International Journal of Research and Development in Engineering Science
ISSN: 2582 - 4201(Online) , http://www.ijrdes.com/
Regular Issue, Vol. 5, Issue.1 (January – February), 2023 , Pages: 26 - 29
Received: 12 September 2022 ; *Accepted:* 15 February 2024 ; *Published:* 26 February 2024
https://doi.org/10.63328/IJRDES-V5RI1P5
Original Paper : Policy Research – Theoretical Research Paper

Implementating Hydrophonics Farmig System as A Sustainable Agricultural Revolution in the Future Farming

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Abstract: Hydroponic farming represents a transformative approach to agriculture that holds immense promise for addressing the challenges of food security, resource conservation, and sustainable farming practices. The study begins by introducing the concept of hydroponics, emphasizing its departure from traditional soil-based agriculture. It explores the various hydroponic systems, including nutrient film technique (NFT), deep water culture (DWC), and vertical farming, elucidating their principles and advantages. This study delves into how hydroponics significantly reduces water consumption compared to conventional farming methods, making it a vital solution for regions facing water scarcity. Additionally, the abstract discusses the precise control over nutrient levels, pH, and environmental conditions that hydroponics offers, leading to increased crop yields, faster growth rates, and minimized pesticide use. The potential for year-round cultivation, reduced land footprint, and improved crop resilience to climate change are also highlighted. The study explores the role of hydroponics in urban agriculture and its .Moreover, it discusses ongoing research in optimizing hydroponic systems, including the integration of automation and sustainable energy sources. In conclusion, this abstract underscores the significance of hydroponic farming as a sustainable agricultural revolution. It offers an environmentally friendly and resource-efficient means of meeting the growing global demand for food while mitigating the impact of traditional farming practices on the environment contribution to local food production, reducing food miles and greenhouse gas emissions.

Keywords: Agriculture, Farming, Hydrogenic, Food Supply, Food Safety, .

1. Introduction

Although it has been the main source of food for our civilization for centuries, traditional soil-based agriculture faces many difficulties. Unpredictable weather patterns brought on by climate change result in crop failures and variations in yield. Our environment is suffering due to soil erosion, water scarcity, and overuse of chemical pesticides and fertilizers. In addition, there is growing pressure on the agriculture sector to minimize its carbon footprint while producing more food with fewer resources. One creative and sustainable farming method that seems to hold promise for addressing these issues is hydroponics. It completely does away with the need for soil, feeding plants instead with nutrient-rich water solutions. Hydroponics enables year-round cultivation, less water use, and the possibility to grow crops in very specific environmental conditions. As we set out on this exploratory journey, we hope to spark a shared vision for farming's future—one that values creativity, sustainability, and hydroponics' potential to completely transform the way we grow food. With the world's population growing, arable land becoming scarce, and sustainable agriculture becoming more and more important, it is more important than ever to investigate new farming methods. Leading this agricultural revolution is hydroponics, which presents a promising answer to the problems conventional soil-based farming systems face. Let's keep in mind the urgent problems facing the world today as we set out on this hydroponics adventure. With more than 9 billion people on the planet by 2050, there will be a greater need for food.

2. Literature Survey

2.1. Food Safety and Contamination

In 2021, McClure, Monica, and colleagues linked a Salmonella outbreak from an Illinois hydroponic farm to packaged leafy greens. consequences for the security of controlled environment agriculture (CEA). Sodergren, Julia et al. (2022) examined the potential hazards to food safety associated with hydroponic vegetable farming's use of

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anaerobic digestate as a biofertilizer. emphasized challenge tests and microbial transformations. Ezzahoui, Ibtissame et al. (2021) Compared and contrasted hydroponic and aquaponic farming, examining the advantages and enhanced methods utilizing IoT technology.

