Research on the integration and co-promotion of industry and sand control in Minqin, Gansu based on field survey approach

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Abstract. This study is predicated on a field survey in Minqin County, Gansu, which sought to explore the practical path of integrated development of industry and sand control. Through a meticulous examination of the synergistic mechanism between sand control and contemporary agricultural technologies, the study successfully enhances vegetation cover and promotes soil improvement in sandy regions. The integration of rural live e-commerce, eco-tourism, and forest economy into the sand control system establishes a virtuous cycle of industry feeding sand control. The study validates the model's efficacy in not only mitigating desertification but also providing a replicable ecological-economic synergistic development path for arid regions by mobilizing rural economic kinetic energy. This finding is of substantial demonstrative value for implementing rural revitalization strategies.

Keywords: Rural Revitalization, Tree Planting and Sand Control, Rural Industry, Ecology and Industry.

1. Introduction

In recent years, China's rural revitalization strategy has emerged as a pivotal element in the nation's developmental agenda. In the course of implementing this strategy, the focus on sand control has surged, emerging as a prominent and rapidly evolving subject area. The prevailing research agenda emphasizes the perpetuation of sand control as a measure [1]. A paucity of systematic investigation and research exists concerning the integration and co-promotion of rural industry, tree planting, and sand control [2]. Minqin County is located in the northeastern part of the Hexi Corridor and the lower reaches of the Shiyang River, forming a narrow oasis between the Badain Jaran Desert and the Tengger Desert. It has a distinct continental arid climate with distinct four seasons, low precipitation, large diurnal temperature differences, and abundant light and heat resources. The combination of light, heat, and water and soil resources is superior, providing unique natural conditions for the development of forage and characteristic fruit industries. In order to address the urgent challenges posed by desertification, it is imperative to devise effective strategies for its prevention and control. A comprehensive approach is necessary to curb the spread of desertification and to develop specialized industries that align with the unique characteristics of each region [3-5]. This study aims to explore the potential of Minqin County as a site for the rapid development of its economy. To this end, the study conducted field visits and investigations in Minqin County, aiming to gain a more intuitive and authentic understanding of the sand control and prevention measures in place, the underlying driving mechanisms, and the operational processes. This research is of paramount importance, as it not only contributes to the enhancement of the local ecological environment, the promotion of economic development, and social stability, but also aids in the construction of an ecological civilization and the implementation of a sustainable development strategy. This study holds significant research value and practical implications for implementing the rural revitalization strategy in Gansu and other regions.

2. Theoretical analysis of rural industrial development

2.1. Detailed the current state of agriculture in the country

(1) Steady growth in the agricultural economy

In 2023, China's agricultural economy demonstrated a consistent growth trajectory. According to data released by the National Bureau of Statistics, the added value of China's primary industry reached RMB 8,975.5 billion in 2023, representing a growth rate of 4.1% at constant prices compared with the previous period. This growth rate signifies the dynamic activities of China's agricultural industry chain, the enhancement of agricultural production efficiency, and the ongoing advancement of the agricultural modernization process. The annual GDP proportion was 7.12%, which was lower than that of other industries. However, agriculture's role as the foundation of the national economy remains robust and unshakable, providing substantial support and assurance for the development of the entire economy and society. The central bank's support is illustrated in Figure 1.

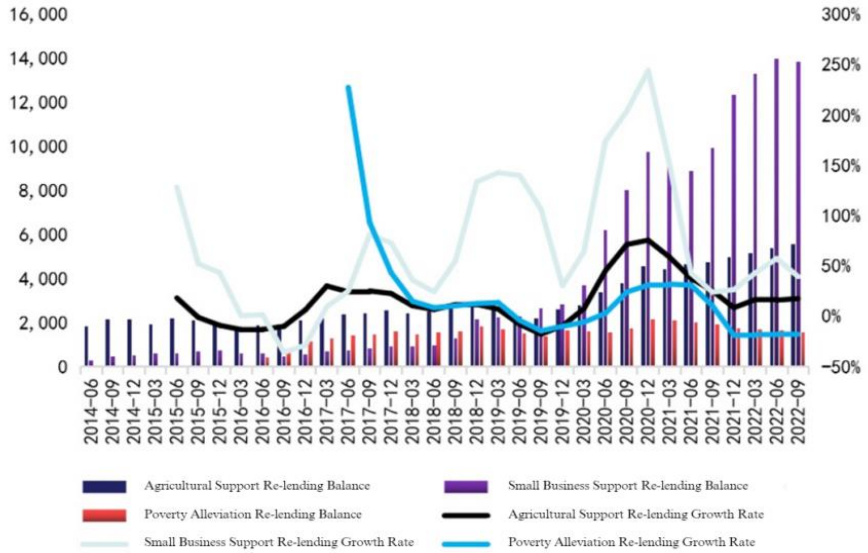

Figure 1. Utilization of central bank development tools in support of the three rural sectors, 2014-2022.

