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THE STUDY OF HYDROPONIC AND AQUAPONIC FARMING SYSTEMS

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ABSTRACT
In terms of agricultural progress, hydroponic and aquaponic farming are at the cutting edge. Together, hydroponics and aquacultureform the system known as aquaponics. Plants may be grown more quickly utilizing hydroponic methods as compared to traditional farming because of the removal of soil-borne diseases, the decrease of insect infections and pests, and the elimination of toxic chemicals. Only plants are now permitted to ingest the nutrients. Even in the most challenging environments, the aquaponic system may be put to good use. Protesters in helicopters there are no longer any seasonal swings, and the system as a whole is more stable. Different aquaponics setups in today's competitive consumer and commercial industries, the ability to operate autonomously with the help of internet of things technologies is a must. This research recommends evaluating organic agricultural practices with hydroponic and aquaponic methods. In order to have a full picture of both approaches.
Keywords: Hydroponic, Aquaponic, Farming Systems and Agricultural

INTRODUCTION
Growing plants in a nutrient-rich water solution is the essence of hydroponics. Without soil, plants grown hydroponically rely on an inert medium to sustain their root systems, such as perlite, rockwool, clay pellets, peat moss, or vermiculite. Hydroponics is based on the idea that a plant's roots thrive best when they have direct access to both the nutrition solution and oxygen. In addition, it might be a helpful tool in addressing issues with conventional farming such as dwindling freshwater supplies, shifting weather patterns, and degraded soil. Growing food hydroponically is a viable choice for farmers in locations with restricted resources, such as metropolitan areas, dry regions, and low-lying islands, where the soil is poor and water is rare. Deep water culture, aeroponics, and drip irrigation are just a few of the hydroponic methods that may be used to cultivate plants. Hydroponics is a method of plant culture in which no soil is used; instead, the plants are grown in a nutrient-rich water solution. Hydroponics is a space- and time-saving method of cultivating plants, making it a great option for urban dwellers and anyone with restricted access to outdoor growing grounds.
In hydroponic farming, plants are grown in nutrient-rich media solutions without the need of soil. Increased yields, less water and fertilizer use, and more environmental control are just a few of the numerous advantages of this kind of plant production. Fruits and vegetables, among others, may all benefit from this agricultural strategy. In a closed system, aquaponics combines the benefits of hydroponics, soil-less agriculture, and aquaculture. Aquaponics utilizes fish, plants, and microbes as its biological components. Aquaponics is a method of farming that combines hydroponic plant growth with recirculating aquaculture; the water from the fish is used as fertilizer for the plants, and the water from the plants is purified before being returned to the fish. As a consequence, fish and vegetables may now be produced locally with additional value while sharing the same water source. The term "aquaponics" refers to a method of food production that harmoniously mixes traditional aquaculture with hydroponics. Normal aquaculture involves the accumulation of animal excrements in the water, which might increase the water's toxicity. The water from an aquaculture system is piped into a hydroponic system, where nitrogen-fixing bacteria convert the byproducts into nitrites and nitrates that the plants may use as food. The aquaculture system recycles the water for further use.
Since aquaponics systems are based on preexisting hydroponic and aquaculture farming methods, they may vary in size, complexity, and the sorts of foods cultivated in them just like any other system in either agricultural discipline. Producing high yields in a wide range of temperatures and environments is possible using hydroponics, which offers numerous advantages over conventional farming methods based on soil. Because it doesn't need soil, hydroponics farming may be done everywhere, including deserts and other dry regions, rooftops, locations with low soil quality, and places with no natural

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resources suitable for growing crops. Hydroponics is more efficient and sustainable than conventional farming since it uses less water.

LITERATURE REVIEW

Kulkarni, Amith A et.al (2019). The purpose of this page is to provide an overview of aquaponics technology, including its underlying principles, various agricultural uses, current developments, and future problems. Statistics and research methodology: In this paper, we explore aquaponics, a system that combines hydroponics—the practice of growing plants and vegetables without soil—with aquaculture—the raising of fish in controlled environments. A controlled system in which fish eat and produce ammonia, beneficial bacteria convert ammonia produced by the fish into nutrients, and the plant absorbs the natural fertilizer and nutrients, aquaponics has become a popular technique. As an added bonus, the nutrient- and ammonia-rich water is constantly recycled. The results of this research show that the aquaponics agriculture system should be used in a wider range of agricultural contexts. The results reveal that this technique improves upon the advantages and gets rid of the numerous disadvantages of conventional soil-based farming. Implementation/Improvement: This method of farming does not involve the use of soil or pesticides. Producing high-quality veggies at a substantially greater output is possible with this technique, and it can be used all year round.