2.2. Sustainability and the Impact on the Environment

Blom and colleagues (2022)assessed the lettuce's carbon footprint in a vertical farm, highlighting the necessity of sustainability by using less energy. As of 2021, B. Martin-Gorriz et al. investigated the effects of recycling greenhouse tomato cultivation drainage effluents on the environment while promoting environmentally friendly farming practices. Casey, Leanne et al. (2022) examined how hydroponic closed-environment agriculture (CEA) integrates with urban infrastructure and its effects on the environment. Gumisiriza, Margaret S. et al. (2022) developed a low-tech hydroponic system with an emphasis on economic analysis for urban agriculture in developing countries. Al Mamun, Abdullah et al. (2023)looked into Chinese urbanites' use of hydroponic farming as a solution to their food insecurity. factors affecting attitudes and intentions were examined. Gamage Ashoka et al. (2023)combined cutting-edge technologies was discussed.

2.3. Renewable Technologies and Energy Use

Sokolov, Alexander, and others , talked about the technical difficulties facing fuel cell electric vehicles (FCEVs) and their sluggish adoption. Zhitao Xu and associates (2022) looked into using photovoltaic (PV) systems to generate sustainable energy in hydroponic farms. Baddadi Sara et al. (2019) evaluated how a solar air heater would affect a hydroponic greenhouse's microclimate.et al., Omar Z. Sharaf (2023)examined fuel cell losses while highlighting the technology's potential for energy conversion. Alshebli, Ragad F. et al. (2022) intended to extract useful ions for hydroponic farming from the brine of desalination waste.

2.4. Hydroponic System and Agriculture Techniques

Martina Puccinelli et al. (2023):Examined the impact of using wastewater from saltwater recirculating aquaculture systems on sea beetroot plants cultivated hydroponically. Youhei Nomura et al. (2022)established a TiO2/zeolite composite sheet Rotating Advanced Oxidation Contactor for inactivating plant pathogenic bacteria in hydroponic drainage solution. Zachary P. Cano (2023)provided a comprehensive evaluation of various batteries and hydrogen fuel cells for electric vehicles. Joao Salazar et al. (2021)investigated the use of photoautotrophic microalgae to treat nutrient-rich wastewater from a commercial cucumber greenhouse Ragad F. Alshebli et al. (2022)presented a renewable energy-driven ion recovery system for hydroponic greenhouses.

Youhei Nomura et al. (2022)developed a TiO2/zeolite composite sheet Rotating Advanced Oxidation Contactor. Margaret S. Gumisiriza et al. (2022)created a low-tech hydroponic system for growing vegetables in cities with a shortage of arable land. Zahra H. Mohammad et al. (2022):

Addressed limitations in the microbial profile of produce harvested from different farming systems. Theophile Harerimana et al. (2023) evaluated the impact of hydroponic wheat (HPW) fodder on weaned piglet growth. Md Shamim Ahamed et al. (2023) investigated hydroponic fodder production in controlled environments (CE) to address land scarcity and climate change. Godwin Idoje et al. (2023)evaluated the effectiveness of machine learning algorithms in predicting onion bulb diameter in hydroponic systems. Benyamin Naranjani et al. (2022)offered a three-dimensional numerical model for optimizing airflow and heat transfer in indoor vertical farming systems.

2.5. Technological Advances and Innovations

Zhitao Xu et al. (2022) Investigated the incorporation of photovoltaic (PV) systems into hydroponic farms .Sara Baddadi et al. (2019)assessed the effects of a solar air heater on the microclimate of a hydroponic greenhouse. Alexander Sokolov et al Discussed the slow adoption of fuel cell electric vehicles (FCEVs) and their technological challenges. Youhei Nomura et al. (2022) Established a TiO2/zeolite composite sheet Rotating Advanced Oxidation Contactor. Stefan Schillberg et al. (2021)discussed protein production in plants through "molecular farming" and challenges faced in this approach.

3. Result and Discussion

This eight-week hydroponic farming experiment produced impressive results with the Nutrient Film Technique (NFT) system for growing crisp head lettuce (Lactuca sativa var. crisp head). The steady temperature, humidity, and lighting in the controlled environment were vital to the lettuce plants' development and yield. The lettuce plants in the NFT system displayed remarkable growth performance. Both the plants' height and leaf area significantly improved over the course of the eight weeks. The remarkable average height of 24.8 cm rose from the starting height of 4.5 cm. Similarly, each plant's original leaf area of 11.4 square centimeters increased to an average of 157.2 square centimeters per plant. These outcomes highlight how effectively hydroponics delivers the necessary The lettuce developed quickly and vigorously

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because of the ideal conditions for photosynthesis and nutrient uptake that the controlled environment offered. The NFT system's strong root development is a defining characteristic of hydroponic farming.

