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Water-Saving Agricultural Technology as Key Part of Innovation of Dry land Farming

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Dryland farming is agricultural techniques for non-irrigated cultivation of crops. It has evolved as techniques and management practices to continually adapt to the moisture in a given crop cycle [4,5,11]. It involves the constant assessing of the amount of moisture present or lacking for any given crop cycle and planning accordingly [1,2]. Key elements of dryland farming include capturing and conservation of moisture as the average annual precipitation available to a dryland farm. Consequently, moisture must be captured until the crop can utilize it. Techniques include summer fallow rotation and preventing runoff by terracing fields [6,7]. Water-saving agricultural technology is regarded as key part of innovation of dryland farming which consists of biotechnology in exploring water saving potential, non-traditional water utilization technology, intelligent monitoring technology, advanced materials and manufacturing technology for water saving products, and integration of water-saving agricultural technology [3,4,5,11,12].

The Roles of Biotechnology in Exploring Water Saving Potential

Biological water-saving technology is a focus of agricultural research, which is based on crop Physiology. Crop physiological control and modern breeding technologies are able to increase the yield and water use efficiency. This is the key to change water use from the traditional ways to the modern water saving technology with high yield and quality [8,9]. Many developed countries attached great importance to the use of genetically modified varieties of crops with drought resistance and water-saving characteristics, such as Australia's wheat varieties, United States cotton varieties, Canada forages, Israel fruit varieties. These varieties not only have water-saving and drought resistance performance but also have a stable yield and excellent quality characteristics. Based on deficit irrigation physiology, it can significantly increase the water use efficiency of crops, such as Regulated Deficit Irrigation (RDI), Alternate Root-Divided Irrigation (ARDI) and Part Root Drying (PRD) efficient use of technology. These have been more and more widely applied in Australia, Israel, Portugal, Morocco, and China. In comparison with traditional irrigation way, it can largely reduce irrigation water and transpiration without decreasing crop production.

Non-traditional Water Utilization Technology

Non-traditional water utilization, including natural rainwater, wastewater, brackish water and others, has become one of modern water saving agriculture focuses to solve the water crisis. Sewage irrigation is regulated based on crop evapotranspiration to control the volume of irrigation. It has made considerable progress in model development of crop water consumption and water requirements with sewage irrigation, sewage irrigation impacts on the plant, soil and groundwater [4,5,10]. Sewage irrigation for agriculture has been applied in 45 states of United States, the reused sewage water irrigation reached 60% of total of all agriculture irrigation water in United States. There are more than 50%, 67% and 90% of reused sewage were used for irrigation in India, Israel and Mexico. Utilization of brackish water is another concern in irrigation agriculture. Many scientists developed brackish water irrigation theory and practicing technology to maintain or even improve crop production. For example, Israel scientists discovered that some crops such as tomatoes and watermelon, were available with salt water drip irrigation, and its fruit was sweet and easy to preserve. Scientists in the United States also found that cotton, barley, sugar beet, saffron and other crops were able to be irrigated with salt water without decreasing in production, and even improved. China has also begun to investigate the effect of brackish water irrigation on soil and crop quality although its technology was not fully explored. Rainwater utilization technology has been developed from empirical approaches to modern high-tech industrialization and technology. It is an old technology that gains popularity in a new way. For example, these application were applied through plastics industrial production and application of cellars in Germany. Many other countries, such as Israel, India, Japan, Australia, and United States are developing theories and methods of rainwater resources utilization. China has developed a relatively mature technology systems and technical standards, and these were regarded as the most widely application throughout the world.

Intelligent Monitoring Technology

It is rather more efficient to combine modern information technology, intelligent technology with 3S technology to promote water-saving management. It has gained widespread concern of water monitoring and information gathering techniques, crop growth simulation and decision supporting techniques, farmland information acquisition and transmission technology [3,4,5]. Computer management system of irrigation water makes it possible from static irrigation to dynamic irrigation. Water management developed to an integrated intelligent system with database, model library, knowledgebase and geographic information systems. Information technology is able to investigate the relationship between meteorological factors and crop water consumption as to determine soil moisture changes and appropriate amount of irrigation. For example, infra-red thermometer is able to monitor crop canopy, leaf surface, and ambient air temperature to determine the crop water requirements, aircraft and aerial and satellite remote sensing to monitor crop growth in the United States. Heat-pulse technique is used to monitor plant stem sap flow and transpiration as to develop soil moisture monitoring and forecasting theory and methods. There have been some representative of the prediction model of water-saving irrigation based on water status of soil and plant of real-time irrigation in Australia and other countries. Irrigation water management technologies in developed countries are moving towards information technology, automation and intelligent directions. Especially in recent years, the utilization of 3S techniques improved the application of maximizing the agricultural input and fully optimizing the potential of crop yield.

New Materials and Advanced Manufacturing Technology for Water Saving Products

Multi-functional, low energy consumption, environmental protection, intelligent control is the new trend of the development of water saving irrigation products. Using advanced manufacturing technologies and new materials speed up the progress and performance of water saving products, especially fast-advanced manufacturing technology and its application in the field of water-saving irrigation technology, greatly shortening the product development cycle. Use of bio-technology, information technology and monitoring technology to improve irrigation and fertilization is the main direction. It gained fruitful achievements through developing crops expert management system for efficient use of water and fertilizer in Israel, the United States, the Netherlands and other countries. Water saving equipment for high-precision and rapid prototyping is the hot spot [11,12]. With the increase of water-saving agricultural inputs, it developed a serial of technical reliability, a life-time service sprayed micro-irrigation water-saving equipment in many countries such as Israel, the United States and China. Chemical aquasorb and water films are ideal for water-saving irrigation materials. Water retaining agent has excellent water absorption which is derived from coal. Mulching is an important technology in agricultural production, new manufacturing technology has been developed for degradable mulch which can be used to tackle pollution. In recent years, the United States, and Japan and other countries has developed drought resistant and water saving agents products and widely used them for crop water-saving and yield. In the United States, polyacrylamide (PAM) was sprayed on the soil surface, which contains soil moisture evaporation, to prevent soil erosion and improve soil structure. It also used desert plants and starchy substances to synthesize the biological high water-absorbing materials, and had achieved significant water retention. It reached a major breakthrough in biodegradable agricultural film in micronized starch preparation and production in China.

Integration of water-saving agricultural technology

In the process of developing water-saving agriculture, it is of great importance to agricultural engineering water-saving and biological water-saving in combination of water conservation management [2,7]. Water-saving agriculture technology is comprehensive benefit of water-saving agriculture and economic development. The most widespread water-saving agriculture techniques in Egypt, Pakistan, and India were Canal seepage control techniques, surface irrigation techniques and rainfall resources utilization approaches due to the economic conditions and technology constraints as developing countries. However, water-saving agriculture approaches were used with curing channel and pipeline technology, spray and injection irrigation, micro-irrigation and improved surface irrigation in the developed countries such as Israel, the United States, and Australia.

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