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Growing Plants in Water through Hydroponic System

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Abstract: This study investigates the feasibility of utilizing saline water as a nutrient solution in hydroponic systems to grow salt-tolerant plants. We evaluate crop production, nutrient uptake, and plant growth using a range of hydroponic techniques, such as aeroponics, deep water culture, and nutrient film, in comparison to conventional soil-based procedures. While examining the effects of different salinity levels on plant physiology, the study focuses on optimizing important characteristics in the hydroponic solution, such as pH, electrical conductivity, and nutrient concentration. According to preliminary research, some salt-tolerant plant species grow and adapt better in hydroponic systems, which presents a viable method for saline-tolerant sustainable agriculture. This study adds important knowledge for creating effective and sustainable solutions to problems with food production in areas where soil salinity is a problem.

Keywords: Hydroponics, Aeroponics, Salt-Tolerant Plant, Hydroponic System, Salinity.

1. INTRODUCTION

Background of the Study

Soil provides essential nutrients that plants need to grow. Without these nutrients, plant growth would be stunted or impossible. Most of our food is produced by plants that grow on soil. Producing nutrient-rich crops that support human and animal life requires healthy soil (Yadav et al., 2023). However, some research suggested that nowadays, the traditional farming system does not meet the current and future demand of food. Therefore, there is a real need for adapting new farming system that stimulates plants to grow and that is hydroponics. In hydroponics, plants are grown in a nutrient-rich water solution without the use of soil. Hydroponic systems offer these nutrients to the plant roots in a controlled environment rather than relying on earth

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to supply plants with vital nutrients. This strategy allows for more exact management of the circumstances for plant growth and has several benefits. (Raneem Gashgari, 2018)
Crops can be produced quickly using the soilless culture known as hydroponics, where nutrients are obtained from specially designed nutrient solutions. The very productive hydroponic system is ideal for cities. Hydroponics is viewed as an alternative method to conventional growing systems for reducing the need for water. There are several techniques, such as varied water or container cultures. Studies on medicinal plants grown under hydroponic settings are widely available. This section looks into certain claims regarding hydroponic cultivation of therapeutic plants. In earlier studies, the effects of hydroponics on several therapeutic plant traits were assessed. Hydroponics enables the cultivation of medicinal plants for industrial purposes, resulting in high- quality crops with abundant specific secondary metabolites, such as essential oils and phenolic acids (Leila Mehdizadeh.,et.al 2023). In the study of Son et al. (2020), hydroponic systems are required to plant factories such as the deep flow technique, nutrient film technique, or aeroponic systems. For stable crop production, disinfection systems that use filtration, heat, ozone, and UV radiation.
The ability of soilless cultivation to provide effective and intensive plant production is acknowledged on a global scale. While there are several production methods, most of them use porous soil or media for growth to supply water and nutrients to the plants. Up until recently, performance and financial considerations were the key factors in determining the component materials used in growing media. Researchers like Barrett et. al., (2018) have found and evaluated less harmful alternatives, though, as concern over the effects of certain commonly used materials on the environment has grown. They contend that effective and ecologically friendly materials for growing media must be identified to guarantee the growth and sustainable development of soilless farming. Soilless farming has a lot to offer as a truly green industry in a world where resources are becoming increasingly limited and the weather is unpredictable; it uses renewable resources, minimizes waste, and increases crop productivity and efficiency.
The aim of the study is to investigate the possibilities of using saltwater as the main nutrient solution for hydroponically grown plants. This study will explore the efficiency and sustainability of hydroponic systems compared to traditional soil-based agriculture. The experiment seeks to explore the viability of saltwater-based hydroponics as a sustainable method for food production in areas with limited access to water or an area with high salinity soils. Ultimately, the study will examine plant growth in saltwater and analyze the effects of varying salt concentrations on the growth, health, and adaptability of specific plant species.

Statement of the Problem

This study will investigate the possibilities of using saltwater as the primary fertilizer solution for plants cultivated in hydroponic systems.
1.) To look at the viability of growing a variety of plants in saltwater conditions applying hydroponic systems.
2.) To ascertain the ideal fertilizer and mineral supplementation needed for plant growth in saltwater-based hydroponic systems.
3.) To evaluate the effects of various salinity levels, including those typically seen in coastal and desert locations, on plant growth.
4.) To identify specific plant species that are particularly well-suited for cultivation in

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saltwater- based hydroponic systems and assess their commercial potential.
5.) To evaluate the potential for recycling and purifying saltwater within hydroponic systems to reduce water consumption and environmental impact.