During the past year, China's agricultural economy has achieved notable success in several key areas. First, in regard to grain production, the country's policy support, scientific and technological progress, and suitable weather have contributed to a steady increase in grain output, accompanied by a notable enhancement in its quality. Concurrently, the planting structure has undergone continuous optimization, fostering the rapid development of specialized agricultural products and green food, which has led to a diversification of market demands.

The level of agricultural equipment has undergone consistent enhancement, with the widespread adoption of intelligent agricultural machinery leading to a substantial enhancement in agricultural production efficiency and a notable alleviation in labor costs. The deepening of the rural industrial development strategy, the integrated development of rural primary, secondary, and tertiary industries, the construction of rural infrastructure, and the improvement of the human settlements environment have also contributed to agricultural economic growth.

The annual gross domestic product (GDP) accounted for 7.12 percent of the total, which is lower than that of other industries. However, agriculture's role as the foundation of the national economy remains unassailable. This is due to the fact that agriculture serves as the cornerstone of national food security, ecological security, and social stability. Furthermore, it provides substantial support and assurance for the development of the entire economy and society.

(2) Good harvest in food production

In 2023, China attained the noteworthy milestone of "twenty consecutive harvests," with a total grain output of 1390.82 billion kilograms, marking a 1.3% increase compared to the previous year.

This accomplishment signifies the robust resilience of China's agricultural production and the substantial strength of its harvest. Notably, the cultivated area and yield of soybeans, a pivotal oilseed crop, exhibited substantial growth, with an increase of 2.2% and 2.8%, respectively, compared to the previous year. This suggests that China has achieved notable advancements in the provision of specialty agricultural products, such as soybeans. The sustained and stable growth in grain production establishes a robust foundation for ensuring national food security and providing substantial support for maintaining the efficient operation of agricultural markets and social harmony and stability. Figure 2 presents specific data on grain production.

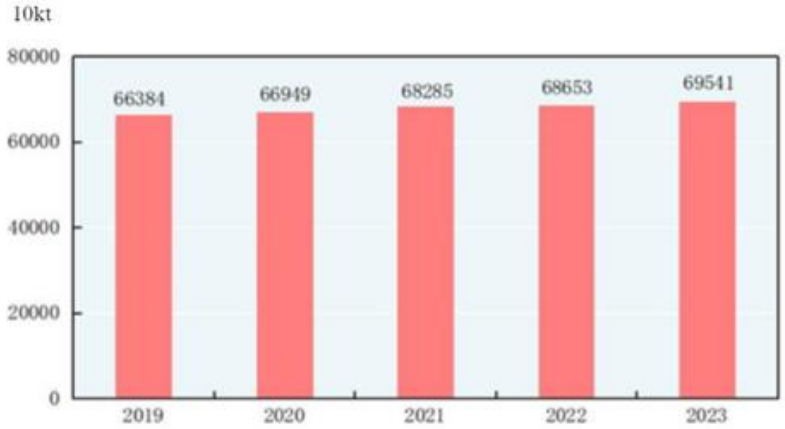

Figure 2. Grain production in China, 2019-2023.

2.2. Development of rural industries

(1) Accelerated development of industrial integration

Recent years have witnessed a pronounced surge in the development of industrial integration within China's rural regions, exhibiting considerable momentum and promise. In the context of the profound integration of primary, secondary, and tertiary industries, the agricultural industry chain has undergone significant expansion, transcending its traditional role as a producer of primary commodities. Instead, it has diversified into processing, warehousing, transportation, and sales, thereby establishing a comprehensive industry chain. The integration of agriculture and other industries has been achieved through the introduction of industrial equipment and advanced technology, resulting in the formation of an intensive, large-scale, and ecological composite business model. This integration has led to the enhancement of the overall optimization of the rural industrial structure and the remarkable growth of economic benefits.

