

Measuring the Development Level of Rural Ecological Governance in Gansu Province

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Abstract

Rural ecological governance is crucial in the context of rural revitalisation and ecological civilisation construction synergistically. This study focuses on the development level of rural eco-governance in Gansu Province, and constructs a comprehensive evaluation index system, covering three dimensions: agro-ecological restoration, environmental governance of origin and resource conservation and utilisation, reflecting all aspects of rural eco-governance in an all-round way. By collecting data related to rural ecological governance in Gansu Province from 2015 to 2022, the entropy weight method was used to determine the weights of each indicator, and the comprehensive score of each indicator was calculated. The measurement results show that during the period of 2015-2022, the development level of rural ecological governance in Gansu Province is on the rise as a whole, but there are gaps in the development level of various regions in the province.

Keywords

Rural Ecological Governance; Entropy Weight Method; Level Measurement; Gansu Province.

1. Introduction

With the rapid development of China's economy, ecological environment problems are becoming more and more prominent, and as an important part of the ecosystem, the ecological governance of rural areas is directly related to the foundation of sustainable development of the whole country. In the comprehensive promotion of rural revitalisation strategy, "ecological livability" has become one of the key objectives of rural construction, strengthening rural ecological governance is not only to meet the urgent needs of farmers' aspirations for a better life, but also to build a solid ecological security barrier, and to achieve a harmonious coexistence of human beings and nature is the way to go. Gansu Province, located in the interior of northwest China, the ecosystem is a complex and fragile ecosystem, facing soil erosion, land desertification, water shortage and many other serious ecological challenges. Rural areas as the province's economic and social development of the weak link, on the one hand, the traditional agricultural production methods, chemical fertilisers, pesticides, excessive use of livestock and poultry waste discharge, resulting in rural surface pollution problems; on the other hand, infrastructure lagging, insufficient investment in environmental protection, so that the rural ecological environment of the carrying pressure is increasing. However, in recent years, Gansu Province has actively responded to the national call to vigorously promote rural ecological governance, from the implementation of rural habitat improvement actions to increase ecological protection and restoration efforts, to a series of initiatives to improve the rural ecological environment, to inject momentum. In this process, accurately measuring the development level of rural ecological governance is of key significance for accurately grasping the effectiveness of policy implementation and timely adjusting governance strategies.

Western countries started to explore the practice of rural ecological governance earlier, and the related research results are fruitful. M. J. P. and Miguel S. (2022) proposed the framework of "sustainable intensification-ecological service synergy" based on the study of agricultural systems in southern South America[1]. Loos et al. (2023) pointed out in their paper that the existing ES assessment frameworks mostly focus on the ecological service synergy. In their paper, Loos et al. (2023) pointed out that existing ES valuation frameworks focus on quantifying ecological-economic values but fail to adequately respond to the power differentials, unequal capabilities, and intergenerational equity claims of different groups over ecological resources[2]. Listyaningsih and Utami (2018) in their paper used the Secang Sub-district of Magelang Regency, Indonesia as a case study to construct a hierarchical analysis based on a hierarchical approach. case, constructed a decision support system (DSS) based on hierarchical analysis (AHP) with approximate ideal solution ranking method (TOPSIS) to provide a quantitative tool for grass-roots governance performance assessment, and proposed that the traditional village government performance assessment suffers from the defects of strong subjectivity, multi-objective conflict and insufficient data dynamics[3]. In China, with the in-depth implementation of the rural revitalisation strategy, the research on rural ecological governance has seen a rise in popularity. Zhai Xuyan and Feng Jin (2024) focused on the value realisation dilemma of rural ecological governance in the process of urban-rural integration and development, pointing out that under the superposition of new urbanisation and rural revitalisation strategy, rural ecological governance has shifted from "environmental remediation" to "value reconstruction". It is pointed out that under the overlapping background of new urbanisation and rural revitalisation strategy, rural ecological governance has shifted from "environmental remediation" to "value reconstruction"[4] Yu Xiaoqian (2024) based on Gansu rural research found that the governance dilemma focuses on the three aspects of farmers' weak ecological awareness, insufficient capital investment, and lack of technical support. The study proposes a "government-enterprise-farmer" synergistic governance model: the government provides policy incentives, the enterprise introduces environmental protection technology, and farmers participate in the ecological industry, forming a community of interest[5]. Cheng Xiaofeng (2024) takes Nuo Village in Yunnan Province as a case study to reveal the logic of "community action" in rural ecological governance in mountainous areas under the perspective of living environmentalism.[6]. According to the study, Nuo Village has achieved the collective sharing of ecological resources and common governance by restricting overgrazing through village rules and regulations and establishing a water source forest protection system[7].

