

Current Situation and Countermeasures of Agricultural Water-saving Irrigation in China under the Restriction of Ecological Environment

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Abstract: Water resources are the premise for all life and production activities. At present, there is a phenomenon of water shortage in many areas within the country, and the distribution of domestic water resources is relatively uneven. Compared with traditional irrigation methods, Water-saving irrigation can improve the utilization rate of agricultural water and the income per unit of crops, and help improve agricultural facilities, protect water resources, reduce the impact of pollution and climate change, and is an effective way to achieve a balance of economic, social and ecological environment benefits in rural areas. Based on the current application of farmland water conservancy and water-saving irrigation technology, this paper expounds the application status and problems, and puts forward the optimization measures of agricultural water-saving irrigation from the perspectives of technology, publicity and policy support, in order to further improve the effect of water-saving irrigation and promote the sustainable development of agriculture.

Keywords: Farmland Irrigation; Water-saving Irrigation; Popularization and Application; Benefits; Crops

1. Introduction

The proposal of the important policy of "determining cities, land, population, and production by water, and developing water-saving industries" has pointed out the direction for optimizing the allocation of water resources and promoting the intensive use of water resources. It provides an important guideline for building a modern society where

humans and nature coexist harmoniously.

As a large agricultural country, China's agricultural water consumption accounts for a high proportion of total water consumption, and the contradiction between insufficient water supply and agricultural development needs is prominent, resulting in severe challenges to ecological security and food security, and seriously restricting sustainable social and economic development. As an important subject of agricultural production, water-saving irrigation has a direct impact on grain output and quality, is very important to keep the basic plate of "three rural", and plays a non-negligible role in realizing the organic unity of economic development and ecological protection, and realizing the coordinated development of "lucid waters and lush mountains" and "golden mountains and silver mountains".

2. Development Status of Agricultural Water-saving Irrigation

China's total water resources are relatively rich. In 2022, the total amount of water resources will be 2798.81 billion cubic meters, and the country's per capita comprehensive water consumption will be about 425 cubic meters. The country's precipitation and water resources are less than the annual average, and the spatial and spatial distribution of water resources is uneven, and the problem of water resource shortage is becoming more and more obvious. China is a large agricultural country, and agricultural water consumption accounts for a large proportion of total water consumption. According to statistics, from 2017 to 2022, agricultural water consumption will occupy 61.16% to 63.04% of the total water (see Table 1 for details), with an average of 61.93%. However, China's irrigation water

utilization coefficient in 2021 and 2022 will only be 0.568 and 0.572, while the agricultural irrigation water utilization coefficient of other large agricultural countries will reach 0.7~0.8. Therefore, improving the utilization rate of

water-saving irrigation in agriculture is of great significance to the development of our country's agriculture and to improve the current increasingly tight supply and demand of water resources.

Table 1. Analysis of agricultural water use in the past 6 years (2017-2022)

Year	Total annual water resources/100 million m ³	Total water use in the country/100 million m ³	Agricultural water use/100 million m ³	Proportion of total water used for agriculture/%
2017	28761.2	6043.4	3766.4	62.32
2018	27452.5	6015.5	3693.1	61.39
2019	29041.0	6021.2	3682.3	61.16
2020	31605.2	5812.9	3612.4	62.14
2021	29638.2	5920.2	3644.3	61.56
2022	27988.1	5998.2	3781.3	63.04

Note: The data in Table 1 are from the 2017-2022 China Water Resources Bulletin

2.1 Existing Water-saving Irrigation Models

2.1.1 Stationary sprinkler irrigation

Stationary sprinkler irrigation systems include micro sprinkler, drip irrigation and other modes. Sprinkler irrigation mainly uses pipes, pumps and automatic sprinklers to spray water into the air, disperse the water into fine droplets in the air, and evenly scatter them in the irrigated area. According to relevant statistics, sprinkler irrigation compared with the traditional flood irrigation mode, the average water saving can reach 40%; the dropper mainly uses a capillary plastic tube with a diameter of about 10mm, and the water is delivered to the roots of crops along the plastic pipe for irrigation, drip irrigation belongs to the whole pipeline water delivery and local micro-irrigation, which can reduce the leakage and loss of water to a minimum. In these systems, the irrigator is usually fixed to the water pipe and does not move. And this kind of mode is mostly carried out by mechanical control, basically does not need manual intervention, the labor cost is low, it is easy to maintain, and it has a comparative advantage in the conservation of water resources. However, the one-time investment cost is high, which affects the mechanized operation.[1]

2.1.2 Mobile sprinkler irrigation

Mobile irrigation is done by means of trusses or irrigation trucks that can walk in the field. This includes roll-shift, pivot, translational, and more. [2,3]The system is suitable for various terrains and landforms, but it requires more labor and is labor-intensive.