Rural live e-commerce, as a representative of the emerging industry, directly connects consumers and agricultural producers through the Internet platform, reducing intermediate links and improving circulation efficiency. This, in turn, enhances farmers' market negotiation ability and maximizes the value of agricultural products. Moreover, the emergence of the rural leisure and tourism industry has led to the identification of new opportunities for the rural sector, effectively transforming natural resources and the humanistic landscape of rural areas into economic assets. This transformation has resulted in the flourishing of new industries, such as agro-entertainment, characteristic towns, and idyllic farm complexes. These developments have not only enriched the connotation of the rural industry but also introduced a new source of vitality [6-7].

(2) Science, technology and innovation for agricultural development

Science and technology innovation plays a pivotal role in promoting the development of rural industries and has become an essential driving force propelling the modernization of agriculture. The continuous breakthroughs in science and technology, along with their widespread application, have led to a significant increase in the contribution rate of agricultural scientific and technological progress, which has now surpassed 63%. This figure is a testament to the substantial enhancement in China's agricultural scientific and technological innovation capacity and level. The integration of the Internet of Things (IoT), big data, and other advanced information technologies into agricultural

production has become increasingly pervasive and sophisticated. This integration has led to significant advancements in the intelligence of agricultural production processes, enhancing both the efficiency and the quality of agricultural products. Furthermore, it has promoted the intensification and refinement of agricultural production methods.

Real-time monitoring of environmental parameters, such as soil humidity, light intensity, and temperature changes, enables Internet of Things (IoT) technology to regulate the agricultural production environment with precision, facilitating operations like on-demand irrigation and intelligent fertilization. Big data analysis assists farmers in comprehending market demands, making informed decisions regarding planting varieties and production scales, mitigating market risks, and enhancing economic returns. Furthermore, novel agricultural management entities, such as family farms, farmers' cooperatives, and agricultural dragon-head enterprises, have been actively cultivated and developed. These entities have played an instrumental role in the introduction and promotion of novel technologies and varieties, thereby becoming pivotal carriers and robust supporters of agricultural modernization [8]. The Internet penetration rate in China's rural areas is depicted in Figure 3.

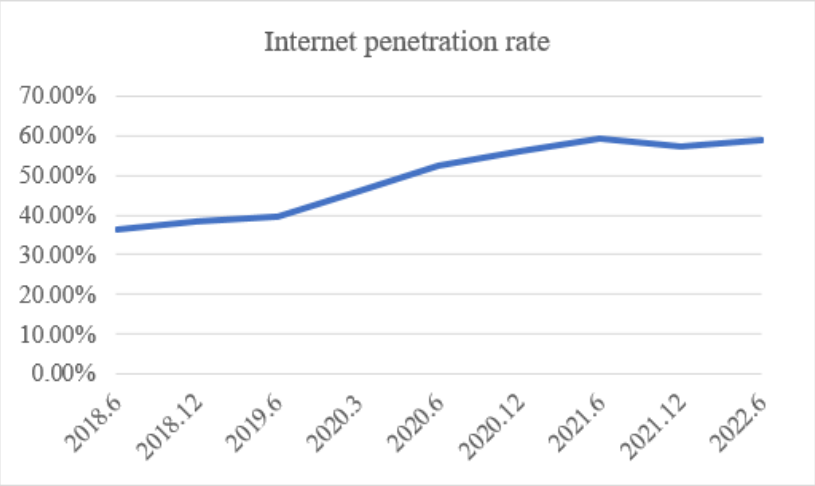

Figure 3. Internet Penetration Rate in Rural Areas of China, 2018-2022.

3. Practical analysis of tree planting for sand management

3.1. Strategic and scientific planning

(1) Establishment of long-term sand management goals

Tree planting and sand control are long-term and arduous tasks that require clear, long-term objectives to guide the way. In establishing these objectives, it is imperative to meticulously assess the prevailing natural, ecological, and environmental conditions, in addition to the requisites for socio-economic advancement. The objectives must be both pragmatic and forward-looking, while aligning with scientific principles and incorporating humanistic considerations. Specifically, the long-term sand control objectives may include the following: restoring and expanding the area of oases, stopping the spread of deserts, improving the quality of the regional ecological environment, raising the level of biodiversity, and promoting the sustainable development of the local economy and society, among other things.

