural ecological environment, and help realize optimum ecological value. Focusing on the rivers, ponds, ditches, canals around the farmers' houses, and the murky and odorous water bodies nearby, several comprehensive measures (such as dredging, ecological restoration, and water purification) were adopted to make rural water bodies appealing in beautified villages.

While ensuring the farmers' health, rural sewage treatment helped the countryside attract tourists to develop rural tourism, improve rural economic development, practice "green water and green mountains are gold and silver mountains", and prioritize rural ecological value.

4) Infrastructure development aids in realizing rural multi-value

Improving rural basic service facilities is crucial to rural economic development, comprehensive revitalization, and multi-directional manifestation of rural values. A complete rural basic service facility system is realized as an essential means to improving production efficiency through correlation and core influencing factors of rural living environment improvement to aid rural multi-value. Also, introducing new industries in realizing rural multi-value is a link between rural internal and external. Building and improving rural industrial roads, improving the network system of industrial supporting facilities, and focusing on dredging ditches, canals, and ponds to provide sufficient support for high quality agricultural development, met the basic conditions required for new agricultural enterprises to settle in rural areas to help industrial development and flourish.

Hardening rural roadways, installing street lamps, building parking lots and leisure squares, and improving farmers' quality of life will encourage urban resi-

dents to relocate to the countryside and enjoy a unique way of life in the rural area. Likewise, improving the rural Internet system, building e-commerce bases, encouraging farmers to develop e-commerce industries, and promoting green agricultural products through live webcasts will help more farmers to adapt to new technologies and methods of increasing income in the new era while meeting the needs of modern agricultural development. Also, the rural culture should be promoted and inculcated.

4. Improvement Path

4.1. Ecological Value

To improve the ecological value of the rural area, the popularization rate of sanitary toilets should be promoted, rural domestic garbage and domestic sewage systems should be comprehensively renovated, and the village's appearance must be improved. First, through transforming sanitary toilets, reducing the pollution of manure to rural air quality, and using a unified collection and treatment system for manure to irrigate farmland, the output of green agricultural products increased. Second, they should strengthen the allocation of garbage collection facilities in public spaces and uniformly collect, clear, and process rural domestic garbage, reduce white pollution, and reduce the impact of garbage on cultivated land and water bodies. Then, combined with the actual situation of the village, the dredging and purification of black and odorous water bodies and wetlands should be strengthened to improve the quality of the water environment. Finally, the farmers should be encouraged to plant ornamental flowers and trees in front and behind their houses and public spaces to improve the quality and ornamental of the rural ecological environment.

The rural ecological value of Dahonggou Town should be designed via a differentiated path according to the various ecological values of each village. For instance, Honggousi and Dahonggou Villages are high value areas for realizing ecological value. It is necessary to strengthen the participation and creativity of farmers based on maintaining the original development conditions and continue planting ornamental trees and flowers in public spaces while tapping into the ecological resources that the village can create comprehensive effects (such as wild Chinese medicinal materials in Honggousi Village) and maximize its value by protecting the ecological environment. Ultimately, it benefits the ecological livelihood of the village for farmers and tourists.

In the middle value areas of ecological value realization, such as Dagou, Dongquanwan, and Donghuai villages, strengthening farmers' awareness of environmental protection is essential to organizing farmers to protect the ecological environment. They are also encouraged to clean up the garbage and black and odorous water in the village in combination with the two measures of domestic garbage and domestic sewage treatment, to improve the overall quality of the environment. Based on these measures, an ecological industry is built, and an ecological value is created. The low value areas of ecological value realization

(such as Malu, Huitiaogou, Xiding, and Xiaxiding Villages should absorb farmers' willingness to transform villages, improve the popularity of toilets, improve the infrastructure for domestic garbage and sewage treatment, and improve the basic level of rural environment quality, to ensure having tidy ecological villages.

4.2. Life Value

To make-up for the shortcomings of farmers' lives, improve rural basic service facilities, create beautiful courtyards, and encourage the development of homestays and agritainment. First, to realize the rural life value, it is necessary to make-up for the short-comings of rural life, improve rural basic service facilities, let farmers improve the quality of life, and allow tourists to experience the same services as urban life. Second, to achieve full coverage of sanitary toilets and domestic waste collection facilities so that farmers can change their traditional living habits, improve the awareness of protecting life and health so that tourists can use sanitary toilets at any time, and practice environmental protection constantly. Then, constructing a leisure and entertainment fitness square and installing street lamps are imperative to enable farmers to enjoy the basic service facilities brought about by the welfare of life even at night. Finally, combined with the transformation of the rural house style, the beautiful courtyard is built as small vegetable gardens and gardens in the courtyard, and it is developed into homestays and agritainment as economic conditions permit. It can improve farmers' economic income and quality of life while attracting tourists.

