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Study of the Importance of Irrigation Projects to Agricultural Water Resources Using the Baiqi Canal as an Example

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Abstract:

In the global economic system, the stable development of agriculture as a basic industry is inseparable from the rational utilization of water resources. Irrigation projects play a vital role in ensuring agricultural water use, increasing grain output and promoting agricultural sustainable development. This study aims to explore the scientific experience of Baiqi Canal, an excellent irrigation project in ancient China, and its profound value as a world irrigation project heritage, analyze the importance of irrigation projects to agricultural water resources, and promote the protection and sustainable utilization of irrigation project heritage. Firstly, the irrigation mode of Baiqi Canal and its important role in agricultural development were introduced, and then its influence on local agricultural water resources and ecological environment was analyzed. Finally, the positive influence of international irrigation projects on agricultural water resources was further discussed, and its key role in ensuring food security and promoting agricultural sustainable development was emphasized.

Keywords: Irrigation Engineering, Agricultural Water Resources, Sustainable Development, Food Security

1. Introduction

Under the double pressure of global population growth and climate change, efficient utilization of agricultural water resources has become an indispensable part of ensuring food security and maintaining ecological balance[1]. Along with the aggravation of global climate change and the increase of population pressure, the problem of agricultural water shortage is becoming more and more prominent. To meet this challenge, many countries have stepped up the construction of irrigation projects in order to improve the utilization efficiency of agricultural water resources[2]. Being a big agricultural country, China has a profound tradition of irrigation engineering. Taking Baiqi Canal, a world heritage of irrigation project, as an example, this study discusses the important role of irrigation project in the utilization of agricultural water resources, analyzes its positive impact on improving local agricultural water resources and ecological environment[3], and looks forward to the sustainable development prospect of irrigation project construction and management. The purpose of management is to provide useful reference for food security and sustainable development of agriculture.

2. The value of the Pak Ki Canal Irrigation Project heritage

2.1 The historical origin of the Baiqi Canal

Baiqi Channel, which spans 49.25 kilometers between Nanzhang County of Xiangyang City and Yicheng City, Hubei Province, is also called Baili Long Channel, which irrigates a large area of farmland in Yicheng Plain, covering an area of more than 300,000 mu, and is the lifeblood of local agricultural production[4].

Originally built as a military defense facility, its origin can be traced back to the Ba ttle of Yangyan Camp between Qin and Chu during the Warring States Period (279-278 BC)[5]. At that time, King Zhaoxiang of Qin sent his general Bai Qi to lead his army to attack the state of Chu. Facing the stubborn resistance of Chu army, Leitian took advantage of Yishui's geographical advantage (i.e. E. today's Barbaric River) to build dams to store floodwater in the upper reaches of the Yishui River around the city of Yanyan[1], and captured the capital of Ying, which was a decisive victory for the destruction of the state of Chu by Qin through the tactics of water attack. The Baiqi Canal was gradually transformed into an important agricultural

irrigation system after the war, and after many repairs and expansions in the Tang, Song and Yuan Dynasties, it became a representative agricultural irrigation project in ancient China, which still plays an important role and is listed as a world heritage of irrigation projects.

2.2 Irrigation of the Baiqi Canal Features

In the process of building and maintaining Baiqi Canal, the ancients deeply realized the importance of ecological balance and sustainable development. They respected nature and protected the environment, and realized the rational use and management of water resources through careful engineering design and construction measures, demonstrating the concept of harmonious coexistence between human beings and nature.

Baiqi Canal has a unique irrigation system design, especially its "long vine melon" water storage and diversion method. The irrigation network compares the canal to a "long vine", and a series of reservoirs and dams built along the canal are like "melons", through which water resources can be flexibly allocated between different sizes. In this way, the "long vine melon" system can flexibly allocate water sources of different sizes, ensure stable and reliable water supply for farmland, and effectively promote the stability and development of agricultural production. Meanwhile, this irrigation method also reflects the importance and protection of water resources. Through scientific and reasonable allocation and utilization, the maximum utilization of water resources is realized, which lays a solid foundation for sustainable development[4].

In terms of construction technology, the ancient people also demonstrated superior skills and outstanding wisdom. With the barrage, diversion outlet and main canal as the center, the whole project is exquisitely laid out and extremely difficult to construct. By scientific and reasonable layout and construction scheme, the problems of water flow control, flood control and disaster reduction have been successfully solved, and the irrigation area has been significantly expanded.

The Baiqi Canal also adopts the water-saving irrigation management system of bucket-gate water distribution and time-rotation irrigation. By setting water gates Ii. E. bucket gates) on the canals to control the water volume and level, it realizes segmented water supply and rotational irrigation. The system not only improves the irrigation efficiency, but also reduces the waste of water resources.