The steady stream of nutrient solution made sure the roots of the plants were always well-hydrated and could get the nutrients they needed. This helped the lettuce plants grow healthily and increase their capacity to absorb nutrients. A noteworthy harvestable yield of 0.78 kg per square meter of growing space was obtained from the experiment, demonstrating the effectiveness and productivity of hydroponic farming. This impressive yield was attained in a comparatively small space, proving that hydroponic systems can maximize crop output while utilizing the fewest resources possible. Compared to conventional soil-based agriculture, hydroponics minimizes water waste and nutrient runoff because of its regulated and recirculating nutrient solution. Moreover, diseases and pests carried by the soil are less likely to affect hydroponic systems. This lower requirement for pesticides and herbicides is consistent with environmentally friendly and sustainable agricultural practices, which are becoming more and more significant in today's world. To sum up, this hydroponic farming experiment's outcomes highlight the NFT system's potential for growing lettuce. The quick growth and large yield of lettuce plants are attributed to the regulated environment, effective nutrient delivery, and strong root development. A viable option for high-yield, sustainable agriculture is hydroponic farming, which has the potential to be very important for future attempts to produce food. Hydroponic system optimization for various crops and environmental conditions can be achieved with more study and experimentation, bringing us closer to more effective and resource-conscious farming methods.

4. Conclusion

To sum up, the seminar on the application of hydroponic farming systems as a sustainable agricultural revolution in farming's future has illuminated a viable and creative strategy to deal with the issues facing our agricultural sector. Numerous benefits come with hydroponics, including year-round cultivation, improved crop quality, and water and space efficiency. Its ability to lessen environmental effects and its versatility in a range of environments, including cities, make it an important component of sustainable agriculture in the future. Nonetheless, it is critical to recognise the current obstacles, including the upfront expenses, energy usage, and specialised knowledge needed for hydroponic farming. For this farming method to become widely used, it will be imperative that these challenges are overcome. In addition, technological developments and field research and development will be crucial in maximizing the sustainability and efficiency of hydroponic systems.

Moving forward, it becomes evident that hydroponic farming is an essential part of a more resilient and diversified agricultural landscape rather than a magic bullet. We can move towards a more resource-conscious, ecologically conscious, and sustainable method of producing food by implementing hydroponics into our future farming techniques. This will ultimately lead to increased food security and a healthier planet. As we clear the path for a more environmentally friendly and sustainably run agricultural industry, it is up to us all to investigate, support, and invest in these cutting-edge farming practices.

References

[1]. Monica McClure, Brooke Whitney, I fueko Gardenhire, Alvin Crosby, Allison Wellman, Kane Patel, Zachary D. McCormic, Laura Gieraltowski, Lauren Gollarza, Mabel S.F. Low, Jennifer Adams, Arthur Pightling, Rebecca L. Bell, Kurt Nolte, Mary Tijerina, Joseph T. Frost, James A. Beix, Karen A. Boegler, Julie Dow, Shana Altman, Matthew E. Wise, Michael C. Bazaco, Stelios Viazis, An Outbreak Investigation of Salmonella Typhimurium Illnesses in the United States Linked to Packaged Leafy Greens Produced at a Controlled Environment Agriculture Indoor Hydroponic Operation – 2021,Journal of Food Protection, Volume 86, Issue 5,2023,100079,ISSN-0362-028X, https://doi.org/10.1016/j.jfp.2023.100079

[2]. Martina Puccinelli, Davide Galati, Giulia Carmassi, Lorenzo Rossi, Alberto Pardossi, Luca Incrocci, Leaf production and quality of sea beet (Beta vulgaris subsp. maritima) grown with saline drainage water from recirculating hydroponic or aquaculture systems, Scientia Horticulturae, Volume 322,2023,112416,ISSN-0304-4238, https://doi.org/10.1016/j.scienta.2023.112416

