

# A Review on Development Water-Saving Agriculture in Asia

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## Abstract

The development of water-saving agriculture is of great significance not only for increasing farmers' production and income, but also for protecting water resources. The purpose of this paper is to learn from the experience of Israel, Japan, Korea and Singapore, improve the low efficiency of agricultural water use in China, and solve the problem of water shortage, promote the development of agriculture. This article concludes that the experience of water-saving agriculture in Israel is advanced irrigation technology, sound laws and regulations, and emphasis on science and technology. Japan's water-saving agriculture is characterized by an efficient irrigation program and a strict agricultural water management policy. Korea's experience in water-saving agriculture is that it has a strict water management system, with the government subsidizing the cost of irrigation projects and integrating water into agricultural development planning. Singapore's experience in water-saving agriculture is to raise awareness of water conservation and to use step water prices. In order to promote the sustainable development of water-saving agriculture in China, the research on water-saving agriculture in the future can be carried out from the aspects of agricultural production or related agricultural technology.

## Keywords

Asian Water Saving, Water Saving Agriculture, Development Experience, Water Resources Management

## 1. Introduction

Effective management can save 50% of water. Advanced water management system can strengthen ecological protection and promote the development of agricultural production function, improve water use efficiency, and make good

use of agricultural water and soil management activities. Agriculture accounts for a large proportion of water resources consumption, so the development of water-saving agriculture is of great significance to water resources management and agricultural production increase. In this paper, four Asian countries with better development of water-saving agriculture are studied, and the experiences of water-saving agriculture development in Israel, Japan, Korea and Singapore are sorted out and compared. Japan's water-saving agriculture is characterized by the adoption of advanced irrigation technology and has strict agricultural water resources management policies. Korea's experience in water-saving agriculture is that it has a strict water management system, with the government subsidizing the cost of irrigation projects and integrating water into agricultural development planning. Singapore's experience in water conservation in agriculture is to raise awareness of water conservation and to use step water prices. The aim of this paper is to improve the low efficiency of agricultural water use, solve the problem of water shortage and promote the development of agriculture.

Israel, Japan, South Korea and Singapore are located in Asia and have some similarities. Their water use efficiency is relatively high, the development of water-saving agriculture is relatively good, especially Israel's water-saving agriculture has been in the forefront of the world.

## **2. Experience of Water-Saving Agriculture in Asia**

### **2.1. Overview of Israeli Experience in Water-Efficient Agriculture**

Israel is a water-scarce country, with only 1.6 billion cubic meters of fresh water available in the country and only 32 billion cubic meters of fresh water per capita, one-third of the world's per capita level. But it has advanced agricultural irrigation technology and scientific water resources management system. What's more, Israel pays attention to water-saving agriculture, so water-saving agriculture in Israel has been in the forefront of the world. Some scholars in our country have studied and discussed the reasons why Israel can create the miracle of water-saving agriculture. Their views can be summarized as follows:

#### **2.1.1. Israel Has Advanced Irrigation Technology**

Israel had adopted many advanced irrigation techniques and had improved the efficiency of water use. According to the research of Lun Shan (1999) [1], drip irrigation technology began in Israel, and the control system of drip irrigation based on crop type and soil type improved the efficiency of water use in the field. Since then, Jinsong Si (2010) [2], Junyi Ma, Ying Wang (2010) [3] and other scholars have shown in their articles that drip irrigation saves one-third to one-half of the water than flooding irrigation, and increases yields by one to five times per unit area, water and fertilizer efficiency of up to 90 percent, which had effectively prevented the salinization of land and the consolidation of soil, increasing Israeli agricultural output fivefold. Foreign scholars such as Amin S

(2004) [4], Peny (2004) [5], Leib G (2003) [6], Tognettis R (2003) [7] [8] also confirm that irrigation plays an important role in water saving. In recent years, with the development of information technology, irrigation management in Israel has become more scientific. Xibin Song (2010) [9] pointed out in his research that Israelis used computer remote sensing and other technologies for management, which realized automatic monitoring and control of irrigation management, improved water utilization and enhanced scientific irrigation management.

### **2.1.2. Sound Laws and Regulations**

Since 1959, the Israeli government has promulgated a series of laws and regulations, such as water law, water measurement law, water well control law and Operation Permit Law, to protect water resources. Jinsong Si (2010) [2] summed up the characteristics of Israel's water legislation system management system. Israeli law stipulates that water resources are the common property of the people and are under the unified control of the state. Any department or individual who wants to develop and utilize water resources must apply for a license and carry out the development according to regulations. The water management department approves the water quota according to the type and the scale of use, and applies the different water price according to the different water consumption quantity, the water consumption quota will be subjected to the severe economic penalty. In their article, Xiaoyan Yi, Yong Wu, Changbin Yin, Ming Cheng, Geng Zhang, and Yusuo Zheng (2018) [10] point out the Israeli experience of law first, strengthening water resources management.