Desai, Nivas et.al (2021). Everyone is worried about whether or not future generations will be able to meet global food demand. Major problems with the current agricultural system include the overuse of pesticides in the name of increased production, the loss of valuable nutrients via leaching, and the shift of farmland to urban development. Water reservoirs have become eutrophic due to the overuse of nitrogenous fertilizers, which has increased by a factor of more than 20 in the previous few of decades. Thus, balancing agricultural and animal production is the only way to maximize water and nutrient efficiency. Land usage reduction is essential to achieving sustainability. For this purpose, aquaponics is a viable option. The organic fruits and vegetables grown in aquaponics, a soilless contemporary agro-system, have caused it to explode in popularity. Remediating aquaculture wastewater is a common use of aquaponics. Using the nitrogen-rich wastewater generated by fish, this bio-integrated agricultural system combines hydroponics for sustainable food production. The connection between aquaculture and hydroponic plants is quite crucial. Aquatic creatures (fish) and the plants utilized in this bio-integrated method of contemporary agriculture form a mutually beneficial interaction. Aquaponics has recently gained widespread interest as a viable sustainable food production strategy.

Surnar, Sharad et.al (2015). Aquaponics was developed to make indoor and outdoor fish production more cost-effective and environmentally friendly. We need to rethink agricultural sciences in light of issues like sustainability, development, and economically efficient improvement of farmer health, which means creating environmentally friendly technology. Aquaponics is a relatively new innovation that combines aquaculture and hydroponics to produce nutrient-rich food in a way that adheres to the principles of sustainable agriculture (wastewater bio filtration by plants) and allows for greater economic efficiency through the addition of a production (organic vegetables).

Singh, Raj et.al (2020). As the global population rises, so does the incessantly rising need for food production. With pollution levels increasing and climatic fluctuations, the conventional agricultural system will be unable to meet the world's growing need for food. To avoid a food crisis in the future, it is critical that new methods of farming and gardening be developed. The purpose of this research was to investigate a promising method for transferring hydroponic system knowledge from the laboratory to the field. Triticum sp. (Poales: Poaceae), Spinacea sp. (Caryophyllales: Amaranthaceae), and Gladiolus sp. (Asparagales: Iridaceae) were used to analyze and verify the in vitro data for comparative accounting between hydroponics and tap water system using numerical tools. Wheat, spinach, and sword lilies all grew far better in Hoagland solution than in regular water. Therefore, the global need for grains, vegetables, and flowering crops now and in the future may be met by using the suggested hydroponic system in the field.

Jordan, Rodrigo et.al. (2018). The purpose of this research was to compare aquaponic and hydroponic lettuce yields as a function of substrate type. Research was carried out at Dourados (MS)'s Federal University of Grande Dourados. Three treatments were tested with 16 duplicates in a randomized full block design. Both of the growing methods were examined separately. Three different substrates—coconut shell fiber, phenolic foam, and expanded vermiculite—were tested. The NFT

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(Nutrient Film Technique) was used to cultivate the plants in both an aquaponic and a hydroponic environment. Lettuce 'Alcione' cultivar was utilized for this harvest. Crop production and root percentage per plant were the key metrics. Macronutrient levels in the leaves were also measured. Higher yields were achieved in both the aquaponic (2.88 kg m-2) and hydroponic (2.58 kg m-2) systems when the substrate was made of coconut shell fiber, making it more appropriate for lettuce cultivation. Mean crop yields were 1.94 kg m-2 for aquaponic systems and 2.15 kg m-2 for hydroponic systems when phenolic foam was used as a growth substrate.

HYDROPONIC FARMING

Hydroponics is a widely used method in modern farming. When compared to conventional farming, hydroponics is a lot less labor-intensive and messier. Hydroponics, says, is the magic bullet for growing plants everywhere, even in deserts. It may aid in the exploration of urbanized areas and the speed at which cities are developing. Due of the complexity of soil required by the typical approach, outer space may also be a useful source of food. India, like many other developed nations, relies heavily on agriculture to fuel its economy. Improve greenhouse technology's efficiency, profitability, and quality with's proposed completely automated hydroponic system in design and construction using IoT technologies. Hydroponic plant production and monitoring may benefit from the addition of smart artificial light and an Internet of Things system by) These technologies have proven useful in urban settings when a real-time system is implemented. presented a signal device using a ribbon cable to detect water level, electrical conductivity (EC electrodes), and the temperature sensor, which would allow for high precision at a cheap cost in the sensors used in the hydroponic system. Additionally, built a CO2 concentration-aware Intelligent Plant Care Hydroponic Box using IoT and a tunable piece of software. The sensors and actuators can be rapidly and easily added, removed, and swapped out in the system.