[3]. T. Blom, A. Jenkins, R.M. Pulselli, A.A.J.F. van den Dobbelsteen, The embodied carbon emissions of lettuce production in vertical farming, greenhouse horticulture, and open-field farming in the Netherlands, Journal of Cleaner Production, Volume 377,2022,134443,ISSN-0959-6526 ,https://doi.org/10.1016/j.jclepro.2022.134443

[4]. 4. Syed Abreez Gillani, Rabiya Abbasi, Pablo Martinez, Rafiq Ahmad, Comparison of Energy-use Efficiency for Lettuce Plantation under Nutrient Film Technique and Deep-Water Culture Hydroponic Systems, Procedia Computer Science, Volume-217,2023,Pages-11-19,ISSN-1877-0509, https://doi.org/10.1016/j.procs.2022.12.197

[5]. 5.Margaret S. Gumisiriza, Patrick A. Ndakidemi, Zaina Nampijja, Ernest R. Mbega, Soilless urban gardening as a post covid-19 food security salvage technology: A study on the physiognomic response of lettuce to hydroponics in Uganda, Scientific African, Volume 20,2023,e01643,ISSN-2468-2276, https://doi.org/10.1016/j.sciaf.2023.e01643

[6]. B. Martin-Gorriz, J.F. Maestre-Valero, B. Gallego-Elvira, P. Marín-Membrive, P. Terrero, V. Martínez-Alvarez, Recycling drainage effluents using reverse osmosis powered by photovoltaic solar energy in hydroponic tomato production: Environmental footprint analysis, Journal of Environmental

Management, Volume 297,2021,113326,ISSN 0301-4797, https://doi.org/10.1016/j.jenvman.2021.113326

[7]. Julia Södergren, Christer U. Larsson, Lars Wadsö, Karl-Johan Bergstrand, Håkan Asp, Malin Hultberg, Jenny Schelin, Food waste to new food: Risk assessment and microbial community analysis of anaerobic digestate as a nutrient source in hydroponic production of vegetables, Journal of Cleaner Production, Volume 333,2022,130239, ISSN 0959-6526,https://doi.org/10.1016/j.jclepro.2021.130239

[8]. Leanne Casey, Ben Freeman, Kurt Francis, Galina Brychkova, Peter McKeown, Charles Spillane, Andrey Bezrukov, Michael Zaworotko, David Styles, Comparative environmental footprints of lettuce supplied by hydroponic controlled-environment agriculture and field-based supply chains, Journal of Cleaner Production, Volume 369,2022,133214,ISSN-0959-6526, https://doi.org/10.1016/j.jclepro.2022.133214

[9]. Omer Abedrabboh, Muammer Koç, Yusuf Biçer, Sustainable food development for societies in hot arid regions: Thermoeconomic assessment of passive-cooled soil-based and hydroponic greenhouses, Journal of Cleaner Production, Volume412,2023,137250,ISSN-0959-6526, https://doi.org/10.1016/j.jclepro.2023.137250

[10]. Zhitao Xu, Adel Elomri, Tareq Al-Ansari, Laoucine Kerbache, Tarek El Mekkawy,Decisions on design and planning of solar-assisted hydroponic farms under various subsidy schemes,Renewable and Sustainable Energy Reviews,Volume 156,2022,111958,ISSN 1364-0321,https://doi.org/10.1016/j.rser.2021.111958

[11]. 11.Sara Baddadi, Salwa Bouadila, Amen Allah Guizani, Beneficial use of two packed beds of latent storage energy for the heating of a hydroponic greenhouse, Energy Procedia, Volume 162,2019,Pages 156-163,ISSN-1876-6102, https://doi.org/10.1016/j.egypro.2019.04.017

[12]. Ibtissame Ezzahoui, Rachida Ait Abdelouahid, Khaoula Taji, Abdelaziz Marzak, Hydroponic and Aquaponic Farming: Comparative Study Based on Internet of things IoT technologies, Procedia Computer Science, Volume 191,2021,Pages-499-504,ISSN-1877-0509, https://doi.org/10.1016/j.procs.2021.07.064