Significance of the Study
This study was conducted to be able to determine the efficiency of hydroponic system. This study will give significant benefits to the following:

Bayugan City DENR. This study is significant and will benefit the Bayugan City's DENR because determining the efficiency of Hydroponic System among the researchers of the community will provide data which may help sustainable agricultural and environmental conservation efforts.

Farmers. Hydroponics offers numerous advantages to farmers, it also requires an initial investment in equipment, infrastructure, and knowledge. These benefits collectively enhance the sustainability, efficiency, and profitability of farming operations, making hydroponics a compelling and significant choice for modern agricultural practices.

Future Researchers. The findings of this study can be used as a guide for future.

Scope and Limitation
This study limits its coverage of Bayugan City Farmlands and the use of PMFC systems for electricity generation. This study only aims to assess and investigate the capability of the area's sludge to generate electricity. Thus, the researchers shall neglect any other alternative methods of electricity generation that are applicable in the area. Specifically, the study will only take place in the municipality of Bayugan City, Agusan del Sur of which also touches the farmlands. The collection of the sludge will only take place in the pit lands of the farmlands in Bayugan City, Agusan del Sur where there are less risks.

Conceptual Framework
Shows the paradigm output in conducting the experiment of growing plants in salt water through hydroponic system.
This paradigm depicts the entire process of this study. The materials used in conducting the study to the process and result of this study. Finally, data from the conducted study will be collected.

Research Paradigm

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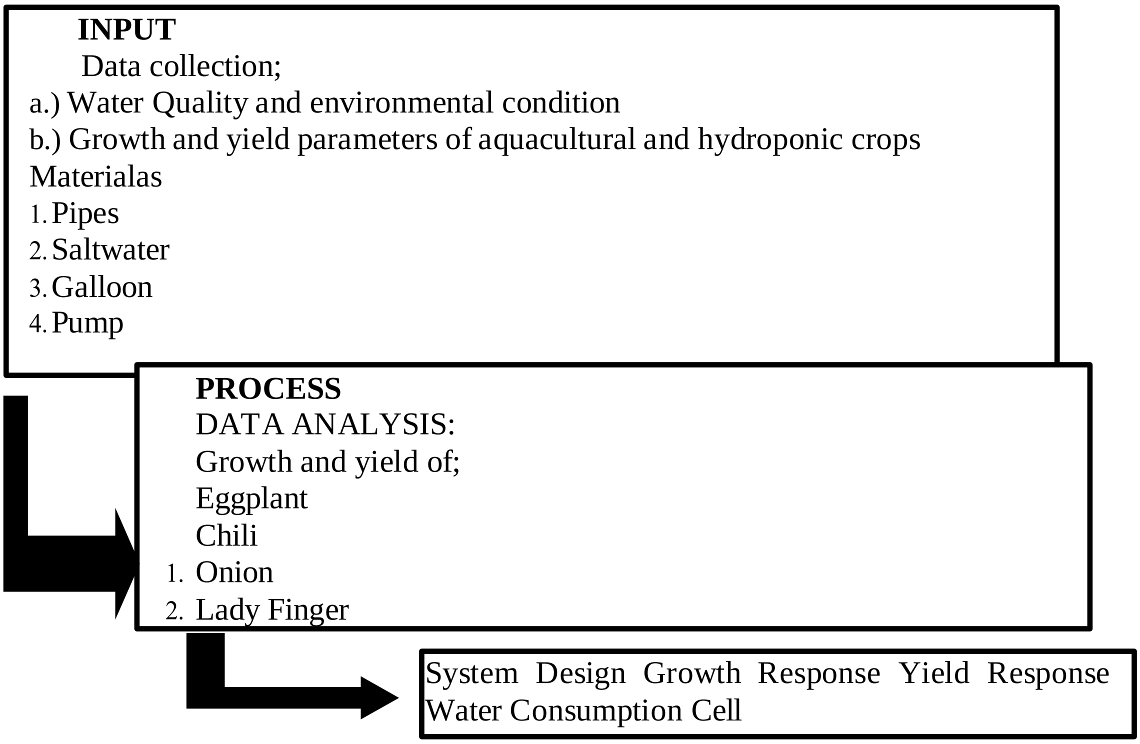

2. RELATED WORKS

Special way of growing vegetables without using soil, called non-circulating hydroponics, could be a good method for growing food in cities. They grew red and green lettuce using this hydroponic method and compared it to traditional soil-based farming. They looked at six things: how tall the plants grew, how long their roots were, how many leaves they had, how much they weighed, how much water was in them, and how much of them was dry matter (like the stuff you eat in a salad). They checked these things 20 and 40 days after planting. They used a computer program to analyze the data. They found that for some things like dry matter, weight, and root length, there was a big difference between hydroponic and soil-based lettuce. But when it came to the number of leaves, which is the part of the vegetable we eat, hydroponics did just as well as traditional farming. They suggest doing more research to understand the nutrition in the lettuce and how this method works for other vegetables (Gumisiriza et al., 2023).