At present, although academic research in the field of rural ecological governance has made some progress, there are still significant limitations. On the one hand, most of the research focuses on the interpretation of macro policies or the analysis of single ecological problems, and lacks in-depth quantitative analysis of the comprehensive development level of rural ecological governance in a specific region; on the other hand, empirical research for the less-developed regions in the western part of the country is particularly weak, and there are significant differences in the influencing factors of ecological governance in different regions and in the research index system, which makes it difficult for the results to directly guide the local practice. Against this background, this paper takes Gansu Province, an underdeveloped region in the west, as the research object, and systematically carries out a study on the measurement of the development level of rural ecological governance, aiming to fill the gaps in regional quantitative research. This study uses the entropy value method to dynamically assess the development level of rural eco-governance in Gansu Province from 2015 to 2022 by constructing an evaluation system containing three primary indicators and 13 secondary indicators. The measurement system can not only provide government departments with precise policy tools - through quantifying the effectiveness of governance, the government can

accurately identify the strengths and weaknesses of inter-regional ecological governance, optimise the allocation of resources, and enhance the effectiveness of governance; at the same time, the results of the measurement also have significant value to people's livelihoods - farmers can use intuitive data to assess the level of development of rural ecological governance in Gansu Province. At the same time, the results also have significant value for people's livelihoods - farmers can understand the progress of local ecological governance through intuitive data feedback, increase their confidence in environmental improvement, and then stimulate their initiative to participate in ecological governance, forming a synergistic governance pattern of "government-led-farmer-driven", and guarding the rural ecological dividend together.

2. Analysis of the Current Situation of Rural Ecological Governance in Gansu Province

Gansu Province is located in the ecologically fragile area of Northwest China, where drought and low rainfall, soil erosion and desertification are prominent problems, and rural ecological governance is the core task of regional sustainable development. In recent years, Gansu has taken the national ecological civilisation strategy as a guideline to promote the systematic governance of mountains, water, forests, lakes, lakes, grasses and sands in a coordinated manner, and has initially formed the governance mode of "government-led, scientific and technological support, diversified inputs, and participation of all people". Through the implementation of ecological restoration projects, the development of green industry, improve the living environment and other measures, the trend of rural ecological deterioration has been curbed, and the local environment has been significantly improved.

2.1. The Province's Soil and Water Erosion Control has been Effective.

Gansu is located at the junction of the three major plateaus of the Loess Plateau, the Qinghai-Tibetan Plateau and the Inner Mongolia Plateau, and is the key prevention and control area of soil erosion in the Loess Plateau, one of the most serious provinces and regions in the country. In recent years, Gansu Province has formulated and issued an Implementation Programme on Strengthening the Work of Soil and Water Conservation in the New Era, amended the Regulations of Gansu Province on Soil and Water Conservation, and has continuously improved the institutional mechanism for the governance of soil and water conservation, and has taken a series of measures to control soil and water erosion, including implementation of key national soil and water conservation projects, such as the management of sloping cultivated land, construction of silt dams, comprehensive management of small watersheds and protection of loess plateau plateau surface. According to the statistics of the Provincial Water Resources Department, since 2012, the province's full-calibre management of soil erosion has covered an area of 60,200 square kilometres, the protection and management of loess plateau has covered an area of 1,548 square kilometres, 16,960,000 mu of terraces have been built, 249 new silt dams have been constructed, and 402 sick and dangerous silt dams have been removed and reinforced, so that the province's area and intensity of soil erosion have decreased year by year, and the rate of soil and water conservation has reached 60.61%.

2.2. Demonstration Experience in Desertification Control

As the core area of the "Three Norths" project, Gansu Province has achieved remarkable results in desertification control and continues to deepen. The project covers 70 counties (cities and districts) in 12 cities and prefectures of the province, with a total area of 361,400 square kilometres. Through systematic ecological management, according to the statistics of the National Forestry and Grassland Science Data Centre, Gansu Province has achieved a cumulative total of 1,754,000 hectares of afforestation, 686,500 hectares of sandy land

comprehensive management, and planted 5,249,000 hectares of grass. This series of initiatives has significantly increased the forest cover and grassland vegetation cover, reduced the intensity and frequency of sandstorms and dust storms, reduced wind and sand hazards and soil erosion, and constructed a solid barrier for regional ecological security.

Linze County relies on the "Three North" project to build protection forests and windbreak and sand-fixing forest systems, successfully reversing the "sand into people retreat" dilemma, and realising the historic transformation of "green into sand retreat"; Minqin County is Minqin County has effectively blocked the trend of convergence of Badanjilin Desert and Tengger Desert through the double-wheel drive of sand control and afforestation and sealing and protection, and the forest coverage rate has jumped from 3% in the 1950s to 18.28%, which has become a benchmark for desertification reversal. These practices not only highlight the regional synergistic effect of Gansu Province in ecological governance, but also reveal the double driving value of project implementation on ecological restoration and livelihood improvement through micro cases.

