IOP Conference Series: Earth and Environmental Science

Development status and trend of water saving agriculture in China

IOP Conf. Series: Earth and Environmental Science **643** (2021) 012086 doi:10.1088/1755-1315/643/1/012086

Development status and trend of water saving agriculture in China

Fuqiang Li[1], Yucai Wang[1] and Hengjia Zhang[1*]

[1] College of Water Conservancy and Hydropower Engineering, Gansu Agricultural University, Lanzhou, Gansu, 730070, China

[*]Corresponding author's e-mail: zhanghj@gsau.edu.cn

Abstract. As an agricultural country, the shortage and waste of water resources seriously restrict the rapid development of agriculture in China, so how to realize water-saving agriculture is imminent. This paper expounds the current situation and existing problems of water-saving agriculture in China, studies and discusses the development trend of water-saving agriculture in the future, which provides a certain theoretical basis for the rapid development of China's agriculture.

1. Introduction

Water resources are not only the basic natural resources of a country, but also the strategic economic resources of a country. In the 21st century, with the rapid growth of population and the rapid development of economy, the demand for water resources is increasing year by year. However, China's water resources are very short, ranking sixth in the world[1]. Moreover, China is an agricultural country. From 2009 to 2018, China's annual agricultural water consumption accounted for more than 60% of the total national water consumption, and agricultural water accounted for a large proportion.It is estimated that by 2030, China's agricultural water consumption will increase from the current 400 billion m^3 to 665 billion m^3, 80% of which will be used for farmland irrigation. Research shows that irrigation water in China is increasing rapidly, while water productivity is declining, especially the shortage of water resources and low utilization coefficient of irrigation water [2]. Therefore, it is imperative to develop water-saving agriculture.

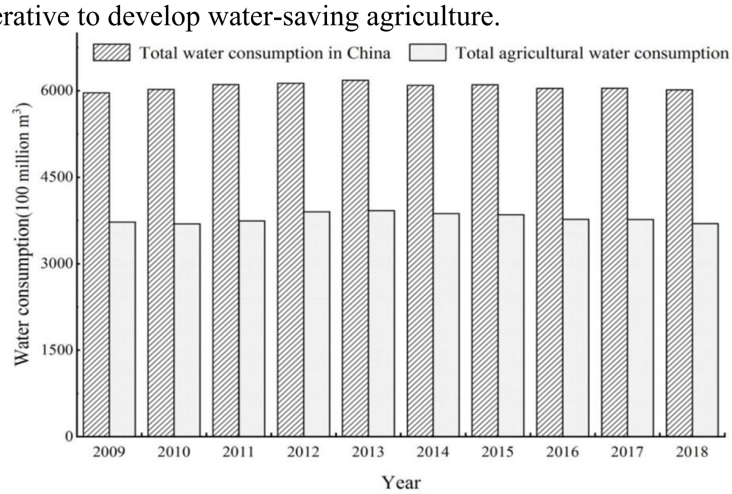

Fig. 1 Total water consumption and agricultural water consumption in 2009-2018.

IOP Conf. Series: Earth and Environmental Science **643** (2021) 012086 doi:10.1088/1755-1315/643/1/012086

2. Development status of water saving agriculture

Agricultural water saving is not only required by the sustainable development of China's national economy and society, but also determined by the severe situation of agricultural resources, especially the shortage of water resources and the imbalance of water and soil resources allocation.Agricultural water-saving plays an important strategic role in ensuring national water security, food security and ecological security, and promoting the rapid development of agriculture. At present, the main agricultural water-saving technologies in China can be divided into three categories: engineering water-saving technology, technological water-saving technology and biological (physiological) water-saving technology.

2.1 Water saving technology

The main water-saving technology is canal seepage control. The purpose of canal anti-seepage engineering technology is to reduce or eliminate the loss of irrigation water from the channel into the canal bed. It is the most widely used water-saving engineering and technical measures in China. The main technologies include: soil material seepage control, stone masonry seepage control, cement soil seepage control, membrane material seepage prevention, concrete seepage prevention and asphalt concrete seepage prevention. Among them, concrete anti-seepage is the most widely used anti-seepage technical measures, which can generally reduce the leakage loss to 90% ~ 95%, with good anti-seepage effect and good durability [3][4][5].