2.1.3 Canal seepage prevention irrigation technology

The channel anti-seepage irrigation technology mainly uses plastic film, masonry and other materials to carry out the operation, and the anti-seepage material is added to the channel lining to ensure the retention of water in the farmland channel, and solves the problem of easy water loss or water seepage in the traditional canal irrigation mode, which has the advantages of high water transmission speed and land saving.

2.1.4 Pipeline water irrigation technology

Pipeline water irrigation technology directly enters the water demand point in the field by laying pipelines and opening water outlets of each pipeline, which effectively avoids the problems of leakage and evaporation in the process of water transportation, and effectively reduces the problem of water loss. [2]However, this technology is usually not applied independently, but is used in conjunction with other water-saving facilities, and the application cost is high.

2.2 The Existing Problems of Water-saving Irrigation in China's Agriculture

2.2.1 The waste of water resources in agricultural irrigation is serious

China's agricultural water waste is serious, especially in the northern region, the climate itself is relatively arid, coupled with the long-term use of extensive production mode and irrigation methods, agricultural irrigation water has been widely crowded out and wasted, and the shortage of water resources is serious. According to relevant statistics,

China consumes about 40 billion cubic meters of water resources in irrigation every year, and a considerable part of them is wasted. This waste not only leads to excessive consumption of water resources, but also exacerbates the problem of water scarcity.

2.2.2 The application of modern water-saving irrigation technology is insufficient

Up to now, modern water-saving irrigation technologies such as drip irrigation and micro-sprinkler irrigation in China have been proposed and applied in some areas, but they have not been popularized and promoted in most agricultural areas, and the application level is limited.[4] According to statistics, from 2015 to 2020, the growth rate of water-saving irrigation area in China increased year by year, from 47.15% in 2015 to 54.65% in 2020, but at present, the area of water-saving irrigation in China only accounts for nearly 1/3 of the red line area of cultivated land. This shows that although the area of water-saving irrigation has been greatly increased, the proportion of water-saving irrigation area in farmland is far from meeting the requirements of efficient water conservation.

2.2.3 It is difficult to popularize modern water-saving irrigation technology

There are many problems in the process of popularization and use of water-saving irrigation technology, and the operation rate and application degree of water-saving irrigation technology and equipment are not high.[5] On the one hand, the requirements of water-saving irrigation technology for the external environment such as space and topography make it expensive to put into operation; on the other hand, in some poor and relatively backward areas, farmers have not yet been able to realize the seriousness of water shortage and the importance of applying water-saving irrigation technology; on the other hand, China has not formed a strict and comprehensive water resources management system for the imperfect management of water resources, and it is difficult to achieve good application results by relying solely on popularization and publicity and citizens' consciousness.

3. Suggestions on Water-saving Irrigation Countermeasures for Agriculture

3.1 Based on Reality, Increase the Support and Guarantee of the Government

Efficient water-saving technology is one of the important technologies to improve the efficiency of water resources utilization and alleviate the shortage of agricultural water. For example, we should strengthen training and guidance on water-saving irrigation technology, increase policy subsidies, and improve the construction and maintenance system of farmland water conservancy facilities, so as to enhance farmers' understanding of the ecological environment and their enthusiasm for adopting agricultural water-saving technologies.[6]

3.2 Focus on the Long-term and Promote the Transformation and Upgrading of Agricultural Water-saving Irrigation Technology

Water-saving irrigation is to serve agricultural construction, and water-saving irrigation technologies are diverse, and each technology has certain applicable conditions.[7] Whether it is an engineering measure or a non-engineering measure, we must proceed from reality, act according to our ability, and pay attention to properly handling the relationship between advanced nature and practicability, as well as between speed and efficiency. Combined with theoretical analysis and practical research, it is necessary to actively develop and develop agricultural irrigation equipment with good product quality, low energy consumption and low price, which is compatible with China's water-saving irrigation technology, so as to realize precise irrigation of different regions, different soil and climatic conditions, and different crops. On the other hand, the production and maintenance costs of irrigation equipment should be reduced as much as possible, the performance of irrigation equipment should be improved, and the promotion and application of water-saving irrigation equipment in China should be promoted.

