Exploration of Green Development in Ecological Irrigation Areas

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Abstract. The concept of green development is an important way to effectively solve the development challenges of ecological irrigation areas. In the context of rural revitalization strategy, based on the concept of green development, this paper explores the connotation of green development in ecological irrigation areas, analyzes the difficulties in the development of ecological irrigation areas from the perspectives of resource utilization, ecological environment, policy management, etc., proposes the development theory of ecological irrigation areas, and explores the green development paths of agricultural progress and industrial integration, ecological restoration and environmental improvement, resource protection and efficient utilization, and scientific management in ecological irrigation areas, and provide reference for achieving green and sustainable development in irrigation areas.

Keywords: ecological irrigation area; green development; path.

1. Introduction

Irrigation areas are advantageous resources for food production, carrying the heavy responsibility of national food security, and serving as the foundation for the development of modern agriculture in the country. Our country has put forward new requirements for the construction of large-scale irrigation areas, focusing on the development of "green ecology", "sustainable development", and "modernization" in irrigation areas. Ecological irrigation areas have become the development trend of water conservancy engineering in the new era, and various parts of the country are exploring the construction process of modern ecological irrigation areas. In recent years, some theoretical and technical research on ecological irrigation areas has been carried out in China. However, there are still few studies on how to achieve green development in ecological irrigation areas. The concept of green development is an important way to effectively solve the development challenges of ecological irrigation areas. In the context of rural revitalization strategy and guided by the concept of green development, this article attempts to explore the challenges and connotations and paths of green development in the development of ecological irrigation areas, with the aim of achieving green and sustainable development in irrigation areas and assisting in rural revitalization.

2. Connotation of Green Development in Ecological Irrigation Areas

2.1 Green Development Concept

2.1.1 Ecotype

Replace the existing rigid channels with ecological channels with virtuous cycles, mainly by setting multi-level artificial falls and rubber dams, to control the ecological flow, water level, and water volume of the irrigation area's rivers; Improve the purification capacity of non point source pollution in agricultural irrigation areas through technologies such as aquatic vegetation restoration and biological fillers; Establish anti-seepage ditches and channels, and construct ditch spatial ecology through "artificial" reconstruction techniques. Building ecological channel irrigation areas

according to local conditions is an important measure to consider soil, water resources, and biological friendly relationships, which can improve local microclimate and increase channel self-cleaning capacity.

2.1.2 Water-saving Type

This type of ecological irrigation area must first have a stable water source, in order to flexibly, reliably, accurately, and efficiently control the irrigation area; Secondly, reclaimed water is mainly used for irrigation in the irrigation area, and a joint configuration of multiple water sources is adopted to achieve water-saving and improve irrigation utilization efficiency. Water resources are the most basic and important natural resources in irrigation areas. It is necessary to prioritize water conservation and prioritize water conservation in terms of concepts and actions. Harmony between people and water in irrigation areas requires addressing the balance of water demand and supply, as well as water environment issues, in order to ensure sustainable economic and social development of water resources in irrigation areas and achieve harmony between people and water.

2.1.3 Modernization Type

This type of ecological irrigation area refers to the achievement of scientific management, efficient utilization of ecological resources, and effective protection of ecosystems through technological and institutional reforms. To build a modern ecological irrigation area, it is necessary to integrate ecological concepts into planning and design, use communication, network, and digital twin technologies, achieve automation, informatization, precision in irrigation area management, and have emergency response capabilities. By intelligently maximizing the management of irrigation project management and water resource scheduling, and relying on the modernization of technology and data, the overall integrity and management service capabilities of the project can be improved.

2.1.4 Humanistic Type

A good ecological irrigation area should not only meet the basic attributes of agricultural irrigation, but also have a certain degree of humanistic value. Humanity is manifested in rural tourism and leisure agriculture, linking agriculture, tourism, natural environment, and humanity together. The construction of leisure agriculture and rural tourism in ecological irrigation areas only requires the utilization of existing agricultural resources within the scope, and corresponding planning, improvement, and management to meet the needs of tourists, which can quickly produce good results. It can maximize the authenticity of resources while improving the agricultural economic benefits of irrigation areas.