2.2 Process water saving technology

With the continuous research on agricultural planting technology, a series of water-saving and moisture conservation technologies have emerged, such as plastic film mulching [6], straw mulching [7], drip irrigation [8], infiltration irrigation [9], and film mulching drip irrigation [10], among which the film mulching drip irrigation has the best water-saving effect. This technology fully integrates the advantages of plastic film mulching and drip irrigation: water saving, fertilizer saving, salt inhibiting, yield increasing, disease prevention, labor saving, etc. Drip irrigation technology uses low-pressure facilities to transport the required irrigation water directly to the root of crops through the capillary, which makes the irrigation water less infiltration in the vertical direction of the soil, and effectively reduces the loss of deep leakage. Moreover, due to the protection of plastic film, the irrigation water will not flow to the soil outside the film, which can effectively reduce the loss of invalid soil water and achieve the effect of water and soil moisture conservation.

2.3 Biological (physiological) water saving technology

At present, the biological (physiological) water-saving technology is mainly based on the different water requirements of crops in different growth stages, and the artificial water control technology --- regulated deficit irrigation. This technology can fully stimulate the physiological and water-saving function of crops, regulate some physiological and biochemical effects of crops affected by genetic characteristics or growth hormone, thus changing the transportation path of photosynthetic products and the distribution proportion of photosynthetic products in various tissues and organs, so as to increase the total amount of organic matter contained in the harvest part, so as to achieve water-saving, yield increase, efficiency increase and crop quality improvement Objective. Therefore, regulated deficit irrigation opens up an effective way to control water movement in SPAC (soil plant atmosphere) system from the perspective of crop physiology, and is a more scientific, economic and effective irrigation strategy [11][12][13].

3. Development trend of water saving agriculture

3.1 Apply biotechnology and engineering technology to fully tap potential water resources

At present, rainwater storage, sewage purification, salt water desalination and other non-traditional water resources development and utilization has become a new way to solve the water shortage in many countries and regions.

Farmland rainwater storage project refers to that in the early stage of crop sowing, firstly, through certain engineering measures, the rainwater collection cellar is excavated in the low-lying area of the field, which is used to collect the surface runoff formed by rainfall during the growth period of crops, so as to provide irrigation for subsequent crops. Secondly, in terms of agricultural cultivation, full film double ridge and furrow sowing can be used to achieve the effect of rainwater collection and utilization [14].

The water quality of domestic sewage and industrial sewage can meet the requirements of irrigation water quality after purification treatment, so the shortage of water resources is alleviated to a certain extent. According to relevant data, at present, 60% of the treated sewage is used for agricultural irrigation in the United States, and the irrigation utilization rate after sewage treatment in Israel is as high as 70%. 50% of the sewage treated and purified in India is used for farmland irrigation every year, and 90% of the sewage in Mexico is used for farmland irrigation after treatment [15]. In recent years, the major agricultural universities in China have also carried out research on farmland irrigation after sewage treatment, but compared with many foreign countries, there is a big gap.

At present, many foreign countries have done some research on the desalination and utilization of brackish water. For example, Spain explored the corresponding technology and theory by establishing brackish water irrigation experimental station.Through the research on cotton, barley, tomato and other crops, American researchers found that the use of brackish water irrigation after treatment can not only stabilize the yield, but also improve the quality of crops [15][16]. The research on Brackish Water in China started late, and the technology and theory are not perfect.

3.2 Crop water demand information collection and precision irrigation technology
The process of crop's perception, transmission and signal transduction of water deficit information was studied, and the diagnostic index system of crop water signal was established. Based on the combination of soil moisture monitoring and prediction, crop water dynamic monitoring information and crop growth information, this paper studies the application of fuzzy artificial neural network technology, data communication technology and network technology to establish a crop precision irrigation system with monitoring, transmission, diagnosis and decision-making functions, and achieves the goal of precision irrigation through intelligent irrigation information acquisition device and its decision-making system [17].

3.3 Farmland water control technology and water saving and high efficiency crop cultivation technology
Taking the main grain and economic crops in China as the research object, the nutrient supply and utilization patterns of main crops in farmland under different regions, planting systems, soil fertility basis and water resources were studied. The optimal irrigation system for increasing yield, saving water and high quality of crops under different water irrigation was put forward, which could be used to adjust the deficit of drip irrigation under mulch film and alternate irrigation in different root zones The new water-saving technology laid a theoretical foundation [18].

3.4 Develop new water-saving equipment and technology according to local conditions
For regions with poor climate conditions, a series of facility agricultural technologies such as hydroponics and fog culture can be used to realize crop production, and the water-saving effect of this technology is excellent. In places with good climate conditions, small, medium and large-scale micro sprinkler irrigation technology can be vigorously developed to achieve water-saving effect [19].

4. Conclusion

In a word, China is a big agricultural country, and water resources are short, so it is imperative to develop water-saving agriculture. In recent years, the research on Water-saving Agriculture in China has made gratifying achievements, but compared with foreign developed countries, whether in the maturity of technology or the integrity of theoretical basis, there is a big difference. Therefore, the development of water-saving agriculture is still the key research and development object in China in the future.