By combining aquaculture (the cultivation of aquatic creatures in tanks, such as fish, crayfish, snails, or prawns) with hydroponics (the cultivation of plants in water), aquaponics is a food production method in which the nutrient-rich water from aquaculture is used to irrigate hydroponically grown plants. Due to the fact that all aquaponic systems are based on both hydroponic and aquaculture farming methods, the size, complexity, and kinds of foods cultivated in an aquaponic system may vary as much as any system found in each unique agricultural discipline.

Raising fish in tanks (recirculating aquaculture) and growing plants without soil (hydroponics) is what's known as aquaponics. Aquaponics is a kind of farming in which fish are used to feed plants with nutrient-rich water, and the plants are used to filter the water for the fish.

Table 1 Comparison Between Hydroponic Systems

Parameter	Agar-filled plastic holder	Rockwool-filled plastic holder	Sponge into a polypropylene sheet	Polyethylene granulate	Stainless mesh fixed two metal rigs/Nylon mesh on photo slide mount	This system
Liquid medium container	Plastic box	Plastic box	Magenta GA-7 vessel*	Glass vessel	Round-rim glass jars/glass vessel	Plastic container
Costs	Intermediate to high	Intermediate	High	High	High	Low
Setup time	Intermediate to high	Intermediate	Low	Low	High	Low to intermediate
Reuse of seed-holder	No	No	No	No	Yes/No	Yes
Throughput	Intermediate	Intermediate	High	High	High/intermediate	Intermediate
Container volume	Small to high	Small to intermediate	Small	Small to high	Intermediate	Intermediate to high
Medium evaporation	High	High	Low	High	Low/High	Low
Seedling number per holder	One	One	One	Many	Many	Many
Sterility	No	No	Yes	No	Yes/No	Yes
Aeration	Yes/No	Yes/No	No	No	No	No
Time for moving and sampling large batches of plants between media	High	High	High	High	High	Low
Development window	Adult plants	Adult plants	Seedling to adult plants	Seedling	Seedling	Seedling to adult plants

COMPONENTS OF HYDROPONICS

Adjustable thermostat There's a sweet spot in the thermometer where plants thrive. Both the surrounding environment and the nutrient solution temperature need to be managed while hydroponics is being used. The ideal range for hydroponic water temperature is between 65 and 80 degrees Fahrenheit. Grow rooms should be kept between 70 and 78 degrees Fahrenheit with a relative humidity of 45 and 55 percent during the vegetative stage, when the lights are on throughout the day.

1. Ventilation fanThe plantation room benefits from a well-ventilated exhaust fan. They congregate mostly on the grow room's ceiling. These aid in the expulsion of stale air and excess oxygen. This aids in maintaining healthy airflow throughout the grow space. When we

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vent out the room's heated, oxygen-rich air, we make way for cooler, carbon dioxide-rich air to enter. Humidity and temperature levels in a space may be maintained with the aid of proper ventilation. It's useful for pest management as well, as pests are more likely to enter and multiply quickly in a greenhouse if the air inside is always still and damp. Stagnant, humid air is conducive to the proliferation of fungus, mold, and mildew. The health and safety of plants cultivated in hydroponics depend critically on adequate ventilation.

2. Evaporative pad and fan systems are another name for pad cooling systems. It is the method of choice for reducing the temperature in a grow room. They are hung on the partitions of the greenhouse. The water tank for the cooling pad is situated outside the grow chamber. The cooling pads are soaked through and through by the water applied by the pump or motor. The water is subsequently evaporated utilizing the grow room's existing heat, which leaves the space cold. The resulting hot air is carried out of the grow chamber by the exhaust fans.
3. Fogger Fogger creates fog, which contains atmospheric water. They are installed on the greenhouse's ceiling. When the temperature in the grow room rises beyond a specific threshold, the fogger begins producing fog, which adds small droplets to the surroundings, cooling it down and keeping the humidity steady.
4. Detector The grow room's sensors use fuzzy logic. They keep track of the current temperature in the room and send commands to the thermostat to keep it at a comfortable level. The temperature controls are linked to the sensors. Instruments used to regulate the temperature of nutrient-rich water often include sensors.
5. Sunshade Shade fabric is used to keep plants at a safe and sustainable temperature. Insects and other pests are kept at bay. Hydroponically grown plants benefit from the greenhouse effect provided by shade cloth. Fabrics like polyester and even aluminum may be loosely braided to create shade fabric.