(2) Development of short-term action plans

The realization of long-term goals necessitates the implementation of a series of short-term action plans. In formulating such a plan, it is essential to break down the long-term goals into a series of quantifiable and assessable milestones. Furthermore, the specific tasks, time nodes, and responsible parties for each stage must be clearly defined. The short-term action plan should be targeted and flexible, and be able to be adjusted and optimized at the right time according to the actual situation. Concurrently, emphasis must be placed on the articulation and coordination between the short-term

action plan and long-term goals. This is essential to ensure the continuity and efficacy of the measures in promoting the realization of long-term objectives.

3.2. Soil type and tree species adaptation analysis

(1) Investigation and classification of soil types

Soil type constitutes a primary factor influencing the growth and survival of tree species. Prior to the implementation of any tree-planting initiatives aimed at mitigating sand erosion, it is imperative to undertake a comprehensive investigation of the local soil types and subsequently categorize them into distinct groups. Through the implementation of soil sampling, laboratory analysis, and other methodologies, the texture, structure, nutrient content, acidity and alkalinity, and other characteristics of the soil should be thoroughly understood. The classification of soil types, such as sandy soil, loamy soil, and clay soil, facilitates the development of targeted soil improvement measures and tree species selection strategies.

(2) Species adaptation

The analysis of the adaptability of tree species constitutes a fundamental basis for the scientific selection of tree species. In the course of this analysis, it is essential to comprehensively assess the ecological habits, growth characteristics, and adaptability of tree species to their respective environmental conditions. A comprehensive analysis can be conducted from the following perspectives: firstly, the drought resistance, cold resistance, salinity resistance, and other indicators of resilience of tree species; secondly, the growth rate of tree species, tree structure, root distribution, and other growth characteristics; and thirdly, the adaptability of tree species to soil conditions, water conditions, light conditions, and other environmental factors. By conducting a comprehensive analysis of the adaptability characteristics of different tree species, the paper can identify those that are particularly well-suited for the local ecological environment, thus facilitating the selection of optimal tree species for planting [9-10].

3.3. Layout planning considerations

Windbreak forest belts constitute a pivotal component of tree planting and sand control strategies, playing a crucial role in mitigating wind speeds, curtailing wind erosion, and safeguarding farmland and oases. In the layout planning stage, the direction, width, and density of windbreaks should be reasonably determined according to the local wind direction, wind speed, and topography and geomorphology. The selection of tree species for the windbreak forest belt should prioritize fast-growing, dense canopy, and developed root species, with the objective of establishing an effective windbreak barrier. Concurrently, emphasis must be placed on the subsequent management and maintenance of the windbreak forest belt to guarantee its continued functionality in terms of windbreak and sand fixation.

Ecological barriers represent a critical measure for safeguarding the regional ecological environment. The strategic planting of trees to control sand movement represents a pivotal approach to mitigating desertification and enhancing the quality of the regional ecological environment. The construction of such ecological barriers must be meticulously planned, taking into account the topography, climate, and ecological characteristics of the local environment. The selection of tree species suitable for the local ecological environment can be undertaken for the purpose of planting, thereby forming a multi-level ecological barrier system. Concurrently, it is imperative to prioritize the harmonious integration of the ecological barrier with the surrounding environment, thereby ensuring its seamless incorporation into the regional landscape while fulfilling its ecological purpose.

In comprehensive layout planning, windbreak forest belts, ecological barriers and other construction measures should be combined with the overall goal of regional ecological environment management. Through scientific and reasonable layout planning, the organic combination and mutual promotion of various management measures can be realized. Specifically, according to the characteristics of the local ecological environment and governance needs, the windbreak forest belt, ecological barriers and other construction measures and oasis construction, soil and water

conservation, biodiversity protection and other work. Through a comprehensive approach and a multi-pronged approach, the sustainable improvement and enhancement of the regional ecological environment will be promoted.

In the layout planning process, emphasis should also be placed on communication and collaboration with local community residents. Through publicity and education, technical training and other ways to improve the community residents' awareness of environmental protection and participation; guide them to actively participate in the work of tree planting and sand control to jointly promote the improvement and enhancement of the regional ecological environment. At the same time, it should also strengthen the cooperation and coordination with the government, enterprises and other parties to form a synergy to jointly promote the sustainable and healthy development of the cause of tree planting and sand control [11].

3.4. Technological innovation and application

With the continuous progress of science and technology, the emergence of new planting techniques and materials, vegetation restoration and soil improvement techniques, as well as the increasing improvement of the monitoring and evaluation system have provided strong technical support for the work of tree planting and sand control. The following will discuss in detail the specific application and effectiveness of these technological innovations and applications in tree planting and sand control in Minqin County.

