IWRM Action Hub

CASE STUDY

China: Rainwater harvesting photovoltaic plant production system to ensure food security and nutrition security in arid areas

Summary

Due to the shortage of water resources, traditional agricultural production methods make it difficult to maintain normal production. To meet this challenge, the water-collecting photovoltaic plant production system came into being. This system cleverly combines photovoltaic technology and water efficient use, by harvesting rainwater and solar energy, to provide the necessary water and energy for agricultural production. In arid areas, such systems can not only significantly increase crop yields, but also optimize the efficiency of water resources, ensure the supply of food, and enhance the supply of nutrients, thus effectively solving the problem of food security and nutrition security.

Background

The challenges of food security in arid areas are multifaceted, closely intertwined with the region's natural conditions, socio-economic factors, and policy environment. The harsh natural conditions of arid regions, characterized by low rainfall, scarce water resources, and poor soil quality, significantly limit the growth and yield of crops. Frequent droughts exacerbate these issues, leading to land degradation and desertification, further threatening agricultural productivity.

In addition to these environmental constraints, agricultural production in drylands is hindered by outdated technologies and insufficient infrastructure. The lack of advanced agricultural techniques, such as water-saving irrigation systems, efficient field management practices, and modern machinery, results in inefficient farming that struggles to withstand the challenges posed by persistent drought conditions.

Economic limitations further compound the issue. Many arid regions are economically underdeveloped, and the low incomes of farmers make it difficult for them to afford essential agricultural inputs such as seeds, fertilizers, and irrigation equipment. This financial strain not only affects food production but also limits access to nutritious food, contributing to food insecurity and malnutrition.

Policy support in these regions is often inadequate, with a lack of targeted agricultural subsidies, insurance schemes, and credit support systems. The absence of comprehensive

policies leaves farmers vulnerable to natural disasters such as droughts, with no sufficient protection measures in place to mitigate the impacts.

Market and logistical challenges also play a significant role in food insecurity. Underdeveloped market infrastructure and inefficient logistics networks make it difficult for farmers to sell and transport their produce. This not only hampers their incomes but also restricts the availability of grain and nutritious food in local markets, exacerbating the problem of food insecurity.

Compounding these challenges is the lack of education and awareness regarding nutrition. Many people living in arid areas do not possess the necessary knowledge to ensure a balanced diet, leading to malnutrition and associated health problems. Without proper education, the cycle of poor nutrition and health issues continues to persist across generations.

Moreover, the impacts of climate change pose a long-term threat to food security in arid regions. The increasing frequency and intensity of droughts, along with extreme weather events such as floods, disrupt agricultural production and threaten the sustainability of food systems.

Overall, food and nutrition security in arid regions is a complex issue that requires innovative solutions. In response, the research group has proposed a groundbreaking water-harvesting photovoltaic plant production system which integrates photovoltaic power generation with water resource collection technologies.

Actions taken

In the context of food security challenges, Lanzhou University Arid Region Agriculture and Ecological Restoration Engineering Research Center of the Ministry of Education proposed rainwater harvesting photovoltaic greenhouse plant production systems as an innovative solution. This system combines photovoltaic power generation and greenhouse planting technology, through the installation of solar photovoltaic panels, which not only provide the required power for the greenhouse but also transmit excess power to the grid, to achieve dual utilization of energy.

Outcomes

The water-collecting photovoltaic plant production system has demonstrated significant advancements in ensuring food security and nutrition security in arid regions through its focus on water-saving, fertilizer-saving, and low-carbon solutions. Several patents have been obtained for key innovations, including a soilless cultivation system for vegetables (ZL 2018 1 1165166.3), a flower seed planting three-culture box (ZL 2020 2 318374.1), a domed greenhouse water-harvesting irrigation device for soilless cultivation (ZL 2021 2 375783.1), and an alternate water-harvesting fallow replenishment and irrigation system for mulch-free planting (ZL 2021 2 3345640.0).

From a water-saving perspective, the system efficiently utilizes water resources by employing photovoltaic water-lifting technology. Without relying on power grids or energy storage equipment, it directly converts solar energy into power for water lifting, effectively addressing the challenge of irrigation in arid areas with power shortages. In combination

with water-saving irrigation methods, such as spray irrigation, drip irrigation, and micro-irrigation, the system achieves up to 22.9% water savings compared to traditional flood irrigation and hand pouring, significantly improving water resource utilization efficiency. Furthermore, the system integrates rainwater harvesting mechanisms, utilizing collected rainwater as a vital irrigation source. This approach reduces dependence on external water supplies and ensures a stable water provision for crops in arid environments.

Lessons Learned

The water-collecting photovoltaic plant production system not only ensures food security and nutrition security in arid areas but also helps promote the sustainable development of agriculture and ecological environmental protection through technical means such as high-efficiency and energy-saving water replenishment and zero-carbon plant factories.

Corresponding Author
Youcai□Xiong

Corresponding Author Contact
94787731@qq.com

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