2.3. Acceleration of Rural Habitat Improvement

Gansu Province has achieved remarkable results in the reform of rural dry toilets in recent years, effectively improving the rural habitat environment and the quality of life of the residents by adapting to local conditions and classifying policies. According to the Gansu Provincial Bureau of Statistics, since 2019, Gansu Province has implemented a total of 1,137,000 rural household toilet renovations, and the penetration rate of hygienic toilets has increased from 10 per cent by the end of 2018 to 33.2 per cent by the end of 2020. By the end of 2022, the number of hygienic household toilets in rural areas in the province will increase to 2,638,000 from 518,000 in 2018, and the penetration rate has risen to 66 per cent, a significant increase compared to 2018's 10% significantly. 1.137 million household toilets were renovated cumulatively in 2023, and 97.8% of administrative villages were built with sanitary public toilets. Some of these areas have made outstanding progress, such as Lintao County, where sanitary dry toilets amounted to 34,900 in 2022, accounting for 69.17% of the total number of toilets renovated. ; Jingchuan County, where household toilets were renovated at a rate of 42%, and public toilets in administrative villages were fully covered. 2,150 new sanitary household toilets were added in 2024, with a universal coverage rate Increase to 94.5 per cent.

2.4. Eco-industry Helps Green Transformation

Gansu Province has achieved remarkable results in promoting green transformation in rural areas through diversified eco-industry practices in recent years, and has formed an exemplary sustainable development model. Gansu CIC Ecological Company promotes ecological restoration in counties with systematic governance, and implements the project of "Integrated Protection of Mountains, Water, Forests, Fields, Lakes, Grasses and Sands" in Lintao County, completing the management of 30,900 mu of degraded forest areas and planting 1,390,500 seedlings through scientific selection and innovative technology, which has significantly improved the biodiversity of the area. In 2025, the newly awarded project of "Three Norths" project involves the restoration of degraded forests of 3,626 mu and the nurturing of middle-aged and young forests of 15,000 mu, which further consolidates the ecological industry in Gansu Province and promotes the green transformation of rural areas. The newly awarded "Three North" project in 2025 involves 3,626 mu of degraded forest restoration and 15,000 mu of medium and young forest nurturing, further consolidating the ecological barrier in the upper reaches of the Yellow River. At the same time for the film residue problem, Gansu constructed a "source prevention and control - recycling - monitoring and management" whole chain system, comprehensively promote 0.015 mm thickening high-strength film and full biodegradable film, covering 36 million mu of arable land, according to Gansu Provincial Department of Ecology and the Environment and a number of departments jointly statistics 2024, the province's used

agricultural film recycling rate of 85.7%, higher than in 2011, 28.6 percentage points, and stable for eight consecutive years, the province's agricultural film recycling rate reached 85.7%. percentage points higher than 2011, and has been stable above 80% for 8 consecutive years.

2.5. Diversification of Funding Input Mechanism

Gansu Province has formed a diversified pattern in terms of the financial input mechanism for rural ecological governance, which is mainly realised through financial priority guarantee, integration of agriculture-related funds, financial synergy support for agriculture and support for special ecological projects. According to the statistics of Gansu Provincial Finance Bureau, a total of 269.17 billion yuan will be invested in the field of agriculture, forestry and water from 2017 to 2020, with an average annual growth rate of 14.2%, increasing from 52.08 billion yuan in 2017 to 77.58 billion yuan in 2020, and the scale of agriculture, forestry and water has become the first major expenditure of the general public budget for the third consecutive year since 2018. The implementation of the 2021 rural revitalisation subsidy funds of 23.84 billion yuan, focusing on supporting ecological-related projects. In 2024, 447 million yuan was allocated for the scientific use of film recycling funds, and thickened film and all-biodegradable film were vigorously promoted, and 54.28 million yuan was invested in the straw comprehensive utilisation pilot, while 8.01 million yuan was spent on fisheries breeding and releasing for the restoration of aquatic biological resources.

3. Existing Problems of Agro-ecological Governance in Gansu

Although rural ecological management in Gansu Province has achieved success at some stage, it still faces multiple challenges, such as harsh natural conditions, high costs of management and inadequate long-term mechanisms. The vulnerability of the ecological base is superimposed on the pressure of man-made development, which makes it difficult to consolidate the results of governance. At the same time, insufficient capital investment, low technology suitability, lack of industrial support and other problems constrain the effectiveness of governance, and urgent need to systematically solve these problems.

3.1. Rural Sewage and Rubbish Treatment Short Board is Obvious

The construction of rural sewage treatment facilities in Gansu Province is lagging, and has become a key factor restricting the improvement of the rural ecological environment. According to the 2022 Gansu Provincial Ecological Environment Department survey, the province's rural domestic sewage treatment rate is only 25.3%, far below the national average of 36%. Especially in Longnan, Linxia and other mountainous areas and ethnic minority areas, limited by geographical conditions, economic development level and other factors sewage treatment rate of less than 15%, a large amount of sewage is directly discharged into the river or seepage into the ground, causing pollution of rural water sources and soil. Dingxi City, as a typical area, as of the end of 2023, only 275 administrative villages have completed the treatment, the rural domestic sewage treatment rate is only 14.6%, there are still 1,564 administrative villages that have not carried out the treatment, and only 48 administrative villages are being implemented in 2024, the progress is very slow.