AQUAPONICS SYSTEM

The terms "Aquaculture" and "Hydroponics" refer to the two main components of the integrated technique known as "Aquaponics," which is used to cultivate both fish and plants. The idea is to divide and share nutritional resources between fish and plants while making more effective use of water to generate two crops rather than one. This kind of farming is popular in locations with limited space or access to natural resources, as well as in densely populated cities. In aquaponics, plants and fish are grown together in the same system. Aquaponics systems may grow a wide variety of plants, but the particular plants that thrive in a given system rely on the age and population density of the fish. Capsicum, tomatoes, lettuce, cabbage, lettuce, basil, spinach, chives, herbs, and watercress are all examples of green leafy crops that thrive in aquaponics systems because of their low to medium nutritional needs.

Fish are given high-quality floating pellet feed, and their waste is piped into bio-filter troughs containing horticulture plants; the water flow rate is controlled by a timer. This setup is known as a recirculation culture system. Aquaponics systems produce entirely natural fish and vegetation. The approach requires a sizable outlay of cash up front, but the ongoing expenses are manageable, and the payoff is satisfactory. The benefits of this approach include reduced resource use (water, land area, garbage, labor, etc.). Aquaponic plants and animals have a mutually beneficial connection. The plants benefit from the nutrients in fish waste, while the fish benefit from cleaner water made possible by the plants.

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Table.2 Types of aquaponics system

Type	Usage
Home-based aquaponics (HA)	• Food products for local consumption purpose is produced from Home-based aquaponics. • It is mostly preferable for hotels, prisons, supermarkets, and shopping malls as ideal settings. • HA is also decreasing the risk of obesity and unhealthy diets due to both the quantity and the quality of protein, fruit and vegetable uptake by home activities
Factory-based aquaponics (FA)	• Factory-based aquaponics (FA) is an industrial food production system that is intended for international trade and subject to the regulations of the receiving market. • Either fresh water aquaponics or seawater aquaponics can be developed as this model. Seawater aquaponics may exhibit more economic benefits for seafood production and the low-salinity or high-salinity marine plants are used This model of aquaponics can reduce operational costs by increasing fish productivity and harvest of vegetables.
Building-based aquaponics (BA)	• Building-based aquaponics (BA) is a medium-scale infrastructure. The idea behind building-based aquaponics is from the innovative forms of green architecture that aim to combine food, architecture, production and design to produce food on buildings in urban areas

Table.3 Types of aquaponics system based on farming scale

Type	Usage
Small-scale Aquaponics	One of the best practices for producing organic food and vegetables as it is a small-scale aquaponics system. It is a sustainable technology that requires minimal water and space A small unit is used here and placed and integrated into the interior design of homes, offices, kitchens, and workspaces.
Low-tech Aquaponics	Aquarium can be transformed easily into an exclusive herb production unit. It demands very low cost and the process requires no special crafts, skills, or tools. It is a fantastic way for the people living in urban to get closer to nature and grow their own fresh herbs, leafy vegetables, and fresh fish protein with less production costs
Micro Aquaponics	An innovative and smart design concept for a micro-scaled aquaponics system paves the way for a new concept of eco-farming systems. The main aim of this system is to use the value of the residue in the water and convert it through a combination of multidisciplinary efforts and thus low environmental impact technologies to become valuable products.

Aquaponic farming

Aquaponic farming was given special attention at least 30 years ago. Research in both the academic and commercial sectors is complicated by the diversity of species and the ways in which they have adapted to their environments. Several factors, including those of a biological and physicochemical nature must coexist for there to be peace and stability in the system. Simply said, aquaponic farming is a novel approach to food production. According to, this technique involves using water and a measured amount of nutrients to ensure the long-term viability of an aquaponic system. To effectively monitor and automate the system, thorough investigation for commercial solutions is required, particularly with regards to elucidating the connection between sensors and each and every parameter. Using a cloud-based IoT, propose measuring the variables and sending the results to ThingSpeakTM through Wi-Fi and the service's API.