### **2.1.3. Emphasis on Scientific and Technological Development, Complete Scientific and Technological System**

Jinsong Si (2010) [2] said in the article that Israel attaches great importance to agricultural water-saving technology research and development and promotion of scientific research results, research funding reached hundreds of millions of dollars. In addition, Xiaoyan Yi, Yong Wu, Changbin Yin, Ming Cheng, Geng Zhang, and Yusuo Zheng (2018) [10] proposed that Israel attaches great importance to the leading role of science and technology, constantly innovating and concentrating its efforts on developing water-saving irrigation technologies in agriculture, the most advanced micro-nozzle technology of sprinkler and drip irrigation in the world has been explored. This is of great help to the development of water-saving agriculture in Israel. The complete science and technology system is more helpful to promote the water-saving agricultural technology to the first line of agricultural production. This view was put forward by Aixiang Tao (2014) [11], who also said that Israel's agricultural science and technology system has reasonable agriculture, scientific research institutions and agricultural science and technology extension system, the two levels of the system coordinated with each other, forming a rational system of agricultural science and technology extension.

## **2.2. Summary of Japan's Experience in Water-Saving Agriculture**

### **2.2.1. Efficient Irrigation Schemes**

Japan is a rainy country, rainfall is more abundant, from the point of view of annual change, water resources storage is relatively stable. Abundant water resources are very beneficial to Japan's agricultural production. However, due to the uneven distribution of rainfall in time and space, which often results in drought in different seasons in different areas, Japan attaches great importance to the development of water-saving agriculture. Hedy W. Lee (1997) [12] wrote that Japan separated irrigation from drainage in order to reuse irrigation water. In addition, Japan has developed and strictly implemented irrigation schemes to meet the water requirements of rice growing season. At present, sprinkler irrigation is the main method of dryland irrigation, and then micro-irrigation, which has made great progress in recent years and become the top 8 places in the world. With the development of irrigation technology, dryland irrigation is not only water-saving irrigation, but also a higher stage of labor-saving and multi-purpose utilization, namely, fertilization, spraying, soil disinfection, frost prevention, pest control to regulate the micro-meteorological environment. Shitao Dong and Yunjie Ai (2016) [13] discussed the management mechanism and effect of agricultural irrigation water. In Japan, people mainly take river water to irrigate farmland, strictly forbid to take underground water to irrigate farmland. At the same time, in order to prevent water resources in the process of irrigation, Japan constructs a large number of agricultural irrigation channels. In addition, a lot of water is needed for field drip irrigation, sprinkler irrigation to save water. Jiusheng Li (1996) [14] in order to save water for agriculture, Japan has adopted reasonable location of water intake, newly built and modified waterways, implemented pipe network, and reduced water loss from water source to farmland, measures to prevent domestic sewage from entering the irrigation system, such as equipment, to save water for agriculture.

### **2.2.2. Having a Strict Agricultural Water Management Policy**

Hedy W. Lee (1997) research on the Japanese agricultural water saving measures, vigorously developing water-saving agriculture is one of the measures. He suggested that Japan's policies to strengthen agricultural water management, such as developing long-term water use plans and strengthening water management organizations, could help save water for agriculture in Japan.

The policies mentioned by the above scholars are all related to the development of water-saving agriculture in Japan, and have achieved certain results, which can be used for reference.

## **2.3. Summary of Water Saving Experience in Korea**

The average annual rainfall in South Korea is 12.45 mm, but because the country's population is so dense, the per capita share of water resources is less than one-eighth of the global average, South Korea is also classified by the United Na-

tions as a water stressed country. In order to reduce the pressure of water resources, Korea also attaches great importance to the management of water resources, and has some successful practices and experiences for us to learn from.

### **2.3.1. Having a Strict Water Management System**

In their research, Guoqing Tong and Hongmei Li (2008) [15] discussed the water resources planning in Korea, including water resources supply and demand assessment, water resources utilization plan, Water Resources Management Plan, River Environment Plan; Resources Evaluation and development planning, as well as groundwater system management and water resources supplement system construction, these measures have helped Korea to improve water resources utilization efficiency and achieve water conservation. Yahui Zhao (2021) [16] summed up the experience of the Korean government in water resources management, including attaching importance to the improvement of the relevant legal system of water resources management, and the clear division of Labor in the organizational system of water management institutions, pay attention to the innovation and perfection of water management mode. These scholars' researches are all about water resources management and successful experiences of water-saving, which can promote the development of water-saving agriculture and can be transplanted to the field of water-saving agriculture.

### **2.3.2. Government Subsidy for Irrigation Works**

Jiusheng Li (1990) [17] summed up his experience of irrigation and water management in South Korea. He believed that the cost of major repairs to irrigation projects in South Korea was totally subsidized by the government, this is very useful for ensuring that irrigation facilities are in good condition and for increasing water use. In addition, according to South Korea's water conservancy investment policy, the government has given preferential treatment to farmers, which has played an important role in narrowing the income gap between urban and rural areas and mobilizing farmers' enthusiasm for growing food. Secondly, South Korea's low water rate policy is beneficial to lighten the burden of farmers, which is worth learning.