2.2 Connotation of Ecological Irrigation Areas

There is currently no clear definition of ecological irrigation areas at home and abroad. Most scholars believe that ecological irrigation areas are high-quality and efficient agricultural areas that integrate rational resource allocation, food safety, ecological environment optimization, and sustainable agricultural development. They are an inevitable product of agricultural development in irrigation areas and integrate ecological channels, water-saving, modernization, humanities, economy, and environment construction.

Based on the development concept and principles of ecological irrigation areas, ecological irrigation areas can be defined as constructing water-saving and modern humanistic irrigation areas with ecological channels based on principles such as biodiversity, sustainable development, and landscape ecology. Guided by the concept of ecological civilization, guided by the harmony between humans and nature, and guided by the quality of agricultural production and living environment, in order to achieve coordinated development of ecology and economy; With the aim of maintaining the stability of the ecosystem in the irrigation area and maintaining a virtuous cycle of the ecosystem within the irrigation basin, through efficient utilization of water resources, water

environment protection and governance, ecosystem restoration and reconstruction, water landscape and water culture construction, and ecological regulation measures, a modern and efficient irrigation area with higher productivity, more reasonable allocation of water resources, and the maximum ecological service function provided per unit of water volume is formed.

3. The Difficulties in the Development of Ecological Irrigation Areas

The difficulties in the development of ecological irrigation areas mainly include the following aspects:

3.1 Resource Utilization

The 2022 China Water Resources Bulletin shows that China's total agricultural water consumption is 378.13 billion m^3, accounting for 63.0% of the total water consumption. The effective utilization coefficient of farmland irrigation water is 0.572. Analyzing the data published in China's Water Resources Bulletin in recent years, it is found that the irrigation water utilization coefficient is increasing year by year, but there is still a significant gap compared to developed countries. In addition, unscientific cultivation techniques and uncoordinated planting structures have resulted in low irrigation water utilization and high water consumption. Not only water resources, but also the utilization rate of land resources, biological resources, etc. in irrigation areas is relatively low. Many water-saving irrigation systems in engineering projects are not complete and have not been based on long-term development mechanisms. Many engineering benefits have not been fully utilized, affecting the overall production level of ecological irrigation areas.

3.2 Ecological Environment

Pollutant emissions from irrigation areas affect regional ecosystems. In addition, most irrigation areas also face serious non-point source pollution, deteriorating irrigation water quality, and reduced ecological diversity. According to the "China Agricultural Green Development Report 2022", the national agricultural fertilizer application amount (converted into pure amount) is 51.91 million tons, and the pesticide use amount (converted into 100% amount) is 248300 tons. The use of large amounts of fertilizers and pesticides has caused non-point source pollution, and some severely polluted areas have been abandoned. The pollution control of irrigation areas not only requires pollution discharge measures, but also suitable technologies. At present, the pollution discharge capacity and technology cannot meet the needs of the public for a beautiful ecological environment. In addition, water pollution poses some hidden dangers to food security, and droughts, floods, alkalis, and insect disasters can exacerbate the contradiction and instability between agricultural supply and demand. Thirdly, a suitable ecosystem has not been established.

3.3 Policy Management

The necessary supportive policies in this field are insufficient, the supporting policies for institutional reform are incomplete, and the mechanisms are not sound. Some water-saving systems have not been strictly implemented, long-term mechanisms have not been established, and some projects have not played their intended value, which has formed certain constraints on the sustainable development of ecological irrigation areas and agricultural progress. In terms of actual production services and management levels, an effective service system has not been established, which has caused significant constraints on the actual productivity of ecological irrigation areas. On the one hand, there is a phenomenon of "Emphasizing Construction and Neglecting Management" in irrigation areas, and the management concept has not been updated. On the other hand, irrigation areas lack management funds.