They provide a real-time alert system for reporting anomalies, as well as a periodic regression analysis, both of which are useful. proposes a Smart Growbox in response to the increasing urbanization of nations with relatively low local food and land shortages, such as Indonesia. The goal of this system is to optimize agricultural produce via the use of different technology. In another study, the researchers found that farmers had more influence over ammonia, temperature, pH, and nutrient

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levels when they used a mobile app on their smartphones connected to the Internet of Things (IoT). To improve the home environment, you may offer a system with internet-connected sensors, actuators, and a microprocessor to keep tabs on everything. The Blynk IoT platform is used to develop the mobile app's capabilities in terms of controlling and analyzing devices.

Table 4. Comparison between Traditional farming and Aquaponics

S.no	Traditional Farming	Aquaponics
1.	It requires a lot of water for growing crops.	It's usage of water is up to 90% less when compared to traditional farming.
2.	Harmful pesticides and other fertilizers may be used in the farming fields.	It is entirely organic and no harmful pesticides can be used as they are harmful for fish.
3.	The removal of weeds can be tiring and water used by weeds is wasted.	There is no chance for the growth of weed in the closed aquaponic system.
4.	The area required to grow the crops is very large.	An aquaponic system is four to six times as productive on a square foot basis as soil-based farming.

Aquaponic methods

In aquaponics, the three main cultivation strategies are the Nutrient Film Technique (NFT), the Ebb and Flow approach, and the Raft or Deep-Water Culture (DWC) strategy.

The most widely used method of hydroponics, known as the Nutrient Film Technique (NFT), may be readily adapted for use in aquaponics. The naked roots of the plants are placed in a watertight gully or channel, and a thin layer of water containing dissolved nutrients from the fish tank is circulated through the roots. The oxygen levels at the plant roots are high since the recirculating stream is just a few centimeters deep. The primary benefit of the NFT system is that it provides a constant flow of water, oxygen, and nutrients to the plant's roots. While NFT is a very effective method, its lack of buffering against flow disruptions (such as power outages) is a drawback.

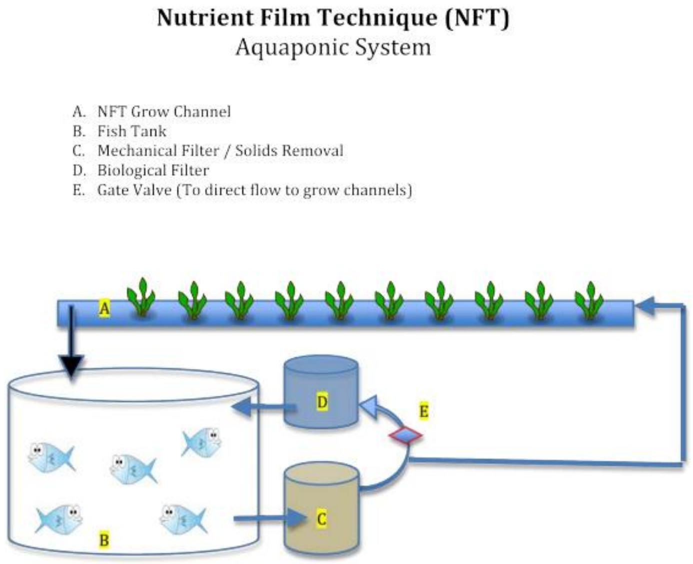

FIG 1 NFT

CONCLUSION

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All of the methods provided in this article make use of sensors, actuators, and other Internet of Things (IoT) devices to control and monitor the environment, and they are described in full in this study. Our goal is to outline an intelligent aquaponic framework that makes use of Internet of Things tools. We also provide diagrams and schemas to help conceptualize the system and provide additional information for when it comes time to create the physical architecture. His goal is to assemble and analyze data from IoT gadgets in order to provide a method of prediction based on Machine Learning Algorithms. But having optimal plant growth isn't enough, so we suggest adding a depth camera module to the proposed system and a mobile app to help keep the ecosystem under check. By contrasting the growing condition with the environment data, we may converge on the best environment, decrease the need for human intervention, and enhance real-time data sharing, all with the help of artificial intelligence provided by machine learning technology.