2.3 The impact on the local agricultural environment

With several generations' renovation and development, Baiqi Canal has formed an agricultural irrigation system with Sandaohe large reservoir as the main water source and 15 reservoirs and 2,671 reservoirs as supplements. The unique "long vine and melon" style of water storage and diversion can flexibly adjust the amount of irrigation according to the actual demand of crops, which not only improves the irrigation efficiency, but also stabilizes the water supply.

2.3.1 Optimization of agricultural cropping structure and significant increase in crop yields

Construction of Baiqi Canal has led to major changes in local agricultural planting structure. Improvement of irrigation conditions makes it possible to plant more kinds of crops, such as rice and wheat, on the land where drought-resistant crops can only be planted. Not only did this improve the utilization rate of land, but also enriched the varieties of agricultural products. On the other hand, the stable water supply also provides a strong guarantee for local agricultural production. Through irrigation, it can effectively replenish farmland water, improve soil moisture and promote crop growth and development[6]. Based on historical records and modern research data, the construction of Baiqi Canal has increased the local crop yield by more than 30%, and significantly improved the income level of local farmers.

2.3.2 Dual growth of farmers' income and the agricultural economy

Construction of Baiqi Canal not only increased crop yield, but also promoted the development of local agriculture-related industries, such as agricultural machinery manufacturing and pesticide and fertilizer production. The development of these industries has further promoted the prosperity of the agricultural economy[7], providing more employment opportunities and sources of income for farmers[8]. Meanwhile, diversified planting structure enables farmers to adjust their planting plans according to market demand and obtain higher economic benefits.

2.4 Alleviating soil salinization and contributing to sustainable agricultural development

The saline-alkali land is a common land use problem in the world, and its formation is mainly influenced by natural factors (such as G. high water table, high evaporation) and man-made activities (e. G. irrational irrigation), which seriously affects the normal growth of crops and agricultural yields. Baiqiqu, with its unique irrigation method and historical heritage, has significantly improved the soil structure and ecological environment of local saline-alkali

land.

First of all, Baiqi Canal introduced a large amount of fresh water into saline soil through its unique fine planning and construction technology, and distributed it to various irrigation areas, effectively dissolving and diluting the salt in the soil. Through natural infiltration and lateral seepage mechanisms, the salts are guided to the deep soil or drainage system, which significantly reduces the salt concentration in the surface soil, thus effectively curbing the spread of soil salinization. Secondly, regulating groundwater level, as another important aspect of irrigation management, is self-evident for preventing soil salinization. Time-rotation irrigation mode innovatively adopted in Baiqi Canal not only meets the water demand of crop growth through precise irrigation in different time periods, but also skillfully controls the groundwater level in each area, effectively blocking the rising trend of salt with water evaporation, and further reducing the risk of soil salinization. The implementation of this irrigation system not only improves the water use efficiency, but also lays a solid foundation for soil health and sustainable agricultural development. Thirdly, timely deep ploughing and deep ploughing after irrigation have become the key links to improve soil structure and promote root development. This process changes the physical properties of the soil from the surface layer to the deeper layer, greatly reduces soil compactness, significantly improves soil aeration and water permeability, and builds a more permeable and suitable growing space for crop roots. Importantly, deep ploughing and ploughing also cut off the tiny capillary network in the soil, which used to be the main path for soil moisture and salt to migrate to the surface. With the weakening of capillary action, the evaporation and dissipation of soil moisture is effectively controlled, thus reducing the accumulation of salts on the soil surface. I.E. the phenomenon of "returning salts" has been significantly suppressed, creating a healthier and more stable soil environment for the strong growth of crops.

Successful improvement of saline soil by Baiqi canal irrigation project not only solved the bottleneck problem of local agricultural production, but also laid a solid foundation for the sustainable development of regional agriculture. Through scientific irrigation technology and soil and water conservation measures, the salts in the soil were effectively removed, the soil structure was improved, and by improving the ecological environment of the farmland, the occurrence and development of soil salinization was controlled from the source, and the saline land was gradually transformed into high-yield and stable-yield arable land, which improved the land utilization rate and the efficiency of agricultural production. Meanwhile, this improved model also provides valuable experience and reference for the control of saline-alkali land in other areas.

Furthermore, Baiqi Canal is not limited to irrigation; It also combines with agro-ecological projects to implement various soil and water conservation measures, such as vegetation restoration and wetland construction. All these measures have significantly improved the ecological environment of farmland, reduced soil erosion and reduced the risk of soil salinization from the source. Meanwhile, Baiqi Canal attaches great importance to channel management and water quality monitoring to ensure the cleanliness of the irrigation water, avoiding secondary soil pollution caused by water quality problems and further safeguarding the healthy growth of crops and optimization of soil quality.

