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# Comparison of Conventional Method of Farming with Hydroponics and Aeroponics

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**ABSTRACT:** The needs of sources create a search for new urge for necessity things such as in food, environment and living standards. One such need is food which is most important part of living. Source of food and their cultivation method varies from ancient days such as conventional farming method which is also called as traditional farming method. With a developing technology, a new approach has been made in food technology i.e., hydroponic and aeroponics farming methods. It is one of the conscience methods of growing foods crops in small scale system where it utilizes a surrounding environment with available materials and chemical materials for growth of crops. Hence forth in this project a novel approach has been carried out systematically. In this present study reveals that all three cultivation methods showed successive growth in the selected crops, with coriander achieving the maximum height after 35 days and spinach having the lowest height in conventional and aeroponic methods. Among all cultivation methods, the number of leaves increased as plants matured, and coriander which have the highest leaf count, especially in hydroponics method. Hence, there is also increase in the crop weight from the initial measurement to the final measurement in all methods, with hydroponics showing potential for higher crop weights, particularly in coriander. Finally all selected crops exhibits good to excellent health in all cultivation methods, with aeroponics consistently resulting in excellent plant health, followed by hydroponics and conventional farming. Water consumption varied significantly among the methods, with hydroponics and aeroponics displaying more efficient water usage than conventional farming, and the lowest water consumption was observed in aeroponics, highlighting potential for sustainable water use in alternative cultivation methods.

**KEYWORDS:** Conventional farming, Hydroponic and Aeroponic, soil – less culture.

## I. INTRODUCTION

Conventional farming, hydroponics, and aeroponics are three diverse approaches to agriculture, each with its own unique characteristics and advantages. Conventional farming, the age-old method of planting in natural soil, relies on traditional farming practices and vast expanses of land to grow crops and raise livestock. Hydroponics, on the other hand, is a modern technique that cultivates plants without soil, instead using nutrient-rich water solutions in controlled environments to optimize growth and conserve resources. Meanwhile, aeroponics represents the cutting edge of agriculture, suspending plants in the air and misting their roots with nutrients, offering unparalleled resource efficiency and sustainability. The choice among these methods depends on factors such as available resources, environmental considerations, and the specific needs of agricultural operations, highlighting the dynamic nature of food production in today's world.

Conventional farming is the traditional method of cultivating crops and raising livestock in natural soil, typically outdoors. It relies on the synergy of sunlight, rainwater, and nutrient-rich soil to support plant growth. Seeds or young plants are sown directly into the ground, where they develop roots and extract essential nutrients. Conventional farming has been the predominant form of agriculture for centuries, but it can be resource-intensive and may involve the use of pesticides and fertilizers. Efforts are ongoing to make conventional farming more sustainable through practices like precision agriculture and organic farming methods.

“Hydroponics is a method of growing certain plants and vegetables without soil instead of plants are grown in solution composed of nutrients in water solvents.”

Hydroponics, derived from Greek words meaning "water-working," is an agriculture method that doesn't use soil. Plants receive essential nutrients dissolved in water, mimicking their natural environment. It has historical roots in civilizations like the Babylonians, Egyptians, and Aztecs, and even sprouting seeds is a form of hydroponic agriculture. Hydroponic systems find wide use in education, research, personal gardening, and the cultivation of various crops, including tomatoes, potatoes, spinach, lettuce, strawberries, cucumbers, and roses. Large-scale hydroponic systems, such as those described by Wheeler et al. (2001), offer a cost-effective means to study potato physiology at the whole-plant level. These systems provide easy access for physiological and anatomical research, making them ideal for investigating tuber initiation (Jesse et al., 2019). Most modern hydroponic systems operate automatically, controlling nutrients, lighting, and water volume based on plant needs.

## II.LITERATURE WORK

Many researchers/authors have made attempt to develop this method of farming. Following paragraph provide a brief review on literature related to hydroponics and aeroponics methods of farming.

**Mamat D. S, et al. (2013)**, in their paper entitled "A Review On Plant Without Soil – Hydroponics" oil-less cultivation techniques like hydroponics and aeroponics provide efficient and controlled environments for plant growth by delivering essential nutrients and water directly to the roots, an intrusive for traditional soil method. Population growth and urbanization decrease per capita land availability for traditional agriculture. Climate change, soil fertility limits, and water scarcity further threaten food production. Soil-less culture offers a space and water-efficient alternative, but challenges like setup costs and crop suitability must be considered for sustainable agriculture. Soil, while essential for plant growth, has limitations like disease presence, unsuitable conditions, and labour-intensive requirements. Soil-less culture, or hydroponics, offers a solution, allowing plants to grow in mineral nutrient solutions without soil. This method is particularly useful in areas with soil scarcity, challenging geographical conditions, and a shortage of labour for traditional agriculture.