In terms of domestic rubbish classification, villagers do not have enough knowledge about domestic rubbish classification, and lack the awareness and habit of classifying rubbish for disposal, leading to mixed rubbish disposal and increasing the difficulty of subsequent treatment. Although the province is equipped with a certain number of vehicles for collecting and transporting rural household rubbish, and some harmless rubbish treatment facilities have been built, in some remote rural areas, rubbish collection, transport and treatment facilities are still not perfect, and there are problems such as insufficient rubbish collection, insufficient transport vehicles, and long distances to treatment facilities. There are also some rural areas

with a weak economic base, with a high demand for operating costs for daily rubbish collection, transport and treatment, and a high pressure on local finances, which makes it difficult to meet the financial needs for the construction of rubbish treatment facilities, the purchase of equipment, and the operation and maintenance of such facilities.

3.2. Agricultural Surface Pollution

Due to the lack of scientific farming techniques and environmental protection awareness of some farmers, long-term excessive and unscientific application of chemical fertilisers and pesticides, resulting in higher levels of residues in farmland water, not only resulting in eutrophication of surface water and groundwater nitrate content exceeding the standard, but also make the soil harmful substances exceeding the standard, the structure suffered damage. At the same time, livestock and poultry manure, crop residues and agricultural residual film and other agricultural wastes have been disposed of unreasonably. For example, some areas of livestock and poultry manure randomly piled up or directly discharged, which not only pollutes the soil and water, but also emits a foul odour polluting the air; crop residues are burned to produce a large amount of smoke and harmful gases, causing atmospheric pollution, and some randomly discarded in the field or ditch seriously affect the environmental aesthetics and smooth drainage.

3.3. Shortage and Irrational Use of Water Resources

Rural areas in Gansu Province are facing serious problems of water resource shortage and irrational use. According to the Gansu Provincial Water Resources Department statistics, the province's per capita water resources possession is only 1/2 of the country, mu average water resources possession is 1/4 of the country, and more than 70% of the area is located in arid and semi-arid zones, where water resources are inherently scarce. From a spatial point of view, water resources do not match with land resources and population concentration. From the time point of view, precipitation is mainly concentrated in the summer, and mostly in the form of heavy rainfall, which is difficult to be effectively stored and utilised, while precipitation is scarce in other seasons, resulting in obvious seasonal water shortages.

Agricultural water use accounts for a high proportion and is inefficient. Agricultural irrigation water accounts for about 80 per cent of the province's total water consumption, and up to 90 per cent in local areas in the west of the river. Traditional irrigation methods, such as flood irrigation, are still common. There is a problem of disproportionate use of water for industry, agriculture and domestic use, with agriculture accounting for a disproportionately high share of water use, while the reuse rate of industrial water, although improved, still has room for improvement. The leakage rate of the urban public water supply network also needs to be further reduced, resulting in the allocation of water resources among different sectors not being reasonable, affecting the overall efficiency of water resources utilisation. Even in some areas, to meet the demand for agricultural irrigation and domestic water, over-exploitation of groundwater has led to a decline in the groundwater level, triggering ecological problems such as ground subsidence and soil erosion.

3.4. Ecological Damage is Easy, Repair is Difficult

Influenced by natural factors, Gansu is located inland, with an arid climate, low precipitation and high evaporation, with an average annual precipitation of about 429mm, which is not conducive to plant growth. At the same time, the province spans some temperature zones, with large annual temperature differences and frequent cold air activities, which can easily trigger spring droughts, dust storms and other catastrophic weather, accelerating land sands. In addition, affected by geographic location, Gansu is located at the junction of the three plateaus, especially the Longzhong Longdong Loess Plateau area gullies and ravines, with rainfall and uneven spatial and temporal distribution, more than a short period of heavy rainfall, slope

scouring and gully strong undercutting led to serious soil erosion. Coupled with the impact of man-made activities, infrastructure construction accelerated, caused by a large amount of man-made soil erosion.

Ecological restoration is difficult. In some areas, the climate is arid and the soil is infertile, making it difficult for vegetation to recover naturally. Artificial afforestation and grass planting are costly and have a low survival rate. For example, in arid areas such as the Hexi Corridor, where water resources are scarce, afforestation requires a large amount of irrigation water, and the trees are vulnerable to natural disasters such as drought and sandstorms. Ecological restoration requires a large amount of capital investment for the purchase of saplings, grass seeds, equipment, and payment of labour costs, etc.. Still, some rural areas in Gansu are economically backwards and have limited sources of funding. At the same time, the technical level of ecological restoration needs to be improved, and more scientific and effective technical methods and professional talents are needed in desertification management and soil erosion management.