REFERENCES

1. Kulkarni, Amith A & P, Dhanush & S., Chethan&Shivaswamy, Thamme Gowda & Shrivastava, Dr-Prashant. (2019). A Brief Study on Aquaponics: An Innovative Farming Technology. Indian Journal of Science and Technology. 12. 1-5. 10.17485/ijst/2019/v12i48/149387.

2. Desai, Nivas& Gaikwad, Dattatraya. (2021). Aquaponics: A biointegrated modern farming system.

3. Surnar, Sharad & Sharma, O & Saini, V P. (2015). Aquaponics: Innovative farming. International Journal of Fisheries and Aquatic Studies. 2. 261-263.

4. Singh, Raj & Upadhyay, Sushil & Diwakar, Aggarwal & Sharma, Indu & Affiliation, Nupur. (2020). A Study on Hydroponic Farming System of Wheat, Spinach and Sword Lily for Sustainable Development of Agriculture. Bio Science Research Bulletin. 35. 58-63.

5. Jordan, Rodrigo & Ribeiro, Evaldo& de Oliveira, Fabricio &Geisenhoff, Luciano & Martins, Elton. (2018). Yield of lettuce grown in hydroponic and aquaponic systems using different substrates. RevistaBrasileira de EngenhariaAgrícola e Ambiental. 22. 525-529. 10.1590/1807-1929/agriambi.v22n8p525-529.

6. rences 1. Scagel, C.F.; Lee, J.; Mitchell, J.N. Salinity from NaCl Changes the Nutrient and Polyphenolic Composition of Basil Leaves. Ind. Crops Prod. 2019, 127, 119–128. [CrossRef]

7. 2. CavarZeljkovi´c, S.; Komz ´ áková, K.; Šišková, J.; Karalija, E.; Smékalová, K.; Tarkowski, P. Phytochemical Variability of Selected Basil Genotypes. Ind. Crops Prod. 2020, 157, 112910. [CrossRef]

8. 3. Ciriello, M.; Formisano, L.; El-Nakhel, C.; Kyriacou, M.C.; Soteriou, G.A.; Pizzolongo, F.; Romano, R.; De Pascale, S.; Rouphael, Y. Genotype and Successive Harvests Interaction Affects Phenolic Acids and Aroma Profile of Genovese Basil for Pesto Sauce Production. Foods 2021, 10, 278

9. Corrado, G.; Chiaiese, P.; Lucini, L.; Miras-Moreno, B.; Colla, G.; Rouphael, Y. Successive Harvests Affect Yield, Quality and Metabolic Profile of Sweet Basil (Ocimumbasilicum L.). Agronomy 2020, 10, 830. [CrossRef]

10. 6. Formisano, L.; Ciriello, M.; El-Nakhel, C.; Kyriacou, M.C.; Rouphael, Y. Successive Harvests Modulate the Productive and Physiological Behavior of Three Genovese Pesto Basil Cultivars. Agronomy 2021, 11, 560. [CrossRef]

11. 7. Hosseini, H.; Mozafari, V.; Roosta, H.R.; Shirani, H.; van de Vlasakker, P.C.H.; Farhangi, M. Nutrient Use in Vertical Farming: Optimal Electrical Conductivity of Nutrient Solution for Growth of Lettuce and Basil in Hydroponic Cultivation. Horticulturae 2021, 7, 283. [CrossRef]

12. 8. Walters, K.J.; Currey, C.J. Effects of Nutrient Solution Concentration and Daily Light Integral on Growth and Nutrient Concentration of Several Basil Species in Hydroponic Production. HortScience 2018, 53, 1319–1325. [CrossRef]

13. 9. Nicoletto, C.; Santagata, S.; Bona, S.; Sambo, P. Influence of Cut Number on Qualitative Traits in Different Cultivars of Sweet Basil. Ind. Crops Prod. 2013, 44, 465–472

14. Available online: https://sustainabledevelopment.un.org/ post2015/transformingourworld (accessed on 10 December 2022).

DOI: 10.48047/INTJECSE/V14I1.499 ISSN: 1308-5581 Vol 14, Issue 01 2022 PP: 4067-4074

15. 13. Vittuari, M.; Bazzocchi, G.; Blasioli, S.; Cirone, F.; Maggio, A.; Orsini, F.; Penca, J.; Petruzzelli, M.; Specht, K.; Amghar, S.; et al. Envisioning the Future of European Food Systems: Approaches and Research Priorities After COVID-19. Front. Sustain. Food Syst. 2021, 5, 642787. [CrossRef]