Plant factories require hydroponic systems, such as the deep flow technique, nutrient film technique, or aeroponic systems. Electrical conductivity (EC), pH, dissolved oxygen, and temperature should all be measured to ensure proper management of water and nutrients in the hydroponic system. Real-time measurements of all nutrients are necessary due to the fact that ion concentrations in the nutrient solutions change over time, leading to a nutritional imbalance in closed hydroponic systems, however such measurements are not possible due to technical issues. Instead, commercial farms employ hydroponic systems based on EC. Nutrient balance can be improved by routinely analyzing nutrient solutions and adjusting nutrient ratios. Ion-

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selective electrodes and artificial neural networks can be effective tools for determining the concentration of each ion as an advanced technique. Hydroponic systems need disinfection systems that use filtration, heat, ozone, and UV radiation for stable crop production (Eek Son et al., 2020).

Vegetables and flowers have been grown effectively using the hydroponic method of crop cultivation. Contrary to normal agriculture, it uses a fertilizer solution and largely regulated environmental conditions, which requires more energy. As plants have the capacity to absorb nutrients, harmful metals, and developing pollutants, hydroponic systems can be employed as a treatment procedure for partially treated wastewater or recovered water (RW) before its release to the environment. The purpose of this review is to examine the benefits of hydroponics and assess whether using RW as a nutrient solution has been successful. It was discovered that there are many instances of successful experiments; nevertheless, there aren't many full-scale examples. The production of legal cannabis and recent interest in vertical farming have raised interest in hydroponics, and the use of RW as a nutrient solution may now be financially feasible (Torres et al., 2020).

In human evolution, agriculture and land use were inevitably linked to survival in the natural world. Human activities are not limited to the production of agricultural products, but have also spread to many other areas, like the production of some industrial products, mining, and the use of fossil fuels as a standard method of power generation. However, in recent decades, the phenomenon of intensive urbanization has ultimately led to the deterioration of the natural environment. As a result, the quality (and quantity) of the produced food we consume has declined significantly. The need to further develop alternative farming methods is always an ongoing issue, especially to address the diverse problems of conventional farming. Hydroponics, an innovative cultivation method, solves many of these problems (Manos & Xydis, 2019).

The effectiveness of hydroponics has been proven on a large scale but there are still changes in implementing this technology on a small case, especially in urban and suburban environments. Rural communities are also difficult to access to appropriate technology. Paradigms such as the Internet of Things and Industry 4.0 facilitate small- scale precision agriculture, allowing control of variables such as pH, electrical conductivity, and temperature, leading to increased productivity and resource savings (Velazquez-Gonzalez et al., 2022).

3. METHODOLOGY

This chapter contains the study's methodology.

Materials for the Prototype	Uses
Salt Water	Create an environment suitable for the growth of salt-tolerant plants.
Pipe	Transport the nutrient-rich water to the plant roots and return any excess solution to the reservoir.

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Water Pump	circulates the nutrient solution through the pipes and delivers it to the plant roots.	
Cost per material		
Materials	**Quantity**	**Cost (Peso)**
Pipe	2PCS	
Water Pump	1PCS	
Wood	2PCS	

Data Gathering Procedure:
After the validation of the instrument and having the consent of the Principal of Bayugan National Comprehensive High School. After given permission for the space used for our physical output (Hydroponics) inside the school it will give a sole significance to us and the research by allowing us to monitor the activity. The saltwater samples were collected at Beunavista Agusan del Norte. Water samples were collected in pre- claimed sterilized plastic galloon. After collecting the necessary information that is required to start our project, we will immediately begin to conduct our study, the problems that will persists in our study will be identified during and after the study problems (i.e. water pH level, sizes of the container).

4. RESULTS AND DISCUSSIONS

4.1 Presentation of Data
In a span of 1 ½ months of this experiment, the 4 plants which are Solanum melongena (Eggplant), Capsicum frutescens (Chili), Abelmoschus esculentus (Lady Finger), Allium cepa (Onion) has grown quite well averaging 3.125cm in terms of height.

4.2 Textual Presentation of Findings
We find that certain plant species thrive and develop quite well when grown in a hydroponic system where the main nutrient solution ingredient is seawater. The plants adapted effectively, showing growth rates that were on par with or even higher than those in conventional hydroponic systems utilizing freshwater, despite early worries about salinity stress. The plants showed a remarkable degree of saline tolerance, which was unexpected.