3.5. Farmers' Environmental Awareness and Participation are Insufficient

There is an obvious shortcoming in environmental protection cognition. Some farmers do not know enough about ecological protection policies, pollution hazards and other knowledge. The traditional way of production and life is deeply rooted. However, the government carries out environmental protection publicity. Still, the form is single and lack of targeting, and it is difficult to combine with the actual needs of the farmers, resulting in the understanding of the policy staying on the surface.

Insufficient participation initiative. Many farmers see ecological management as the responsibility of the government, and believe that it is not cost-effective for them to contribute to it. At the economic level, environmental measures may increase short-term costs, and inadequate subsidies or compensation mechanisms reduce the incentive to participate. At the same time, the design of environmental programmes often ignores the actual demands of farmers. For example, policies such as the return of farmland to forests that do not take into account livelihood alternatives are likely to provoke resistance.

Low degree of organisation. Rural environmental self-governance organisations are absent, and the lack of leaders to guide them makes it difficult for villagers to form a collective action force. The elderly and women in the left-behind group account for a high proportion of environmental protection action ability is limited, while the young and strong go out to work to further weakening the basis of participation. In addition, infrastructure support is insufficient; even if the farmers have the will to protect the environment, it is difficult to implement. These factors together constrain the sustainable promotion of ecological governance.

4. Level Measurement Empirical Research

4.1. Indicator Selection and Data Source

4.1.1. Indicator Selection

Based on the principles of systematicity, scientificity, typicality, comprehensiveness and operability, and taking into account the availability of data, the article constructs the indicator system of agricultural ecological governance in Gansu Province from three aspects: agro-ecological restoration, environmental governance of the production area, and resource conservation and utilisation, as shown in Table 1.

Table 1. Gansu rural ecological governance development level measurement index system

First-level indicators	Secondary Indicators	Variable	Indicator Attributes
	Forest cover (%)	X1	+
	Integrated grassland vegetation cover (%)	X2	+
Agro-ecological restoration	Soil and water conservation rate (%)	X3	+
	Safe utilisation rate of contaminated arable land (%)	X4	+
	Village greening coverage rate (%)	X5	+
	Fertiliser use rate (%)	X6	+
	Intensity of pesticide use (ka/ha)	X7	-
Environmental management of production area	Comprehensive straw utilisation rate (%)	X8	+
	Comprehensive utilisation rate of livestock and poultry manure (%)	X9	+
	Disposal rate of agricultural film (%)	X10	+
	Cultivated land retention (ha)	X11	+
Resource-saving utilisation	Land replanting index (%)	X12	+
	Effective utilisation coefficient of farmland irrigation water	X13	+

4.1.2. Data Sources

The various data used in the article mainly come from the 2015-2022 Gansu Grassland Inspection Report, Gansu Statistical Yearbook, Gansu Ecological Environment Condition Bulletin, Gansu Soil and Water Conservation Bulletin, as well as the public data on the official website of the State Forestry and Grassland Bureau, the public data on the official website of Gansu Department of Agriculture and Rural Affairs, and the public data on the official website of Gansu Department of Water Resources.

4.1.3. Research Methods

The article chooses the entropy weight method to measure the weight of each indicator and the development level of rural ecological governance in Gansu Province, and the basic steps are as follows:

(1) Data processing of the measurement system

Since the unit of measurement of each indicator is not uniform, it is impossible to make direct comparison, to eliminate the influence of the quantitative outline, it is necessary to standardise the original data matrix $X = (x_{ij})_{n \times m}$ before calculating the synthesis and weight, and get the standardised matrix $Y = (y_{ij})_{m \times n}$, to eliminate the influence of the indicator unit on the evaluation results, and to ensure the realisation of the comparability of each indicator.

For positive indicators:

$$y_{ij} = \frac{x_{ij} - \min(x_j)}{\max(x_j) - \min(x_j)} \tag{1}$$

For inverse indicators:

$$y_{ij} = \frac{\max(x_j) - x_{ij}}{\max(x_j) - \min(x_j)} \tag{2}$$

Where $\max(x_j)$ and $\min(x_j)$ are the maximum and minimum values of the j indicator, respectively.

(2) Calculate the information entropy of indicators

Calculate the weight of the i th sample under the j th indicator for the indicator $p_{ij} = \frac{y_{ij}}{\sum_{i=1}^n y_{ij}}$. Then calculate the information entropy of the j th indicator $E_j = -k \sum_{i=1}^n p_{ij} \ln p_{ij}$, where $k = \frac{1}{\ln n}$, is guaranteed $0 \leq E_j \leq 1$.

