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Experimental and Numerical Modelling of Condensed Atmospheric Air for Irrigation of Agricultural Crops

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Extended Abstract

The research aims to develop efficient methods to extract water from the air, specifically for irrigation of crops, by utilizing moisture available in atmospheric air. Rainwater collection, dew collection, and fog water collection are some of the methods that have been widely investigated as a means to mitigate the impact of the growing population and shrinking clean water resources (Jarimi, 2020, Peeters et al., 2020, Tu et al., 2018). Typically, attempts to collect dew investigate completely passive, planar, tilted surfaces made of different materials. An example of an early study is Alnaser and Barakat (2000), who proved the feasibility of irrigation by condensation on foils in a desert region in the winter months. Significant research aims to extract water from atmospheric air using desiccants (e.g., Zhao et al., 2019) and include experimental efforts and numerical simulations (Kumar and Yadav, 2015, Wang et al. 2017). Moreover, active systems are necessary to achieve high yield (Khalil et al., 2016). However, there is little basic information on condensation on external surfaces with complex geometries and specific aspects of its implementation in conjunction with plants in various environmental conditions.

The main objective of the research is to investigate irrigation systems that use moisture in ambient air. The goal is to develop models, simulations, design, and analysis tools for condensation processes on tubes or conduits with other geometries that can be used to support crop growth and improve its effectiveness and its yield. We investigate condensation on pipes laid on the surface or suspended above it, with various geometrical configurations and pipe cross-sections. Simulations include evaluating environmental conditions, such as moisture content, temperature, wind, and their variation at scales ranging from daily to seasonal. Besides, we examined various options for installing such pipes include flat laying on the ground, saw-tooth configuration, helical pattern with varying pitch, and others.

The research contributes to sustainability by reducing water consumption and improving the living conditions of underprivileged populations. Based on the projected performance of the system, the most suitable plants irrigated by water supplied from the ambient air can be identified. The ability to integrate the irrigation system's geometrical design options and ensuing performance with plant characteristics (such as height, size, and density of leaves, as well as rate and quantity of water consumption) will lead to optimized system configurations.

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