(1) Introduction to New Implant Technology and Materials

In the Minqin County Tree Planting and Sand Control Project, the application of drip irrigation technology is mainly reflected in the following aspects: firstly, the establishment of drip irrigation system, including water source, pumping station, water pipeline network, drip irrigation belt and other components; secondly, the development of a reasonable irrigation plan according to the type of plant and growth stage, to ensure that the plant receives sufficient water; thirdly, the strengthening of the drip irrigation system's maintenance and management, to ensure that the system operates normally. Through the application of drip irrigation technology, the survival rate and growth rate of tree planting and sand control projects can be significantly improved, irrigation costs can be reduced, and economic and ecological benefits can be enhanced.

In addition to drip irrigation technology, there are many other new materials and technologies that have been widely used in tree planting and sand control in Minqin County. For example, biodegradable mulch can reduce weed growth and soil erosion while maintaining soil temperature and humidity; microbial fertilizers can improve soil fertility and plant nutrient absorption efficiency by improving the structure of soil microbial communities; drought-resistant genetic engineering technology can improve the drought-resistant ability and adaptability of plants through genetic modification. The application of these new materials and technologies provides more options and possibilities for tree planting and sand control.

(2) Exploration of Vegetation Restoration and Soil Improvement Technologies

Vegetation restoration is one of the core tasks in tree planting and sand control. In order to realize effective vegetation restoration, Minqin County has tried a series of scientific restoration techniques. First, suitable tree species were selected for planting according to the local climate, soil and vegetation characteristics of Minqin County. When choosing tree species, priority was given to native tree species and drought-resistant, cold-resistant, saline-resistant and other resilient tree species. Secondly, reasonable planting density and configuration were adopted to improve the coverage and stability of the vegetation. For example, a multi-layered vegetation structure is formed by combining trees, shrubs and grasses; or belt planting and grid planting are used to reduce wind erosion and soil erosion. In addition, the post-management and maintenance of vegetation should be strengthened, including pruning, weeding, fertilization, pest control and other measures, to ensure the healthy growth and sustainable development of vegetation.

Since desertified soils in Minqin County are usually characterized by infertility, salinity and sloughing, a series of measures have been taken to improve soil quality. First, soil nutrient content is

increased and soil fertility is improved by applying organic and mineral fertilizers. Organic fertilizers can improve soil structure, increase soil organic matter content and improve soil water retention capacity, while mineral fertilizers can supplement soil nutrients such as nitrogen, phosphorus and potassium. Second, physical and chemical methods are used to improve soil properties. For example, chemicals such as gypsum are used to reduce soil salinity; soil conditioners are used to improve soil structure and water-holding capacity. In addition, green manure crops and straw are planted to increase soil organic matter content and improve soil structure.

(3) Community participation and institutional innovation

In Minqin County, Gansu Province, community participation and mechanism innovation are key elements in the sustainable and effective implementation of the project. By raising residents' awareness of and participation in sand control, establishing a benefit-sharing mechanism, and implementing policy support and incentives, Minqin County has not only effectively mitigated the problem of land desertification, but also promoted the economic development and social harmony of the local community. The practice and effectiveness of these three aspects will be discussed in detail below.

In Minqin County, raising residents' awareness of sand control is a top priority. To that end, the local government and environmental organizations have jointly carried out a series of informative and diverse publicity and education activities. These activities include both traditional static publicity methods such as the distribution of brochures, the hanging of slogans and the display of wall posters, as well as the integration of modern technological means, such as the use of social media, short video platforms and other new media for wide dissemination.

With regard to the content of the activities, in addition to popularizing the importance of tree planting and sand control, scientific methods and successful cases, special attention was paid to combining actual cases to tell the positive changes brought about by sand control to the local environment, economy and life. Through real and touching stories, residents were inspired to identify with and participate in the sand control work.

On the one hand, experts and scholars are invited to explain sand control knowledge and technology to residents through the organization of special lectures and training courses; on the other hand, schools, communities and other public platforms are utilized to carry out the activity of "Little Hands Pulling Big Hands", so as to make students become the little messengers of sand control propaganda, and to drive their family members to participate in sand control work together.