(3) Calculate the entropy weight of indicators

Calculate the coefficient of variation of the j th indicator $d_j = 1 - E_j$. Finally calculate the entropy weight of indicator $jw_j = \frac{d_j}{\sum_{j=1}^m d_j}$, which satisfies $\sum_{j=1}^m w_j = 1$.

(4) Calculate the comprehensive score of the ecological governance level in year i . Calculate the comprehensive score $S_i = \sum_{j=1}^m w_j y_{ij}$, $i = 1, 2, \dots, m$ using the entropy weight w_j and the standardised data y_{ij} . Among them, $0 \leq S_i \leq 1$. S_i is proportional to the development level of rural ecological governance; the larger the value obtained indicates the higher the development level of rural ecological governance in that year is higher.

4.1.4. Analysis of Results

Using the data of each indicator in Gansu Province from 2015 to 2022, the entropy weight method is used to measure, and the results of the weight analysis of each indicator of rural ecological governance in Gansu Province are shown in Table 2.

Table 2. Weight table of the measurement system of rural ecological governance development level

First-level indicators	Second-level indicators	Weight	Ranking of Indicator Weights
	Forest cover (%)	0.10545	1
	Integrated grassland vegetation cover (%)	0.05988	13
Agro-ecological restoration	Soil and water conservation rate (%)	0.07820	6
(0.4106)	Safe utilisation rate of contaminated arable land (%)	0.08262	5
	Village green coverage rate (%)	0.08447	3
	Fertiliser use rate (%)	0.07646	7
	Pesticide use intensity (ka/ha)	0.08369	4
Environmental management of production area	Comprehensive straw utilisation rate (%)	0.06268	12
(0.3597)	Comprehensive utilisation rate of livestock and poultry manure (%)	0.06899	9
	Disposal rate of agricultural film (%)	0.06787	10
	Cultivated land holdings (ha)	0.09091	2
Resource conservation and utilisation	Land replanting index (%)	0.06624	11
(0.2297)	Effective utilisation coefficient of agricultural irrigation water	0.07254	8

From the weights of the indicators in Table 2, it can be seen that among the first-level indicators, the weight of agro-ecological restoration is 0.4106, which is the largest weight in the measurement system of the development level of rural ecological governance, and this indicator system shows that the foundation of Gansu's rural ecological governance and the primary task is agro-ecological restoration, and the effectiveness of agro-ecological restoration is a "hard indicator" to measure the progress of rural ecological governance. "The weight of 0.3597 for environmental management of production area is in the second place, which indicates that while focusing on agro-ecological restoration, the pollution of agricultural direct production environment should not be neglected, and the management and protection of production environment is the guarantee for farmers' income and sustainable development of agriculture; the weight of 0.2297 for the conservation and utilisation of resources is the lowest, but this indicator has a special significance for the ecological management of Gansu's rural areas. governance has special significance, Gansu's agricultural resource endowment is poor, especially the shortage of water resources, restricting the development of agricultural production. resource conservation and utilisation can not only optimise the efficiency of agricultural production, but also help farmers rely on the inevitable way of survival.

From the view of secondary indicators, the top five indicators in terms of weight are: forest coverage, with a weight of 0.10545, arable land retention, with a weight of 0.09091, village greening coverage, with a weight of 0.08447, pesticide use intensity, with a weight of 0.08369, and the safe utilisation rate of contaminated arable land, with a weight of 0.08262, which are the most important indicators affecting the rural ecological environment. These indicators are the most important indicators affecting the rural ecological environment, and Gansu rural ecological management needs to start from these factors, and Gansu rural environmental management will surely achieve better results. 13 secondary indicators ranked in the weight of the five more backward indicators are: grassland integrated vegetation cover, weight 0.05988, straw comprehensive utilisation rate, weight 0.06268, land replanting index, weight 0.06624, the rate of disposal of agricultural film, weight 0.06787, the rate of disposal of agricultural film, weight 0.08369, the intensity of pesticide use, the safe utilisation rate of contaminated arable land, weight 0.08262. weight 0.06787, comprehensive utilisation rate of livestock and poultry manure, weight 0.06899. Although these indicators have relatively small weights, their role in rural ecological governance cannot be ignored, and they are the main factors affecting rural production and living environment.

4.2. Analysis of the Results of the Ecological Governance Development Level Measurement

The comprehensive level of rural ecological governance in alternate years is measured using 2015-2022 data in Gansu Province, as shown in Table 3:

Table 3. The results of the comprehensive rural ecological governance score in Gansu Province in 2015-2022

Year	Level of agro-ecological restoration	Producing the environment governance level	Level of resource saving and utilisation	Comprehensive score
2015	0	0	0.090905967	0.090905967
2016	0.046177518	0.051246961	0.094989778	0.192414257
2017	0.098958562	0.105272192	0.101135815	0.305366569
2018	0.151943977	0.160858059	0.107910132	0.420712168
2019	0.211460352	0.213840198	0.114905395	0.540205945
2020	0.297597362	0.269442297	0.125981558	0.693021216
2021	0.365078857	0.315984086	0.131912731	0.812975674
2022	0.410616821	0.359698428	0.138778784	0.909094033

To analyse more intuitively, based on the results of Table 3, a graph of the results of the comprehensive scoring of the level of rural ecological governance is derived, as shown in Fig. 1.

