FrontAg Nexus

Practice Abstract

Hydroponics for Climate-Smart Vegetable Cultivation: Optimizing Resource Use and Reducing Environmental Footprint

Problem/Challenge

The Mediterranean faces intensifying agricultural challenges from climate change, marked by severe water scarcity, land degradation, and unsustainable environmental footprints. Urgent action is needed to develop resilient, resource-efficient food production systems that align with the Water-Energy-Food-Ecosystem (WEFE) Nexus.

Our Solution/Key Finding

The FrontAg Nexus project highlights advanced hydroponic systems as a climate-smart solution. These soilless cultivation methods offer precise control over nutrient delivery and water use, enabling significant resource optimization. Adopting closed-loop hydroponic systems, especially when integrated with renewable energy and alternative water sources (like desalinated water), enhances sustainability and circularity.

Benefits & Impact

Hydroponics enables substantial water savings, potentially up to 60% compared to conventional open-field cultivation [1]. Case studies from Morocco (tomatoes) and Tunisia (strawberries) demonstrate reduced greenhouse gas emissions and lower overall environmental impact, particularly when paired with sustainable energy sources and closed-loop water management [2]. This approach fosters resilience, contributes to food security, and reduces strain on natural ecosystems within the WEFE Nexus.

Applicability Box

Theme: Climate-Smart Hydroponics & Resource Optimization

Keywords: Hydroponics, Water Efficiency, Climate Resilience, Renewable Energy, Urban Farming, Mediterranean

Context: Arid and semi-arid regions, urban agriculture, commercial greenhouses, and policy development for sustainable food systems.

Required Resources: Initial infrastructure investment, technical expertise in nutrient management and system operation.

Scalability: Adaptable from small-scale indoor farms to large commercial operations.

Readiness Levels: Evolving TRL (generally high for components, lower for full integrated systems), varying BRL/SRL due to high upfront costs but growing market interest [3].

Risk Management/Considerations: High initial investment, requires consistent energy supply, and skilled operational management to prevent disease outbreaks.

Practical Recommendations

Farmers should consider investing in closed-loop hydroponic systems for vegetable cultivation, prioritizing renewable energy integration for long-term sustainability. Policymakers are urged to develop targeted incentives, streamline regulatory frameworks, and support urban/rooftop agriculture initiatives to accelerate the adoption of water-efficient, low-carbon hydroponic technologies.

References and Further Information

[1] A. Al-Ajmi, "Water use efficiency of vegetables grown in hydroponics," *Journal of Hydrology,* vol. 556, pp. 64-70, 2018.

[2] UM6P, "D1.2: Supply and value chain analysis of climate smart and water saving agri-food production systems," FrontAg Nexus Project Deliverable, Ben Guerir, 2024.

[3] E. Appolloni, V. Cerasola, G. Pennisi, W. Biru, G. Buchenrieder, T. Uyar and Y. Yavuz, "D1.1: Systematic literature review (SLR) of frontier agriculture systems and empirical evidence in the Mediterranean Region," FrontAg Nexus Project Deliverable, Bologna, 2023.

About this practice abstract

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FrontAg Nexus: The project was launched in May 2023 to promote sustainable agri-food practices by applying the Water-Energy-Food-Ecosystems (WEFE) Nexus approach. Focusing on six Mediterranean countries—Israel, Italy, Morocco, Tunisia, Turkey, and Jordan—the project addresses climate change, resource scarcity, and food insecurity through collaborative research and innovation.

Project Website: https://frontagnexus.eu

Funding

PRIMA PARTNERSHIP FOR RESEARCH AND INNOVATION IN THE MEDITERRANEAN AREA

This work is part of the FrontAg Nexus project. This project (GA n° [2242]) is part of the PRIMA program supported by the European Union.

Co-funded by the European Union

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