3.3 Pay Attention to Practical Results and Innovate the Promotion Form of Agricultural Water-saving Irrigation

In order to develop efficient and water-saving agriculture, it is necessary to break the traditional irrigation thinking of farmers for a

long time and vigorously promote the application of agricultural water-saving irrigation technology. First of all, the government can use radio, television, newspapers, and so on to carry out multi-angle and multi-level propaganda so that the peasant masses can fully understand the advantages of water-saving irrigation technology. Second, the government can cooperate with local agricultural production cooperatives and businesses to participate in water-saving irrigation and drive the enthusiasm of surrounding farmers to participate. [8]At the same time, the government can also increase the establishment of "experimental fields" to publicize the use of water-saving irrigation in agriculture, so that farmers can personally feel the convenience of agricultural water-saving irrigation and the efficiency of irrigation.[9]

4. Analysis of the Benefits of Agricultural Water-saving Irrigation Technology

In recent years, all countries and regions in the world have vigorously developed water-saving undertakings, and have achieved significant comprehensive benefits, agricultural water-saving irrigation technology benefits are significant, mainly divided into direct benefits and indirect benefits of two parts, embodied in the conservation of irrigation water, saving land resources, saving man-hours, saving energy, increasing production and income and many other aspects, covering ecological benefits, economic benefits, social benefits and other dimensions.

4.1 Ecological Efficiency

With people's increasing attention to environmental protection, ecological irrigation has become one of the development trends. The development and change of water-saving irrigation technology not only focuses on the efficiency of farmland irrigation, but also pays attention to the protection of soil and water quality according to local conditions. Through multi-mode water-saving and water-conserving irrigation, it is beneficial for China to break through the strange circle problem of "less and less water and worse ecological environment", as well as maintain soil health, prevent soil compaction and water loss, so as to maintain the sustainability and high quality of agricultural farmland.[10]

4.2 Economic Benefits

The development and application of agricultural water-saving irrigation technology has improved the quality of agricultural irrigation and effectively increased crop yield.[11] Specifically, the implementation of water-saving irrigation in agriculture has not only greatly reduced the amount of groundwater taken, but also enabled the ecological environment in various localities to achieve a virtuous cycle, got rid of the problems of "relying on the sky for food," "land desertification and compaction, and decreased productivity," greatly increased agricultural output, and reduced labor intensity and difficulty. Secondly, water-saving irrigation can save more than 30% of electricity compared with traditional surface irrigation, which not only saves a lot of irrigation costs, but also saves electricity, alleviates the shortage of power supply in the rural irrigation season, and also brings more long-term income increase benefits to farmers in disguise.

4.3 Social Benefits

The development of water-saving irrigation technology in agriculture can not only achieve direct economic benefits, but also produce significant social benefits. Through water-saving irrigation, we can further improve the conditions of agricultural production, promote the scientific and technological progress of farmland water conservancy, drive and promote the development of emerging industries, and promote the realization of the rural revitalization strategy. In addition, the application of agricultural water-saving irrigation can also promote the optimal and rational allocation of water resources, alleviate the contradiction between agricultural water and urban life and industrial water, drive people's ideological and conceptual renewal in water use, accelerate the reform of water charges, and improve the level of water management.

5. Conclusion

Water resources are the decisive factor to ensure the sustainable development of agriculture, with the growth of population and the increasing demand for agricultural development, the development of water-saving

irrigation technology has not only become an important support for China's agricultural development in the new era, but also the inevitable trend of alleviating water shortage and solving water resources problems, and it is the key to promoting the construction of beautiful villages in China and realizing the sustainable development of agriculture. Therefore, the current problems of agricultural water waste, water pollution, insufficient application of water-saving irrigation and difficult promotion should not be underestimated. Under the condition of ecological environment constraints, the promotion and application of efficient water-saving irrigation methods for farmland irrigation has become an inevitable trend of agricultural development. Considering various factors, agricultural water-saving irrigation should adapt to the development of the times, combine new irrigation technology with traditional methods, adapt to the needs of sustainable development, and achieve multiple benefits, in order to further improve the effect of water-saving irrigation and promote the sustainable development of modern agriculture.

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