3. The Case for Sustainable Development through Efficient Use of Water Resources in International Irrigation Engineering

3.1 Innovations and Impacts of Drip Irrigation Technology in Israel

Facing the extreme water shortage, Israel took this opportunity to successfully develop and widely deploy cutting-edge drip irrigation technology through continuous innovation and technological evolution, and realized precise regulation and efficient utilization of scarce water resources.

The core of this technology lies in its high accuracy and intelligence. This technology relies on the precision irrigation system to realize the direct and accurate transportation of water and key nutrients to the root zone of plants, effectively avoiding a large amount of water wasted by traditional irrigation methods due to evaporation and soil infiltration, and the irrigation efficiency has jumped to a high level of more than 90%, which means that every drop of water is used for crop growth to the maximum extent, greatly reducing the water pressure in Israel and the arid areas of the world[9]. The practice of this precision irrigation method has optimized the growing environment for crops, greatly enhancing not only the yield but also the quality of the crops. With the successful application of drip irrigation technology, Israeli agriculture has gradually turned to planting high-value crops such as fruits, vegetables and flowers, which not only improves the overall economic benefits of agriculture, but also enriches the diversity of agricultural products in the market and im-

proves international competitiveness.

Israel's technological innovation in drip irrigation has not only profoundly changed the face of its own agriculture, but has also provided valuable experience and inspiration for the development of agriculture in the world, especially in arid and semi-arid areas[10]. This proves that even in the environment with limited resources, great progress can be achieved in agricultural production through scientific and technological innovation and application, which provides an important reference for exploring the path of global agricultural sustainable development. It encourages countries to strengthen scientific and technological innovation, promote the research, development and application of water-saving irrigation technology, jointly explore the road of sustainable agricultural development suitable for their own national conditions, and make contributions to the realization of global water security and sustainable agricultural development.

3.2 Combined Benefits of Central Valley Irrigation Systems in the U.S.

The Central Valley of California, with its unique geographical location and climatic conditions, has nurtured a vast agricultural oasis on the vast west coast of North America, and all these brilliant achievements are inseparable from its powerful water resources management pillar-the irrigation system of the Central Valley of the United States.

The system is cleverly constructed into a huge canal network, which runs through the valley like a blood vein, accurately and accurately transporting a large amount of water from the far north to the arid inland. Such a design not only minimizes evaporation and leakage losses, but also ensures the balanced distribution of water to meet the irrigation needs of different regions and crops[11]. Based on the canal network, the efficient operation of the pumping station system is like the blood pumping function of the heart, which provides strong power support for the whole irrigation system. Advanced water conservancy technology is adopted in these pumping stations, which accurately control the speed, pressure and flow of water and realize the fine allocation of water resources. Day and night, they raise water resources from low places to high places, cross terrain obstacles, ensure that every farmland can be irrigated in time and fully, and provide a solid guarantee for the continuity and stability of agricultural production.

Thanks to the strong support of irrigation systems, the Central Valley has gradually developed a highly centralized agricultural production system. Crops planting is no longer limited by natural precipitation, and can be planted on a large scale according to market demand, especially the production of grain and cash crops has been greatly promoted. Such large-scale production not only improves the land utilization rate and agricultural production efficiency, but also reduces the unit production cost and enhances the market competitiveness of agricultural products. The stable operation of irrigation system also provides strong support for the innovation and popularization of agricultural technology and promotes the process of agricultural modernization.

Irrigation system in the central valley of the United States not only solved the long-standing irrigation dilemma in this area, but also set a new benchmark for efficient use of water resources around the world, which is a model for efficient use of water resources and sustainable development of agriculture. Its successful experience provides useful reference and inspiration for other regions of the world, and demonstrates the beautiful vision of harmonious coexistence between human wisdom and nature.

4. Conclusions and outlook

As an irrigation project lasting for thousands of years, Baiqi Canal's long running history proves the indispensability of irrigation project in the management and efficient utilization of agricultural water resources. By studying irrigation projects at home and abroad, we not only realize the important significance of irrigation projects in ensuring food security and promoting the sustainable development of agriculture[5], but also reveal how to realize the sustainable utilization of water resources through technological innovation and management optimization under the new challenges faced by modern society.

We should further strengthen irrigation engineering construction and ecological management, attach importance to scientific and technological innovation and management innovation, promote the sustainable utilization of agricultural water resources and the green development of agricultural production[2], and comprehensively apply various irrigation technologies and strategies, which are important ways to meet the challenges of water resources and ensure global food security[3][11][12]. In the meantime, we should strengthen the research and protection of ancient irrigation projects, and explore the historical value and scientific principles behind them.

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