4. Theories of Ecological Irrigation Area Construction

The construction of ecological irrigation areas requires theoretical support such as optimized allocation of service functions, regulation of farmland energy, and evaluation of ecosystem security.

4.1 Service Function Optimization Configuration Theory

According to literature, the core of the theory of optimizing the allocation of service functions in irrigation areas is to coordinate the relationship between agricultural production and ecological environment construction, clarify the ecological structure and functional positioning of irrigation areas, and propose scientific methods for optimizing the allocation of water and soil resources.

Ecological space, production space, and living space constitute the structural positioning of the agricultural ecosystem as a "trinity"; Analyze the effectiveness of ecological units such as mountains, water, forests, fields, lakes, grasses, and sands in landscape ecosystems, and establish the ecological system structure and functional positioning of "mountains, rivers, forests, fields, lakes, grasses, and sands" at the irrigation area scale. Scientifically plan land resources such as cultivated land, forest land, grassland, and construction land to maximize the comprehensive ecological benefits of land resources; Reasonable allocation of water resources and scientific coordination of the relationship between agricultural production and ecological environment construction are the fundamental guarantees for ecological environment protection and high-quality agricultural development in irrigation areas.

4.2 Theory of Farmland Energy Regulation

The regulation of farmland energy mainly includes the optimization design theory of water-saving and energy-saving irrigation and drainage systems and the fine regulation theory of farmland crop habitat.

The optimization design theory of water-saving and energy-saving irrigation and drainage systems in ecological irrigation areas aims to improve the efficiency of water resource utilization and the real-time supply and allocation capacity of irrigation water. It systematically analyzes the natural conditions, agricultural planting structure, and water source conditions of the irrigation area, forming an optimization theory of efficient transmission and distribution, energy-saving and consumption reduction, water-saving and efficiency enhancement, water salt compatibility, ecological safety, and green development of agricultural high-efficiency and energy-saving irrigation and drainage systems; The fine regulation theory of farmland crop habitat aims to efficiently and sustainably utilize soil and water resources, improve water and fertilizer production efficiency, crop yield, fruit quality, and regulate farmland crop habitat. Combining modern cultivation, crop physiology, and theories related to efficient utilization of farmland water and fertilizer, the theory and technology of crop habitat regulation are innovated from four aspects: regulating soil supply, root absorption, stem transmission, and crop production.

4.3 Ecological System Security Assessment Theory

The evaluation of ecosystem security in irrigation areas mainly involves quantitative evaluation of its structural rationality, integrity, and degree of service function realization. Based on the characteristics and service functions of the ecosystem in the irrigation area, a quantitative evaluation index system can be established to evaluate and control the socio-economic, landscape pattern, water and soil resource utilization, wetland environment, atmospheric environment, biological vitality, crop growth, yield and quality, etc., in order to achieve coordinated development of resources, environment, economy and society within the irrigation area. By establishing the carrying capacity of water and soil resources in irrigation areas, establishing an evaluation model for irrigation areas, and developing a comprehensive evaluation method for the ecological system security of irrigation areas that integrates "mountains, rivers, forests, fields, lakes, grass, and sand", a warning indicator system and ecological security management method for ecological security in

irrigation areas are proposed, and a theory for ecological system security evaluation suitable for different types of irrigation areas is constructed.

5. Ecological Irrigation Area Construction Paths

5.1 Agricultural Progress and Industrial Integration

The construction of ecological irrigation areas should strengthen agricultural progress and industrial integration, achieve increased grain production and quality, and effective supply of other products. The bottom line of agricultural quality and yield is a prerequisite for the sustainable development of ecological irrigation areas. Firstly, strengthen the rational use of fertilizers and pesticides, prevent substandard sewage irrigation, prevent the reduction of arable land, and achieve coordinated development of arable land quantity, quality, and ecology. Secondly, improve agricultural structure and production mode, and create characteristic and advantageous industries in ecological irrigation areas. Thirdly, strengthen the development of smart agriculture in irrigation areas to achieve efficient, low consumption, high yield, and high quality agricultural production. Fourthly, the integration and development of industries, and the construction of the entire industrial chain.