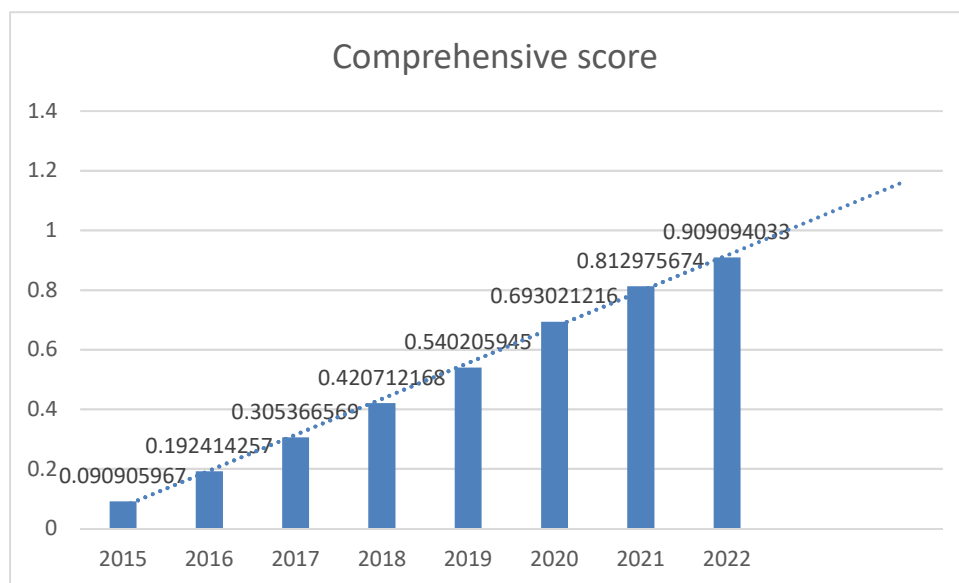


Fig. 1 Results of comprehensive scoring of rural ecological governance level in Gansu

Analysis of results form Table 3 and Fig.1, it can be seen that the three indicators of agro-ecological restoration level, the level of environmental management of the origin, and the level of resource conservation and utilisation and the comprehensive score all show an upward trend in the period of 2015-2022,) (which indicates thatthe work in the relevant fields has made some progress and developed well during 8 years.

The Agricultural Ecological Restoration Index has been gradually increasing since 2015, with an index value of 0.046177518 in 2016, marking a breakthrough from zero to a positive value. The initial growth rate was relatively fast, but slowed slightly in the later stages. By 2022, the value had reached 0.410616821, representing a significant increase. This indicates that during this period, the importance of agricultural ecological restoration has been increasingly recognised, and relevant policies and measures have been effectively implemented, yielding notable results.

The original environmental governance index also began to show a significant increase starting from 2016, with an index value of 0.051246961, indicating a clear upward trend. Particularly from 2017 to 2019, the growth rate was relatively high, increasing by 0.054025231 and 0.055585867, respectively. By 2022, the value reached 0.359698428. This indicates that investments in production area environmental governance have been steadily increasing, environmental governance efforts have been progressively implemented, and corresponding achievements have been made at different stages.

The resource conservation and utilisation index was 0.091 in 2015 and has continued to grow every year since then. Although the growth rate has been relatively stable and not as high as that of agricultural ecological restoration and production site environmental management, it increased to 0.139 in 2022, representing a growth of 4.8%. This indicates that although progress in resource conservation and utilisation has been relatively slow, it has been continuously improving and enhancing

5. Conclusion and Recommendation

5.1. Conclusion

After assessing the multi-dimensional indicators of rural ecological governance in Gansu Province based on the entropy weight method, this paper finds that it has made some progress in certain aspects. At the level of ecological resources protection, the forest coverage rate has been increased in some areas, and the area of soil and water erosion control has increased, reflecting that the foundation of the ecological environment is gradually improving. However, in terms of the overall score, the overall level of development still needs to be improved, and there is a significant imbalance in development between regions. Regions with better economic development perform better in terms of rural ecological governance inputs, technology application, etc., while some economically developed and settled regions have a slow ecological governance process due to a lack of funds and backwards technology. As can be seen from the weights determined by the entropy weight method, different indicators have different degrees of influence on the development of rural ecological governance. Among them, the weight of the indicators related to agro-ecological restoration is higher, indicating that agro-ecological restoration is the key link of rural ecological governance in Gansu Province at present and has made better progress. The control of agricultural surface pollution should not be ignored, as the excessive use of chemical fertilisers and pesticides is still an important factor threatening the rural ecological environment, and it is difficult to implement and promote the relevant management measures. Rural ecological governance in Gansu Province needs to adhere to the concept of "mountains, water, forests, lakes, grasses and sands" systematic governance, integrating ecological protection and livelihood improvement, and exploring a new model of ecological civilisation construction in Northwest China's thousands of arid zones through technological innovation, institutional optimisation and cultural empowerment. At the same time, the need to focus on differentiated policymaking - the western region to "water conservation and sand prevention" as the core, Longzhong and Longdong highlight "soil and water conservation", Longnan Gannan focus on "biodiversity conservation Longzhong and Longdong focus on "soil and water conservation", and Longnan and Gannan focus on "biodiversity protection", to achieve the organic unity of ecological and economic benefits.