To further develop each village in Dahonggou Town, designing a differentiated improvement path is necessary to help realize the rural life value. Dahonggou Village has the highest degree of realization of life value, mainly because it is a government residential town with complete basic amenities. It has developed homestays and farmhouses through beautiful courtyards. However, the characteristics of the local lifestyle have not been fully explored; hence, tourists cannot be retained. Therefore, future development needs to fully exploit the enthusiasm and creativity of most farmers, present a unique local lifestyle with government guidance, ensure farmers' participation and enterprise cooperation, improve the quality of life, cater for the environment, and retain tourists in rural consumption.

Honggousi, Malu, and Dagou Villages are the median areas of realizing life values. They must rely on measures and preferential policies to help rural development promote the construction of basic amenities (such as leisure and fitness squares, viewing pavilions, and lighting street lamps) under the leadership of the town government. Also, they must improve the quality of rural life and selectively encourage farmers to build beautiful courtyards according to the peculiarities of the village, thereby laying the foundation for developing rural industries. In the low-value areas (such as Dongquanwan and Huitiaogou Villages), the primary way to realize the life value is to optimize and integrate the existing re-

sources of the village due to the small population and the scattered residence of farmers. By so doing, it optimizes the basic service facilities of the village and improves the quality of life of the existing farmers.

4.3. Productive Value

Strengthen the improvement of industrial supporting service facilities, clean up rivers and ditches in depth, and establish an infrastructure network system. First of all, the development of modern agriculture is inseparable from mechanization. Gradually build and improve the industrial roads, agricultural irrigation canals and other basic supporting facilities required for the development of modern agriculture and rural tourism, so that mechanization and large-scale agricultural development become a reality, thereby increasing the total agricultural production and ensuring national food security. Secondly, through the comprehensive treatment of sludge, sewage, and garbage in black and odorous water bodies, ditches, and ponds, the pollution of soils, drinking water sources, and groundwater would be reduced, thereby promoting the green health of agricultural products. Finally, gradually improving the infrastructure network system, such as rural Internet, gas, high-voltage electricity, and sightseeing trails, helps to orientate the farmers into green production and lifestyle, as the new rural formats (such as rural e-commerce and live broadcasting) are developed.

There were apparent differences in the production value of each administrative village in Dahonggou Town, and the differential promotion path was designed according to the actual development of each administrative village. The high value production areas in Honggousi and Dahonggou Villages should be based on the formed large-scale agricultural industry and sufficient rural labor force. It should improve the road network system supporting the industry, the irrigation facilities (such as ditches in some conditional areas), and the use of nearby water resources and treated sewage to irrigate crops toward increasing their agricultural outputs. At the same time, attracting tourists, developing the e-commerce industry, and increasing the added agricultural value via superior natural background conditions and beautiful courtyard constructions are necessary.

Dagou Village is the median area of production value realization, and developing rural tourism is progressing. In the future, retaining some farmers to develop large-scale agriculture, increasing agricultural production value by improving the village's basic service facilities, and integrating cultivated land resources will be necessary. At the same time, strengthening environmental sanitation remediation to enhance rural tourism quality will be imperative.

Administrative villages, such as Malu, Dongquanwan, and Donghuai Villages, are rural areas with low production value realization. To strengthen these areas, basic public service facilities should be constructed to improve residents' quality of life while promoting domestic sewage and waste treatment to protect the existing ecological environment and resources. At the same time, improving the

network system (such as the Internet) and continuing to develop and expand the breeding industry through advanced agricultural science and technology (such as unmanned air vehicle (UAV) and GPS positioning) to provide high-quality alpine beef and mutton for surrounding cities.

4.4. Cultural Value

Guide and control the coordination of architectural features and village culture, build a cultural corridor and village history museum, and strengthen the construction of industrial supporting facilities to help experiential agriculture. First, the traditional village carries a broad and profound folk culture and a long-standing humanistic spirit. It is necessary to guide and control the coordination between the new rural houses and the traditional villages regarding architectural modeling and style renovation to ensure that the traditional culture is sustained. Second, encourage farmers to freely express their creativity and imagination and actively participate in constructing rural cultural corridors and village history museums. They should include the developmental history of the village, the lives of people who have made significant contributions and those successful celebrities outside the area, the moral qualities to be observed in the village, and provide more valuable souvenirs in the village, so that local farmers and foreign tourists can experience local culture and remember homesickness. Finally, improving industrial supporting facilities and the creation of green landscapes will help the development of leisure agriculture, let urban residents and tourists experience the unique local farming culture, accept agricultural production labor education, and improve the awareness of the masses to save food.