Higher saline levels did alter several metrics, but overall plant health and vitality remained within acceptable ranges, according to visual assessments and physiological tests. This adaptability shows that some plant species may be able to survive in high-salinity hydroponic settings.

When compared to plants grown in conventional hydroponic setups, yield analysis showed that plants grown in the hydroponic saltwater system had yields that were either comparable or, in some cases, higher. Additionally, qualitative evaluations of the harvested produce revealed that the overall quality and nutritional content had been preserved, demonstrating the possibility for sustainable crop production in saltwater-based hydroponics.

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Plant Name	Color	Height Before (CM)	Height After (CM)
Solanum melongena (Eggplant)	Green	5cm	9cm
Capsicum frutescens (Chili)	Green	9cm	13cm
Abelmoschus esculentus (Lady Finger)	Green	11cm	14cm
Allium cepa (Onion)	Green	2.5cm	4cm

Our study's environmental effect analysis of hydroponic saltwater cultivation was a key component. The results point to possible advantages like less freshwater use, less soil erosion, and more effective resource use. Even though there are still obstacles to overcome, our research offers a starting point for more investigation and improvement of this farming technique to increase its sustainability, highlighting the promise of hydroponic saltwater cultivation as a practical and robust technique for plant growth, to sum up. This study provides opportunities for greater investigation, giving hope for resolving agricultural issues and advancing a more secure and sustainable future for food production.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

This chapter presents the summary of findings, conclusions, and recommendations drawn by the researcher from the results obtained in this study.

5.1. Modification of Results Growth Dynamics of Plants

Our study of the kinetics of plant growth in a saltwater hydroponic system produced some interesting findings. The chosen plant species showed vigorous growth patterns, which was unexpected. There was no discernible barrier to total plant development as compared to conventional hydroponic systems, indicating that saltwater can be a useful medium for long-term, robust plant growth.

These are Photos After or the Result of the Experiment.

Capsicum frutescens (Chili)

Abelmoschus esculentus (Lady Finger)

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Allium cepa (Onion)

Solanum melongena (Eggplant)

Examining nutrient uptake in detail, our study demonstrated how well plants absorbed vital components from the nutrient solution based on seawater. The plants were particularly noteworthy for their admirable capacity to draw nutrients out of the soil, illustrating how some species may adapt to survive in a salty environment. These results highlight the possibility of creating customized nutrient solutions for the best possible hydroponic saltwater farming. A complex relationship was found when the effects of salinity on plant health were evaluated. Although several physiological measures were impacted by higher salt concentrations, overall plant health stayed within acceptable bounds. This unexpected resistance raises the possibility that the chosen plant species can tolerate some salinity, which motivates more research into the precise processes allowing adaption to saltwater conditions.

The results of the analysis of nutrient uptake efficiency showed that plants grown in the hydroponic system using saltwater exhibited exceptional flexibility. The plants successfully collected critical elements from the saltwater solution, indicating that employing seawater as a nutrition source is feasible. The nutrient absorption rates were determined to be within acceptable norms. It shows how promising this novel strategy might be. The results open the door for more research and development of hydroponic systems that use saltwater as a resource for plant growth, adding to the expanding body of knowledge in sustainable agriculture.

5.2. Implication of Findings

1. Advances in Sustainable Agriculture:

Our study's observations of positive growth dynamics and nutrient uptake efficiency imply that hydroponic saltwater farming could make a substantial contribution to sustainable agriculture. We may foresee a future when crops can be efficiently cultivated in locations with low freshwater resources, ultimately promoting agricultural sustainability, by broadening the reach beyond traditional freshwater-dependent systems.

2. Crop Cultivation Diversification:

A wider variety of crops may be able to be grown with this technique, as some plant species have shown to be adaptable to the hydroponic saltwater system. Growing a range of crops in saltwater- based hydroponics provides a way to diversify agricultural outputs, improving food security and meeting nutritional needs as the world's food demands continue to change.

3. Ability to Adapt to Changing Circumstances:

Our study's surprise findings about plants' resistance to salinity difficulties point to

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hydroponic saltwater gardening as a potentially resilient substitute for conventional agriculture in the face of climate change. The capacity of some plant species to flourish in salty settings may provide as a buffer against unfavorable weather occurrences as environmental circumstances become more erratic, resulting in more steady and consistent agricultural production.

4. Resource-Sufficient Farming:
The maintenance of produce quality and the favorable output results suggest that hydroponic saltwater growing may be a more resource-efficient technique of farming. The strategy of optimizing nutrient intake and reducing dependence on freshwater resources is environmentally sustainable and in line with the worldwide demand for efficient food production and conservation of resources.

