animals

MDPI

Systematic Review

Integration of IoT in Small-Scale Aquaponics to Enhance Efficiency and Profitability: A Systematic Review

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Simple Summary: The Internet of Things (IoT) can improve small-scale aquaponics, a sustainable farming method that combines fish farming with plant growing in water without soil, by making the process more efficient and profitable by optimizing resource use, closely monitoring water quality, and ensuring the best conditions for both fish and plants to thrive. Aquaponics is beneficial for the environment and can help ensure a steady food supply but presents challenges for small-scale farmers due to a lack of expertise in water chemistry and system upkeep, as well as high operational costs. Identified challenges in aquaponics operation include high water and energy costs, maintaining the right balance of fish and plants, and the risk of mosquitoes breeding in the water. This systematic review offers a comprehensive guide to setting up and maintaining an aquaponics system, including choosing the right fish and plants, designing the system, monitoring water quality, and feeding the fish. The importance of knowledge sharing among farmers is also highlighted to improve aquaponics practices. The integration of IoT into these systems can reduce the need for manual work and improve the availability of information related to system control, which could facilitate further adoption and optimization of aquaponics farming practices.

Abstract: Aquaponics combines aquaculture and hydroponics to offer a sustainable approach to agriculture, addressing food security issues with minimal environmental harm. However, small-scale practitioners face challenges due to a lack of professional knowledge in water chemistry and system maintenance. Economic hurdles, such as operational costs and energy-intensive components, hinder the viability of small-scale aquaponics. Selecting suitable fish and plant species, along with appropriate stocking densities, is crucial. Media Bed (MB), Deep Water Culture (DWC), and the Nutrient Film Technique (NFT) are commonly used hydroponic techniques. This study outlines optimal conditions, including water quality, temperature, pH, and nutrient concentrations, essential for symbiotic fish and plant cultivation. Integrating IoT technology enhances efficiency and profitability by optimizing resource utilization, monitoring water quality, and ensuring optimal growth conditions. Knowledge sharing among practitioners fosters innovation and sustainability through collaborative learning and best practices exchange. Establishing a community for knowledge sharing is vital for continuous improvement, advancing small-scale aquaponics towards a more efficient and sustainable future.

Keywords: Internet of Things (IoT) technology; operational costs; resource utilization; small-scale aquaponics; water quality parameters

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1. Introduction

One problem currently facing all of humanity is the food demand can no longer be maintained by additional natural resources and land exploitation [1]. Hence, it is crucial to