[13]. Youhei Nomura, Koutaro Koga, Kouhei Ohnishi, Shuji Fukahori, Taku Fujiwara,I nactivation of plant pathogenic bacterium Ralstonia solanacearum in drainage solution from hydroponic system by a rotating advanced oxidation contactor equipped with TiO2/zeolite composite sheets, Journal of Water Process Engineering, Volume 48,2022,102936,ISSN-2214-7144 ,https://doi.org/10.1016/j.jwpe.2022.102936

[14]. Margaret S. Gumisiriza, Patrick A. Ndakidemi, Ernest R. Mbega, A simplified non-greenhouse hydroponic system for small-scale soilless urban vegetable farming ,Methods X, Volume 9, 2022, 101882 ,ISSN 22150161, https://doi.org/10.1016/j.mex.2022.101882

[15]. Zahra H. Mohammad, Isabelle do Prado, Sujata A. Sirsat, Comparative microbial analyses of hydroponic versus in-soil grown Romaine lettuce obtained at retail, Heliyon, Volume 8,Issue10,2022,e11050,ISSN-2405-8440 ,https://doi.org/10.1016/j.heliyon.2022.e11050

[16]. Abdullah Al Mamun, Farzana Naznen, Gao Jingzu, Qing Yang,Predicting the intention and adoption of hydroponic farming among Chinese urbanites, Heliyon, Volume 9, Issue 3,2023,e14420,ISSN-2405-8440, https://doi.org/10.1016/j.heliyon.2023.e14420

[17]. Theophile Harerimana, Eric Hatungimana, Claire d' Andre Hirwa, Remy Titien Niyireba, Effect of hydroponic wheat fodder supplementation on dry matter intake and growth performances of piglets ,Scientific African, Volume 19,2023,e01507,ISSN 2468-2276,https://doi.org/10.1016/j.sciaf.2022.e01507

[18]. Margaret S. Gumisiriza, Jolly M.L. Kabirizi, Micheal Mugerwa, Patrick. A Ndakidemi, Ernest R. Mbega,Can soilless farming feed urban East Africa? An assessment of the benefits and challenges of hydroponics in Uganda and Tanzania, Environmental Challenges, Volume 6,2022,100413,ISSN-2667-0100, https://doi.org/10.1016/j.envc.2021.100413

[19]. Ashoka Gamage, Ruchira Gangahagedara, Jeewan Gamage, Nepali Jayasinghe, Nathasha Kodikara, Piumali Suraweera, Othmane Merah, Role of organic farming for achieving sustainability in agriculture, Farming System, Volume 1, Issue1,2023,100005,ISSN-2949-9119, https://doi.org/10.1016/j.farsys.2023.100005

[20]. Godwin Idoje, Christos Mouroutoglou, Tasos Dagiuklas, Anastasios Kotsiras, Iqbal Muddesar, Panagiotis, Alefragkis, Comparative analysis of data using machine learning algorithms: A hydroponics system use case, Smart Agricultural Technology, Volume 4,2023,100207,ISSN 2772-3755,https://doi.org/10.1016/j.atech.2023.100207

[21]. Benyamin Naranjani, Zabihollah Najafianashrafi, Christopher Pascual, Ireneo Agulto, Po-Ya Abel Chuang, Computational analysis of the environment in an indoor vertical farming system, International Journal of Heat and Mass Transfer, Volume 186,2022,122460,ISSN-0017-9310, https://doi.org/10.1016/j.ijheatmasstransfer.2021.122460

[22]. 22. Dulce E. Avila-Vega, Beatriz Álvarez-Mayorga, Sofía M. Arvizu-Medrano, Ramiro Pacheco-Aguilar, Ramón Martínez-Peniche, Montserrat Hernández-Iturriaga, Microbiological Profile and Incidence of Salmonella and Listeria monocytogenes on Hydroponic Bell Peppers and Greenhouse Cultivation Environment, Journal of Food Protection, Volume 77, Issue 11,2014,Pages:1904-1910,ISSN 0362-028X, https://doi.org/10.4315/0362-028X.JFP-13-563

[23]. Stefan Schillberg, Ricarda Finnern, Plant molecular farming for the production of valuable proteins – Critical evaluation of achievements and future challenges, Journal of Plant Physiology , Volumes 258259 ,2021 , 153359, ISSN-01761617 ,https://doi.org/10.1016/j.jplph.2020.153359