5.2 Ecological Restoration and Environmental Improvement

The construction of ecological irrigation areas should grasp the bottom line of ecology and environment. Control non-point source pollution and strictly control the use of pesticides; Prevent the abuse, overuse and misuse of fertilizers, and establish a standard system for heavy metals and toxic substances; Prevent secondary pollution and improve comprehensive waste utilization policies. Secondly, improve sewage treatment technology and take different measures for different types of sewage. Thirdly, strengthen the construction of ecological ditches and reduce the use of hard materials; Reduce biological isolation and restore the function of aquatic ecosystems. Fourthly, improve the soil ecological environment, improve pollution prevention laws, regulations, and standards, and promote soil environmental assessment and governance. Fifthly, optimize the planting structure of irrigation areas, determine yield based on water, and optimize structure based on water.

5.3 Resource Protection and Efficient Utilization

There should be a reasonable upper limit for the development and utilization of resources and energy in ecological irrigation areas. Strengthen the effective protection and efficient utilization of land resources. Reasonably divide agricultural, forestry, animal husbandry, fishing, grass, residential, and industrial land, strengthen coordination among different regions based on the theory of healthy development of the biological chain and harmonious coexistence between humans and nature, and promote the construction of high standard farmland; Strengthen the effective protection and efficient utilization of water resources, strengthen water conservation in engineering, technology, and management, and strengthen pollution prevention and control in actions, technology, and policies; Reasonably utilize other resources and energy, turn waste into treasure, and efficiently recycle; Effectively solve the problem of non-point source pollution in livestock and poultry breeding industry.

5.4 Integration of Water Landscape and Water Culture, Harmony between People and Water

Irrigation areas should plan ecological layout in accordance with the requirements of rural revitalization strategy, combining hydraulic buildings with surrounding rivers and channels to form the overall landscape of rural water conservancy, reasonably constructing channel ecological waterscapes and hydrophilic platforms, excavating and constructing water cultural heritage in irrigation areas, and achieving coordinated development between water bodies and the surrounding

environment. The development goal of ecological irrigation areas is to achieve harmonious development of the entire irrigation area, including coordination of water resource usage and coordination between water managers and water users. Improve the utilization rate of water resources in irrigation areas and restore the healthy operation and management environment of irrigation areas, achieving harmony between people and water.

5.5 Scientific Management System

In the practice of ecological irrigation area construction, it is necessary to further innovate the construction concept, change the construction method, integrate scientific and environmental development concepts, and continuously improve the level of ecological irrigation area construction. In specific operations, it is necessary to adhere to the market-oriented role and achieve optimal allocation and efficient utilization of resources. In development practice, it is necessary to build a three-dimensional and scientific construction management system. From the perspective of the country and society, it is necessary to strengthen policy guidance and incentives, increase funding and policy support for ecological irrigation areas, encourage the construction of ecological irrigation areas through multiple channels, and improve the comprehensive level of agricultural production in China.

6. Conclusion

The construction of ecological irrigation areas is an effective way to ensure the effective supply of agricultural products, ensure food security, and achieve green and sustainable development in irrigation areas. It is of great significance for the resolution of the "Agriculture, Rural Areas, and Farmers" issues and the implementation of rural revitalization strategies. The construction of ecological irrigation areas is a complex and systematic project. By grasping the actual needs of irrigation areas, taking into account factors such as water and soil resources, environment, and management, and adapting to local conditions and planning in a coordinated manner, we aim to build an ecologically sustainable irrigation area with prosperous industries, beautiful environment, livable ecology, efficient resource utilization, and affluent living conditions. We aim to protect human health and build a good living environment, enhance the rational utilization of water and soil resources, and ensure food security, water supply safety and ecological security.

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