### **2.3.3. Integration of Water Resources into Planning in Agricultural Development**

Jiusheng Li (1990) [17] thinks that South Korea regards water conservancy planning as one of the important contents in the comprehensive agricultural development project, which is worthy of reference for China. His views help us to sum up the experience of Korea, help us to apply to China's practice of water-saving agriculture.

## **2.4. Summary of Singapore's Experience in Water Conservation**

Located in the south of the Peninsular Malaysia, Singapore has a remarkable equatorial climate, with rainfall mainly concentrated from November to January

to march, although the rainfall frequency is relatively high, the duration is relatively short. Limited by geographical conditions, Singapore is extremely short of fresh water resources, groundwater resources reserves are insufficient, per capita water resources are extremely low. In recent years, the Singapore government has taken various measures to realize the efficient development and utilization of water resources, and has obtained the successful experience. These water-saving experiences are helpful to develop water-saving agriculture with Singapore, and also worth our learning and learning.

#### **2.4.1. Raising Awareness of Water Conservation**

Zhenci Xu and Zenghui Pan (1999) [18] summed up Singapore's beneficial water-saving policies, including the establishment of a complete water-saving agency, the formulation and promotion of education program, the installation of water-saving equipment, and the adoption of a water supply permit system. Water-saving measures, such as water-use reviews and water-tariff adjustments and water-saving subsidies, have strengthened water conservation. Cecilia Tortajada (2006) [19], Kohbonaik (2003) [20] also presented experiences and measures on water conservation in Singapore. These measures have contributed to the development of water-saving agriculture to varying degrees, for example, improving farmers' water-saving consciousness and water-rate grading management can reduce the waste of water resources in agricultural production. Otherwise, C. Torta Hada *et al.* (2013) [21] also elaborated on the important role of educational activities in Singapore, with school students as the main target group for education, and the awareness and habit of water conservation at an early age can help to reduce water waste.

#### **2.4.2. Use of Tiered Water Rates**

In the article, C. Torta Hada *et al.* (2013) [21] analyzed a series of policies enacted in Singapore, including the adjustment of water prices and the introduction of a tiered water price system. A water-saving tax (WCT) has been introduced, whereby a 5 percent tax is levied on residents who use more than 20 m of water per month, and a higher, 10 percent tax is levied on non-residents. The authors believe that these measures effectively reduce water consumption and provide alternative sources of water, and their successful experiences can be used for reference by developed and developing countries.

### **3. Review and Prospect of Research**

#### **3.1. Review on Development Experience of Water-Saving Agriculture in Asia**

In terms of research perspective, domestic and foreign scholars mostly study from the perspective of public management, water-saving management or water resources management as a starting point, less from agricultural production or related agricultural technology. For Israel and Japan, scholars at home and abroad have made rich studies, some of which start from agricultural production

or water-saving agriculture to analyze water-saving agriculture, however, both South Korea and Singapore focus on water resources management.

In terms of research methods, empirical research in China is weak. And almost no use of quantitative research methods, but by enumerating data graphs and other simple data to do some descriptive analysis. For the choice of Investigation Object and method, the post-event analysis formed by one-off investigation is the main method. However, in recent years, scholars have gradually paid attention to the case-based process study, a case study and an experimental model were used to investigate the whole process of a water-saving agricultural measure from design to adoption, and then to the impact of the consequences.

In terms of research content, at present, the empirical research on water-saving agricultural development in Asia is not balanced among different countries, and the experience of water-saving agricultural development in more developed countries such as Israel and Japan is more abundant, scholars choose the perspective and the content of its research is also more. As for countries such as South Korea and Singapore, most of the discussions are from the perspective of water resources management, and most of the research contents are water-saving measures and policies, there is no agricultural technology or agricultural production-related issues, the study is more one-sided.

To sum up, at present, experts and scholars have summed up a lot of experience on the development of water-saving agriculture in different countries in Asia. Although some countries' experiences of water-saving agriculture development are not very sufficient, their experiences of water resources management can still be used for reference in developing water-saving agriculture in China. In the future, more attention should be paid to the combination of qualitative and quantitative research, case-based process research should be strengthened in research methods, and the study should be systematic, practical and operational. The research contents can be extended to the development comparison of water-saving agriculture in many countries, summarize the common experiences and measures, and select the useful parts to transplant to the development of water-saving agriculture in China.

### **3.2. Research Perspectives**

Based on the above comments, water-saving agriculture in Asia is making continuous progress, and scholars' research on water-saving agriculture in Asia is also increasing, at present, the research trend is that most of scholars learn the experience of water-saving agriculture from the developed areas. But later, we can also learn from other water-saving measures or water conservation measures to identify if their experience can be used in their own countries in the water-saving agriculture. In addition, from the perspective of agricultural production and water-saving agricultural technology research can become a new direction of development, but also the future development of sustainable water-saving agriculture in China.

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## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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