Minqin County also focuses on combining sand control education with local culture, through arranging cultural and artistic programs on sand control themes, holding sand control photography exhibitions and other forms, so that residents can enjoy a cultural feast while deepening their understanding and support for sand control work.

With the in-depth development of publicity and education activities, the awareness of Minqin County residents of sand control has increased significantly, and their participation has also increased. More and more residents spontaneously join in the ranks of tree planting and sand control, they not only actively participate in tree planting and reforestation activities, but also take the initiative to take the responsibility of protecting the forest and preventing damage. This universal participation has greatly promoted the progress of sand control in Minqin County.

At the same time, the increased participation of residents has brought positive results in other aspects. On the one hand, it enhances the cohesion and centripetal force of the community and promotes harmonious coexistence among neighbors; on the other hand, it stimulates the creativity and innovative spirit of the residents and provides more ideas and methods for sand control [12].

4. Conclusions

Minqin County in Gansu Province has provided a demonstration sample for the synergistic development of ecological governance and rural revitalization in arid areas through the innovative practice of integrating and co-promoting industry and sand control. The study found that Minqin

County relies on sand control and modern agricultural technology to promote the steady growth of the agricultural economy and lay a material foundation for economic development. In the practice of sand control, the scientific planning of windbreak forest belts and ecological barriers, the introduction of drip irrigation technology, biodegradable membranes and other water-saving materials, combined with soil improvement and vegetation restoration techniques, have transformed sandy land into arable resources, and significantly increased the vegetation coverage rate. Meanwhile, industrial integration has become the core driving force for the sustainability of sand control. On the one hand, the industrial chain has been extended through the development of live rural e-commerce, eco-tourism and forest economy; on the other hand, the innovation of community participation mechanism has stimulated the endogenous motivation of residents to control the sand, forming a benign cycle of feeding the sand control with industry and optimizing the industry with sand control. At the policy level, the synergistic force of China's rural revitalization strategy and ecological protection policy has provided a systematic guarantee for Minqin to coordinate ecological restoration and industrial development. The model proves that the in-depth integration of ecological governance and industrial economy cannot only curb the spread of desertification, but also activate the endogenous development momentum of the countryside, providing a replicable path for similar regions to realize the ecological-economic win-win situation.

References

[1] QIAN Guixia, WANG Xiaoxin, LI Wu, et al. Evolutionary process and realization path of China from sand prevention and sand control to sand management and sand use [J]. Journal of Applied Ecology, 2024, 35(1):8-16.

[2] Wang Xingxia. Influencing factors of agricultural economic growth and ways of sustainable development [J]. China Collective Economy, 2021, (22):11-12.

[3] YANG Yadong, CHENG Changlin,DU Yating,et al. Evaluation of the development status of rural industries and their employment-led potential in counties across China[J]. Journal of Agricultural Engineering, 2021, 37(13):322-330.

[4] Feng Li. Exploration on the path of improving quality and efficiency of characteristic agricultural industry in Minqin County [J]. Agricultural Science and Information, 2024(6):135-138.

[5] Yin Sha, Yang Xinjun. Adaptation of Rural Transformation and Development Path Optimization in Fragile Environment Areas--Taking Minqin County of Gansu as an Example [J]. Human Geography, 2024, 39(2):54-63.

[6] WANG Xinchun,WANG Jun,ZHANG Shiyong. Gansu Jinta:Industrial sand control realizes win-win situation[J]. China Finance, 2017(17):1.

[7] Guo Xu. Inner Mongolia: Sand control and industrialization resonate together [J]. Xiaokang, 2023(18):64-67.

[8] Bian Xiuqin. Research on the impact of agricultural economic growth on accounting model [J]. Financial News, 2023, (13):132-134.

[9] Yang Aiquan. Selection and planning of main tree species for afforestation projects in Minqin County [J]. Agricultural Disaster Research, 2023, 13(10):317-319.

[10] Song Dacheng, Ma Quanlin, Liu Shiquan, ET al.Species diversity and soil moisture change characteristics of Minqin clay sand barriers-artificial pokeweed forest [J].Arid Zone Research / Ganhanqu Yanjiu, 2024, 41(4).

[11] Liu Yi. Construction of ecological forestry to realize coordinated development [J]. China Paper Journal, 2004(z1):3.

[12] Sun Guiren. Research and analysis on the construction of ecological culture and tourism industry chain in Minqin County under the new development concept [J]. Agricultural Science and Information, 2023(1):162-164.