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# Developing a sensor-based agricultural water management system for irrigation scheduling, automation, and optimization

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**ABSTRACT**

The role of agriculture has been marked significantly in sustaining societies throughout the globe. Its relevance to dry arid regions like GCC (Gulf Cooperation Council) region countries is more particular due to food security, sustainability, and climate change. Qatar's efforts in safeguarding food security have been witnessed greatly in recent years due to the country's increased food demands, caused by its rapid population growth and economic development. The blockade imposed on Qatar in 2017 also raised a serious concern for food security and self-sufficiency. This situation emphasizes the need to explore options for precision irrigation water management through climate-smart farming in Qatar to meet its food security and sustainability targets as a part of the National Food Security Program and Qatar's National Vision 2030 (QNV-2030). An automated irrigation system can assist in irrigation scheduling for precision water conservation and natural resource (water) optimization through enhancing irrigation water use efficiency. A scientific and smart-agriculture approach is being adopted as a work package of an applied research project, "Development of Smart Agricultural Technologies to Optimize Resource Allocation to Ensure Food Security – A Pathway Towards Sustainable Vegetables and Date Palm Production in Qatar" funded by the Qatar Research, Development and Innovation (QRDI) Council — Qatar. This novel approach involves developing and testing a sensor-based smart and sustainable irrigation system to irrigate date palm trees and agricultural fields cultivating vegetables in Qatar. As a first step, a laboratory experimental setup was developed consisting of A) a wireless SM-100 soil moisture sensor B) an irrigation solenoid valve controller, C) a single channel relay, D) a solenoid valve, E) a step-down transformer 240/24VAC (volts, alternating current), and F) soil state representations. The system was tested to mimic soil moisture conditions for wilting point and field capacity to respectively start and stop irrigation via controlling a solenoid valve of an irrigation system wirelessly connected with a soil moisture sensor. In its second step and after a successful laboratory trial, the system is prepared to be installed and tested in the field under real conditions of GCC region countries to irrigate date palm orchards and greenhouse crops. The system will operate with

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a soil water characteristics curve to be established as part of this step. With the successful use of artificial intelligence in various fields of system automation, the automation of irrigation systems can benefit from these modern approaches to system automation. The novel system thus developed will help ensure GCC region countries address challenges of food security, sustainability, and climate change.

*Keywords:* Irrigation scheduling, system automation, soil moisture monitoring, water characteristics, water management, precision irrigation, artificial intelligence.