The overall cultural value realization in Dahonggou Town was relatively high, and most administrative villages were in the middle and high value areas. According to the actual development situation, the differentiated promotion path was designed to help realize the rural cultural value. Dahonggou, Honggousi, and Dagou Villages should promote building village cultural corridors and history museums and solidifying the excavated rural cultural resources. At the same time, they should integrate wasteland and living space, create distinctive leisure agriculture experience projects, attract residents of surrounding cities, and fully develop and inherit the village's characteristic culture. In the middle-value areas, such as Malu, Dongquanwan, Huitiaogou, and Xiding Village, it was necessary to strengthen the improvement of various basic service facilities, improve farmers' quality of life, and encourage farmers to actively participate in the excavation of rural cultural resources through appropriate incentives. The action lays the foundation for building the village's characteristic cultural industry. Finally, Donghuai and Xiaxiding Villages, which have fewer farmers and insufficient cultural resources, should strengthen the integration of resources, improve the quality of life and spiritual outlook of farmers, and continue to propagate and inherit the spiritual civilization of farmers and herdsmen.

5. Discussion

5.1. The Importance of Realizing the Rural Multi-Value

Revitalizing the available resources in rural areas and realizing the rural multi-value have become an important means to broaden the channels for farmers to increase their income, improve the quality of rural life and promote the sustainable development of rural areas in China and even in the world [31]. China's urban-biased development strategy under the long-term urban-rural dual system had led to the outflow of rural population, the abandonment of rural cultivated land resources, and the neglect of rural multi-value [32] [33]. In the world, such as Thailand, Malawi and South Africa were also facing rural decline [1]. The academic community explores the rural value from the perspectives of space production [34] and rural transformation [35], and found that the realization of rural multi-value can break the barriers that hinder the sustainable development of rural areas to a certain extent [36] [37] [38]. In fact, the countryside not only provides various production factors for urban development, but also provides production and living places for rural residents, and condenses the diversified culture of the countryside. As an exogenous thrust to stimulate the endogenous power of rural areas, the realization of rural multi-value will continue to promote farmers, enterprises, governments and other rural actors to use rural resources, obtain economic effects, and improve rural environment and quality of life [39]. Specifically, the realization of rural ecological value can provide ecological products for farmers or foreign tourists and resist external interference; the realization of rural production value can make full use of land resources, provide products, increase social wealth, and broaden income channels. The realization of rural life value is to provide farmers with better living products, living environment and basic service facilities, and improve the quality of life of farmers; the realization of rural cultural value can provide cultural products for residents, protect, inherit and carry forward rural culture, and promote sustainable rural development.

5.2. China's Experience in Promoting the Realization of Rural Multi-Value

Based on the research of this paper, it is found that the effect of rural living environment improvement and the realization degree of rural multi-value were spatially convergent. High-quality rural living environment was the basic support to realize the rural multi-value. China's rural areas have improved the rural ecological and health environment and improved basic service facilities and industrial supporting facilities through the implementation of rural living environment improvement measures such as toilet renovation, household waste management, domestic sewage treatment, village appearance improvement and infrastructure development. The improvement of rural background conditions promotes the realization of rural multi-value. Specifically: 1) Household waste management can effectively improve the level of rural health environment, im-