5.2. Countermeasures

(1) Strengthen the management of domestic sewage and black smelly water bodies: for densely populated rural areas with better economic conditions, build centralised sewage treatment facilities with a perfect sewage collection pipeline network to collect and treat domestic sewage in a unified manner[8]; and in areas with dispersed settlements, adopt small-scale decentralised sewage treatment equipment, such as integrated sewage treatment devices and biogas digesters, etc, to realise in-situ treatment and reuse. Based on the existing foundation, a comprehensive inventory of rural black odour water bodies, the water body accounts, and the main body responsible for treatment. Use comprehensive means such as dredging and ecological restoration to purify water bodies and restore water ecology.

(2) Strengthen the prevention and control of agricultural surface pollution: reduce the amount of chemical fertiliser by promoting soil testing and formula fertiliser technology, and accurately applying fertiliser based on soil nutrient conditions and crop fertiliser demand patterns; actively promote the advantages of organic fertiliser, support organic fertiliser production enterprises, increase the proportion of organic fertiliser used, and improve the soil structure. Organise pest control professional service organisations to carry out large-scale prevention and control, improve the effectiveness of prevention and control, and reduce the use of pesticides. Improve the recycling network of used agricultural film, set up recycling stations in townships and villages to facilitate farmers to sell used agricultural film; encourage enterprises to

participate in recycling and utilisation, and give policy support and financial subsidies to improve the recycling rate of used agricultural film.

(3) Promoting the treatment and resource utilisation of domestic rubbish: establishing a domestic rubbish treatment model of "household classification, village collection, township transfer and county treatment" in rural areas, guiding farmers to carry out preliminary classification of domestic rubbish, which is divided into recyclables, hazardous rubbish and other rubbish; villages set up rubbish collection points, which are regularly collected by specialists; townships are responsible for transferring garbage to the county-level garbage treatment centre. The townships are responsible for transferring the rubbish to county-level rubbish treatment plants for centralised treatment. Constructing facilities for the resourceful use of rural domestic waste, such as composting plants and biomass energy conversion facilities, to convert organic waste into organic fertiliser and biomass energy, to achieve waste reduction and resourcefulness.

(4) Increase ecological protection and restoration: for areas with serious soil erosion, implement management measures such as planting trees, planting grass to protect slopes, and building terraces to reduce soil erosion and improve the ecological environment; in ecologically sensitive areas such as rivers, lakes, and wetlands, draw ecological protection red lines, strengthen protection and management, and restore and enhance ecosystem functions. In conjunction with the national land greening campaign, tree-planting activities have been carried out on both sides of rural roads, around villages, and in farmland protection forest belts to increase forest coverage and improve rural ecological landscapes; the protection of forest resources has been strengthened, indiscriminate logging has been severely cracked down on, and forest fire prevention and pest control measures have been put in place.

(5) Improve farmers' awareness of ecological and environmental protection: farmers' ecological awareness is relatively weak, government departments can make extensive use of radio, television, network, bulletin boards and other channels to publicise the importance of rural ecological environment protection and related policies and regulations, to improve farmers' awareness of ecological and environmental protection, and regularly organise environmental protection knowledge lectures and training activities, inviting experts to explain to the farmers the hazards of ecological damage to their lives, so that they have the consciousness of consciously protecting the ecological environment. Experts are invited to explain to farmers the harm caused by ecological damage to their lives, so that they have the consciousness of consciously protecting the ecological environment, and through the training, farmers can master certain agricultural surface pollution prevention and control techniques, to reduce the ecological damage in agricultural production.

(6) Improve the mechanism of policy support and capital investment: the government further increases capital investment in rural ecological management, sets up special funds for rural sewage treatment, black smelly water body remediation, agricultural surface pollution prevention and control projects; integrates agricultural funds from various departments to form a synergy of funds and improve the efficiency of fund use. Formulate preferential policies to attract social capital to participate in rural ecological governance projects, and encourage enterprises to invest in the construction and operation of rural sewage treatment facilities, domestic rubbish treatment facilities, etc., and give policy support, such as tax exemptions and loan interest subsidies, to enterprises participating in rural ecological governance.

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