**Vandan B R et al. (2017)**, it has been explained "An experimental study of crop growth for conservation of land and water in hydroponics: a soil-less system" the hydroponic cultivation of vegetables not only conserves water but also maximizes crop yields in a controlled environment. A discusses on the rapid advancement of technology in today's world and its negative impacts, particularly the scarcity of water and the loss of fertile land due to concrete structures, it highlights the emergence of hydroponics as a technology that can address these issues by using soilless cultivation methods and reducing water consumption. It also provides a brief history of hydroponics and describes an experimental study conducted with different crop seeds using the nutrient film technique (nft) hydroponic system. The study monitored factors such as pH and total dissolved salts to optimize crop growth. Overall, it emphasizes the potential of hydroponics to address water and land conservation challenges in agriculture. The study using the NFT hydroponic system showed faster, healthier plant growth and increased yields compared to traditional methods. For a 1-acre hydroponic setup covering 43,560 sq.ft, the daily water requirement was approximately 4,048.9 litres.

**Vandana B R et al. (2017)**, in their paper entitled "A Review on Comparison between Hydroponics & Conventional Method of Growing for Conservation of Water & Land" a soil-less cultivation method, enables efficient plant growth by providing essential nutrients in a carefully managed water-based system. Human progress and rapid urbanization have led to negative consequences, including reduced land availability for agriculture and water pollution. Soil-less agriculture, which doesn't rely on traditional soil and incorporates water-efficient methods, is emerging as a solution to these challenges. Soil is vital for plant growth but can introduce issues like disease and pollution. Conventional soil-based farming faces challenges in urbanized areas with limited resources, leading to the exploration of soil-less methods like hydroponics and aeroponics. Soil-less cultivation is set to thrive, particularly in urbanizing countries like India, where land and water scarcity are pressing issues. Government support can further drive its adoption.

**Nisha Sharma et al, (2018)**, in their paper entitled "Hydroponics as an advanced technique for vegetable production" The Nutrient Film Technique (NFT) is a hydroponic system known for efficient nutrient management and water conservation, contributing to its growth in the hydroponic market. In 2018, hydroponic cultivation gained global popularity due to efficient resource management and food quality. Soil-based agriculture faced challenges like urbanization, natural disasters, and chemical use, depleting land fertility. This article discusses various hydroponic systems, their benefits (e.g., year-round production, minimal pests), and significant water savings (70-90%) while highlighting leading countries in hydroponic technology. Hydroponics is a soilless plant-growing technique coined by Professor William Gericke in the 1930s. It's gaining popularity globally due to efficient resource use, supporting

various crops and a growing hydroponic market. In recent years, hydroponics has emerged as a promising approach for year-round cultivation, particularly for short-duration crops like vegetables, even in limited spaces and with minimal labour requirements. This technology can significantly benefit areas with soil and water limitations, as well as underserved communities. In India, the hydroponic industry is poised for substantial growth. Encouraging commercial hydroponic farms will require the development of cost-effective technologies that reduce labour dependency and lower both start up and operational costs.

**Reena Kumari et al., (2019)**, studied on “Modern Agriculture Technology” Aeroponics, a soilless farming method, offers precise control over plant nutrition and efficient resource use, making it a promising solution for future food production challenges. Its vertical farming approach and disease-free propagation have made it commercially viable for various crops, including tomatoes and leafy greens. Aeroponics research dates to the 1920s and was initially more of a research tool than a practical farming method. Notable milestones include W. Carter's work on air culture in 1942 and the first commercial aeroponics system, the Genesis Rooting System, in 1983. NASA's experiments conducted in 1990 demonstrated its productivity, and the system has numerous benefits, such as year-round cultivation, fast plant past growing, and reduced water and mineral usage. Aeroponics is a novel approach to agriculture that offers various advantages, including disease-free produce and efficient resource utilization. However, it requires careful monitoring and maintenance to ensure optimal plant growth.

**Mazhar H. Tunio et al., (2019)**, in their paper entitled “Potato production in aeroponics: An emerging food growing system in sustainable agriculture for food security” analysed on Aeroponics, utilizing ultrasonic atomization to deliver a nutrient solution, offers a soilless and efficient method for potato production and various other crops in a controlled environment. This passage discusses the global production of potatoes and their nutritional value, highlighting the importance of improving potato cultivation techniques, particularly in developing countries, and introduces the concept of aeroponics as a soilless cultivation method to address challenges related to soil quality, diseases, and water scarcity in potato production. Its soilless cultivation treatment similar to hydroponics but distinct in its use of fine droplets of nutrient solution to support plant growth, offering numerous advantages for efficient potato production and has a history dating back to the 1920s when it was initially used for root physiology research, eventually evolving into a commercial cultivation method with the introduction of the Genesis rooting system in 1983. Aeroponics is a game-changing system for potato production, addressing food security challenges in resource-constrained regions with its exceptional yield increases and disease control. Its versatility also extends to the cultivation of various vegetables, promising sustainable agriculture solutions.