prove villagers' awareness of environmental protection, and help the development of eco-tourism, agritainment, homestay and other industries; 2) Toilet renovation through the transformation of farmers' toilets and the construction of public toilets, the quality of rural life is improved and the health of farmers' lives is guaranteed; 3) Domestic sewage treatment through the improvement of sewage treatment facilities to solve the phenomenon of rural soil and water pollution, help rural enterprises, ecological aquaculture development, improve the level of rural economic development; through the purification and cleaning of black and odorous water bodies, ditches, canals and ponds, the air quality and ecological environment in rural areas are improved to ensure the safety of drinking water; 4) Infra-structure development improves the degree of transportation convenience and provides a convenient channel for rural industrial development; improve the Internet system, leisure activities and other facilities to improve the quality of rural life and ensure the well-being of farmers; 5) The improvement of village appearance has effectively improved rural competitiveness and farmers' well-being. The villagers are full of vitality and motivation, stimulate the endogenous power of rural development, constantly tap rural resources, and realize the rural multi-value. In addition, the establishment of a long-term management and protection mechanism is an important guarantee for the continuous improvement of the quality of rural living environment and the rapid realization of rural multi-value [40] [41] [42]. Among them, the scientific assessment mechanism can clarify the responsibility of the actors and improve the efficiency of remediation; reasonable reward and punishment mechanism can effectively stimulate the creativity of behavioral subjects and quickly promote the mining of available resources in rural areas; strict supervision mechanism can ensure the effective implementation of various measures and help the sustainable development of rural areas.

5.3. Research Limitations and Prospects

The research results of this paper will enrich the current understanding of the rural living environment improvement and the realization of rural multi-value, provide policy enlightenment for strengthening the rural living environment improvement and realizing rural multi-value, and provide Chinese experience for the realization of rural multi-value in the world. However, the research in this paper had certain limitations, including the single research case selected in this paper and the short research time series. Promoting sustainable rural development and revitalizing the world's villages is a major issue that many countries are facing or will face. It requires the joint efforts of governments and scholars at home and abroad to contribute wisdom. Therefore, in order to better guide the sustainable development of the world's rural areas, the following issues need to be paid attention to in future research: 1) Acquisition of long-term sequence survey data. From the perspective of time scale, the long-term series of survey data is undoubtedly more helpful to fully and accurately reveal the realization

mechanism of rural multi-value from the perspective of the rural living environment improvement, and it can also provide data support for building a more scientific and accurate mathematical model. In the future, relevant research needs to use long-term survey data to deeply explore the mechanism of the rural living environment improvement on the realization of rural multi-value, and design a more targeted promotion path to help achieve rural revitalization and sustainable development goals. 2) Enrich research cases and strengthen comparative analysis. The level of social and economic development and rural background development conditions in different regions of China and even the world are very different. In the future, it is necessary to select different countries, different regions and different types of villages to carry out comparative research, so as to accurately and objectively reveal the logical relationship between the rural living environment improvement and the realization of rural multi-value. At the same time, the research also needs to deeply explore the regional differences and factor transmission mechanism, so as to provide scientific guidance for China and even the world to improve the quality of human settlements, realize the rural multi-value, and promote the development of rural economy.

6. Conclusions

Starting from the practical problems the current rural areas face, this study recognized the conceptual connotation of rural living environment improvement and rural multi-value realization and explored the theoretical logic between the two. From the two dimensions of “commonness + individuality”, the evaluation index system of rural living environment improvement effect and rural multi-value realization degree were constructed, revealing their realistic correlation and action process. Further, it designed the differentiation path of rural living environment improvement to help rural multi-value realization. The main conclusions of the study were as follows.

1) Improving the rural living environment basically supported rural multi-value. The effect of rural living environment improvement and the realization degree of rural multi-value were spatially convergent.

2) Based on the influence of various measures and their configuration on the realization of rural multi-value, this paper analyzed the mechanism of rural living environment improvement to help achieve rural multi-value. a) Toilet renovation and household waste management were core to achieving rural multi-value; b) improving the village’s appearance was the key to realizing rural multi-value; c) domestic sewage treatment was the focus of realizing rural multi-value; and d) infrastructure construction was crucial to attaining rural multi-value.

3) Design a differentiated promotion path from the four dimensions of rural multi-value: adequately promote the popularization rate of sanitary toilets, comprehensively renovate rural domestic garbage and domestic sewage treatment facilities, focus on improving the appearance of the village, and help realize

the ecological value. To circumvent the shortcomings of farmers' lives, improve rural basic service facilities, build beautiful courtyards, encourage the development of homestays and agritainment, and help realize the life value. Also, improve the industrial supporting service facilities, thoroughly clean up rivers and ditches, establish an infrastructure network system, and help realize production value. Finally, guide and control the coordination of architectural features and village culture, build a cultural corridor and village history museum, strengthen the construction of industrial supporting facilities to help experiential agriculture, and help realize cultural values.

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Author's Contributions

Cheng G.S completed conceptualization, methodology, validation, formal analysis, investigation, data curation, writing—original draft preparation, visualization. Author has read and agreed to the published version of the manuscript.

Conflicts of Interest

The author declares no conflicts of interest.

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