

# Examine of Aquaponics' Energy-Efficient Manufactured Illumination

## Abstract

Aquaponics, an emerging alternative to traditional farming practice, promises to offer a sustainable and efficient solution to this problem, though it's economic viability is still being tested. In conclusion, combining reduced energy consumption along with increased energy efficiency address both the economic and environmental sustainability of this growing technology's. The United Nations general assembly adopted the 2030 agenda for sustainable development that includes seventeen sustainable development goals (SDGs). The second goal in the list named "zero hunger" aims at establishing a sustainable food production system and implementing resilient agricultural practices that increase productivity and production while maintaining the ecosystem and fighting against climate change (UN, 2015). 1.2. Sustainable Food.

**Keywords:** Aquaponics • Energy-use efficiency • LEDs • Smart monitoring • Sustainable food production systems

## Introduction

### Food security crisis

Unsustainable world population growth has exacerbated resource scarcity. A recent study conducted by the United Nations projected the human population to reach a staggering 10 billion people by the year 2050, as compared to the present 7.9 billion. This is bound to place additional burden on our food and agricultural system, and with the traditional farming practices, the resources required to cater to such a population seem vulnerable. An estimated 40% of the available land area is used for agriculture alone; which patently represents the inefficiency of the traditional farming system. Additionally, agricultural irrigation is believed to consume 70% of available freshwater resources. The United Nations general assembly adopted the 2030 agenda for sustainable development that includes seventeen sustainable development goals (SDGs) [1]. The second goal in the list named "zero hunger" aims at establishing a sustainable food production system and implementing resilient agricultural practices that increase productivity and production while maintaining the ecosystem and fighting against climate change.

### Sustainable food production system

Managed agricultural systems that incorporate

high external inputs. In the past, however, sustainable agriculture requires while being ecologically safe and socially acceptable. New forms of urban agricultural systems such as rooftop greenhouses have been developed but are limited by the economic viability due to the current building legislation for adapting greenhouse structures. At the same time, various solutions to the growing food crisis in the context of sustainability have been proposed in the past a holistic approach to enhancing the urban agriculture efficiency and optimizing the overall resource consumption is lacking. With the urban population expected to grow further [2]. Aquaponic farming concepts that comprise of aquaponics, a merger of tank-based aquaculture with hydroponics, and transaquaponics, a merger of tankless aquaculture with non-hydroponic plant cultivation, have been discussed recently. Such systems may offer economic, social, and environmental sustainability while delivering food security and nutrition for all, thus paving the way towards a cleaner food production system (FAO, 2018) [3].

### Aquaponics– A resource efficient alternative

Is in the sustainable intensification of agricultural practices around the world, and

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aquaponics promises to be a technology that has evolved over the recent years to optimize resource use efficiency and maintain the ecosystem balance. As depicted in aquaponics comprises a recirculating aquaculture system (RAS) and a hydroponics component. The waste excreted by fishes constituted of ammonia ( $\text{NH}_3^+$ ) along with other constituents is converted by selected microbes to nitrates ( $\text{NO}_3^-$ ) rapid growth of plants. As the waste produced in aquaculture is used as raw input for hydroponics component, aquaponics is adept at emulating [4].

### Research Methodology

This systematic review adheres to a clearly defined protocol and attempts to answer a set of research questions. Ranging across a multitude of dimensions, these research questions are devised to get insights into artificial luminance energy-use efficiency in the aquaponics system [5]. plants whilst minimizing the energy consumption?3 What is the optimum daily light integral or photosynthetic photon flux density that induces enhanced crop yield?4 How does the artificial light switching frequency impact the energy use efficiency of different plant species?5 How have the recent developments in Iota and automation impacted the energy-use efficiency of aquaponics?6 What are the future search directions and open perspectives of energy-efficient aquaponics in terms of its large-scale implementation to establish a sustainable food production system? Literature Search and Selection Criteria After establishing the research questions, an approach need to be formulated to identify the relevant literature. For the purpose of this review, the literature sources focus on two online publication repositories: Scopus and IEEE Explore. A preliminary search equation consisting of ideas and concepts directly related to energy use efficiency in aquaponics is outlined. Preliminary search equation: (energy AND efficiency) AND (aquaponics) OR (vertical AND farming)).Based on (Scopus - 2,654 and IEEE Explore - 150) [6].

### Results

Results The systematic literature review yields articles from multiple disciplines, as shown in Figure 5, with the majority of articles belonging to the energy (20.8%) and engineering (19.5%) domains. 16.9% and 14.7% of the reported articles are associated with environmental sciences and agriculture & biological sciences, respectively [7]. in achieving a comprehensive

summary of the recent trends related to energy-use efficiency in aquaponics. Although the majority (31%) of papers are retrieved from a mix of various reputed journals such as Applied Energy, or Science of the Total Environment, a significant portion (21%) of visualization of the publications' distribution in journals is presented in Figure 6. The major trends that became apparent after conducting the systematic literature review on energy use efficiency in aquaponics [8-10].

### Conclusions

This paper is an effort to perform analysis and review on the energy efficiency in illumination of plant growing compartments in aquaponics. An attempt has been made to answer various research questions pertaining to artificial lighting used in aquaponics. It is concluded that LEDs offer significant advantages over other existent alternatives, such as 75% higher EUE, about 50% light conversion rate, reduced operational costs, and long-lasting service period while at the same time providing robustness in tailoring specific light treatment for different plant species and growth phases. Artificial light DLI in the range of 11.52 – 14.4 mol.m<sup>-2</sup>.d<sup>-1</sup> is found to be optimum for enhanced plant growth, while a high switching frequency. Cleaner and Circular Bio economy 2 (2022) 100015 is found to offer about 50% energy savings as compared to continuous operation mode. The paper also discusses the emerging trends of improving energy efficiency of aquaponics with smart monitoring and big data. Aquaponics learning factories that can bridge large-scale commercial units with energy-efficient, smart robust systems and help strengthen.

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