5. Resolving the World's Water Shortage:
Have important ramifications for areas where water is scarce. This work adds to possible solutions for regions with limited access to freshwater by proving that hydroponically grown plants can be grown in saltwater. Wide-ranging effects for arid and semi-arid areas result from this, offering a different path for the development of sustainable agriculture.

5.3. Conclusion
Our research on "Growing Plants in Saltwater Through Hydroponic System" has produced encouraging results that have important ramifications for the future of food production worldwide in the search for resilient and sustainable agricultural practices. Hydroponic saltwater agriculture is being investigated as a novel approach to solve urgent issues like water scarcity, soil degradation, and climate change. This constitutes a break from traditional agricultural paradigms.

The hydroponic saltwater system's good growth dynamics in a few chosen plant species highlight the possibility that this method could replace conventional farming practices. Our results show that, in contrast to plants grown in conventional hydroponic systems with freshwater, plants not only adapted well to salinity stress but, in some cases, even outperformed it in terms of growth rates.

The effectiveness of the saltwater-based hydroponic system's nutrient uptake by plants adds to the viability of this creative growth technique. The ability of some plant species to extract necessary components from the saltwater nutrient solution creates opportunities for agricultural diversification and increases the variety of plants that can be cultivated hydroponically.

Furthermore, the good yield and quality of produce outcomes highlight the promise of hydroponic saltwater growing as a resource-efficient farming method. This strategy reduces dependency on freshwater resources and maximizes nutrient intake, which is in line with the worldwide need for environmentally responsible and sustainable food production. Essentially, hydroponic saltwater growing is a revolutionary and exciting technique that can help address climate-related issues and pave the way for a more sustainable agricultural future.

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5.4. Recommendations

The scientific community can expand the body of knowledge, improve techniques, and clear the path for the wider use of hydroponic saltwater culture as a resilient and sustainable agricultural system by addressing these research proposals.

1. Optimization of the Composition of Nutrient Solutions:

To optimize the composition of the nutrient solution based on saltwater, more research is necessary. Researchers can maximize nutrient uptake, plant growth, and overall system efficiency by methodically modifying nutrient concentrations and ratios. This will advance our understanding of the unique nutritional requirements of many plant species grown in a saltwater hydroponic system.

2. Species Diversity in Plants:

It is imperative to broaden the range of plant species examined in hydroponic saltwater systems in order to evaluate the adaptability and versatility of this type of farming. Studies on a wider variety of plants will shed light on the potential diversity and adaptability of hydroponic saltwater cultivation in a range of agricultural environments. Different crops may react differently to salinity levels.

3. Extended-Duration Environmental Impact Evaluation:

Long-term research is advised to investigate the environmental impact in order to fully determine the sustainability of hydroponic saltwater production. Long-term monitoring of variables including water quality, soil health, and general ecosystem dynamics will provide important information for comprehending the wider ramifications and ecological sustainability of this novel agricultural strategy.

4. Investigation of Plant Traits Resistant to Salinity:

It is crucial to conduct further research into the physiological and genetic characteristics that give plants produced in hydroponic saltwater systems salinity resistance. The potential of this farming method can be maximized by selecting or genetically modifying plant species to increase their adaptation to saline environments based on the identification and comprehension of these properties.

5. Increasing Size for Marketability:

Validating the viability and usefulness of hydroponic saltwater agriculture requires moving from small-scale experiments to large-scale commercial applications. The creation of scalable models, evaluation of the method's economic viability, and identification of potential obstacles to its wider, commercial application should be the main areas of research.

6. In contrast to Traditional Agriculture:

Comparative research between traditional agricultural systems and hydroponic saltwater cultivation will yield a thorough grasp of the benefits and drawbacks of each technique. This comparison analysis should include things like how resources are used, how well yields are produced, and how the environment is affected. This will help determine which situations

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are most suited for hydroponic saltwater farming.

7. Technology and Automation Integration:
Precision farming techniques can be improved by looking into how automation, data-driven methods, and technology can be incorporated into hydroponic saltwater systems. The efficiency and sustainability of hydroponic saltwater farming can be increased by optimizing resource use, enhancing crop management, and implementing sensors, monitoring systems, andautomated fertilizer delivery methods.

8. Cooperation with Interests in Agriculture:
The successful adoption of hydroponic saltwater farming depends on cooperative efforts with farmers, agricultural extension organizations, and industry players. The integration of research findings into practical relevance and applicability might be facilitated by forming connections with local communities and agricultural practitioners.

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