Acknowledgments

The authors would like to thank the Key Research and Planning Projects of Gansu Province (No. 18YF1NA073) and the National Natural Science Foundation of China (No. 51669001) for the funding & lab facilities.

References

[1] Yang, H.J. (2005) Study on the effective utilization of agricultural water resources in Northwest China [D]. Northwestern University.
[2] Chen, M., Huang, Z., Chen, W.J. (2011) Study on water resources utilization and protection in Northwest China [J]. China Engineering Science.,13 (01): 98-101
[3] Li, B.C. (2020) Anti seepage construction and ideas of water conservancy channel engineering [J]. Henan water conservancy and south to North Water Diversion.,49 (09): 64-65
[4] Qiao, G.F. (2020) Application of canal seepage control technology in water saving reconstruction project [J]. Henan water conservancy and south to North Water Diversion., 49 (05): 37-38
[5] Shao, W.T. (2020) Significance and technology of canal seepage control in water conservancy projects [J]. Henan water conservancy and south to North Water Diversion.,48 (12): 46-47
[6] Wang, C. (2020) Effects of plastic film mulching on winter wheat planting [J / OL]. Molecular plant breeding.,12 (02):1-9
[7] Zhang, W.F., Yang, S.Q., Pan, C.Y., Lou, S. (2020) Effects of straw mulching on root distribution and yield of summer maize under optimized well canal rotation irrigation [J]. Acta agriculturalis Sinica.,51 (S1): 25-33
[8] Li, S.Z., Zhang, L.M., Gao, W.S., Bai, X.S., Liu, J., Dong, X.J., Yang, H.Z., Sha, H., Gao, Y. (2020) Effects of rewatering after drought on photosynthetic response characteristics of Sugarbeet in leaf cluster stage under drip irrigation mode [J]. Acta pratacultural Sinica.,29 (11): 198-204
[9] Zhao, J., Sun, M.Y., Gao, X., Zhao, C.J., Cui, S.P., Zhou, B.Y., Guo, D., Ma, W. (2020) Application of new negative pressure infiltration irrigation technology in precision control of farmland soil moisture [J / OL]. Journal of crops.,12 (02): 1-5
[10] Jia, B., Li, Z.Z., Wang, R., Sun, Q., Wang, Z.J., Liu, G.H. (2020) Study on relative root length density model of mulched drip irrigation maize under different nitrogen application rates [J]. Acta agricultrual machinery.,51 (09): 266-273
[11] Wen, Y., Wang, Z.H., Li, W.H., Ding, H.W., Zou, J., Chen, R., Zhang, J.L. (2020) Effects of regulated deficit irrigation and fertilization ratio on growth, yield and quality of drip irrigated grape [J]. Journal of irrigation and drainage.,39 (11): 38-46
[12] Zhou, H.L., Zhang, L.J., Liu, N.N., Fei, C., Chen, Y., Dai, Y.X., Su, J.X., Fan, H. (2020) Effects of nitrogen management on Photosynthetic Physiological Characteristics of drip irrigated Sugarbeet under regulated deficit irrigation [J]. Acta phytophysiology.,56 (10): 2168-2178
[13] Zhao, J.H., Zhang, J.Y., Peng, Y.P., Yang, L. (2020) Effects of Regulated Deficit Irrigation on Photosynthetic Characteristics and yield of walnut under drip irrigation [J]. Water saving irrigation., (09): 52-57 + 63
[14] Li, L.S., Zhang, Q., Li, Y.J. (2000) Construction of "water cellar" for small rainwater storage

project [J]. Shanxi Water Conservancy Science and technology., (S1): 72-73

[15] Wu, P.T., Feng, H., Niu, W.Q., Zhao, X.N. (2007) Development trend and future research and development focus of modern water-saving agricultural technology [J]. China Engineering Science., (02): 12-18

[16] Wu, M., Huang, Z., Li, Q.Y., Lin, L. (2012) Research progress of brackish water desalination technology [J]. Journal of water resources and water engineering., 23 (02): 59-63 + 66

[17] Liu, X.Y. (2020) Study on farmland irrigation system based on soil moisture monitoring [J]. Automation application., (09): 1-3

[18] Chai, Q. (2010) Research progress and Prospect of split root alternate irrigation technology [J]. China Agricultural Science and technology guide., 12 (01): 46-51

[19] Bao, L., Wang, Z.L., Jin, W.L., He, W.S. (2019) Effects of different nutrient solution concentration and spray frequency on growth and yield of potato grown in fog cultivation [J]. soil and fertilizer in China., (04): 148-155