### III.MATERIALS & METHODOLOGY

Fundamental Requirements of Conventional , Hydroponics and Aeroponics:

Germinating Medium: The substrate used in hydroponic cultivation is inert and does not provide any nutrients to the plants. Its main purpose is to provide a foundation for the roots to grow in. Various types of growing mediums are available for hydroponic plant growth, including Coco coir fiber, Rockwool, Perlite, Vermiculite, LECA (Lightweight Expanded Clay Aggregate), expanded clay, Crushed rock, Sand, Scoria, and Gravel. These growing mediums allow us to control the nutrient supply accurately and monitor the pH levels within a hydroponic system and aeroponic system additionally, using a growing medium other than soil offers several advantages." That includes

1. Abhorrence of root penetrations
2. Sustenance of palatable oxygen and water
3. Extended air course and draining

#### Germination:

For conventional farming, 18 cubes of coco peat were employed as the growing medium. In this setup, six selected seeds each of Spinach, Lettuce, Coriander, and Red Amaranth were placed within the coco peat cubes. Adequate holes were made at the base of these cubes to ensure proper water drainage and prevent overwatering, thereby avoiding plant dehydration. As time progressed, the seeds in the coco peat cubes germinated and developed into mature plants.



Detailed records were maintained, documenting the growth progress, and regular measurements were taken to monitor the plant's health. Photos were also captured to track their development.

For hydroponic cultivation, 18 blocks of Rockwool were used as the growth medium. Similar to the conventional setup, the Rockwool blocks were equipped with holes at the base to facilitate proper drainage. Six seeds each of Spinach, Lettuce, Coriander, and Red Amaranth were placed in these Rockwool blocks. Over time, the plants in the hydroponic system began to sprout and grow. Continuous monitoring and data collection were performed to assess their growth parameters and overall health, including regular photographic documentation.

"In the case of aeroponic cultivation, a distinct approach was taken. Twelve selected seeds each of Spinach, Lettuce, Coriander, and Red Amaranth were used for observation. These seeds were placed in a specialized aeroponic chamber, where the plant roots were suspended in air and periodically misted with a nutrient-rich solution. This method allowed for a unique growth environment where the plants received nutrients directly through misting. As time passed, all four plant varieties exhibited signs of germination and growth within the aeroponic system. Detailed records were meticulously maintained, including measurements of various growth parameters, and images were captured regularly to monitor their development.

**Table. 1.1 Materials Properties of Conventional, Hydroponic & Aeroponics**

Sl. No	Materials Required	Conventional Farming	Hydroponics	Aeroponics
1	<b>Growing Medium</b>	Soil-based; crops grow in natural soil.	Soilless; crops grow in nutrient-rich water or other inert growing mediums like perlite, coco coir, or vermiculite.	Soilless; plants are suspended in air, with roots periodically misted with nutrient solution.
2	<b>Water usage</b>	Generally higher water usage due to natural soil irrigation.	More efficient water usage as water is recirculated in a closed system.	Extremely efficient water usage, with misting reducing water consumption significantly.
3	<b>Growth Speed</b>	Slower growth compared to hydroponics and aeroponics due to nutrient availability limitations in soil.	Faster growth due to direct nutrient delivery to plant roots.	Similar to hydroponics, rapid growth due to efficient nutrient and oxygen delivery.
4	<b>Space Requirements</b>	Requires more space for crops as they spread roots in soil	Compact systems; suitable for limited space and vertical farming.	Space-efficient; plants can be stacked in vertical towers
5	<b>Environmental Impact</b>	May have higher environmental impact due to pesticide use, water runoff, and soil degradation.	Generally more resource-efficient, but the production of nutrient solutions can have environmental considerations.	Highly resource-efficient; minimal environmental impact, especially regarding water usage.

IV.EXPERIMENTAL WORK

The study to design the low-cost pilot scale self-watering hydroponic system and to study the effect of well water on plant growth is carried out in the proper procedure of two different methods, i.e., Conventional method i.e., hydroponic system and aeroponic method by using water. Results of the study are discussed below using graphical representation

The Parameters of Crop Growth and Plant Growth

1. Plant height
2. Number of Leaves
3. Final weight of the plant
4. Plant Health
5. Water Consumption

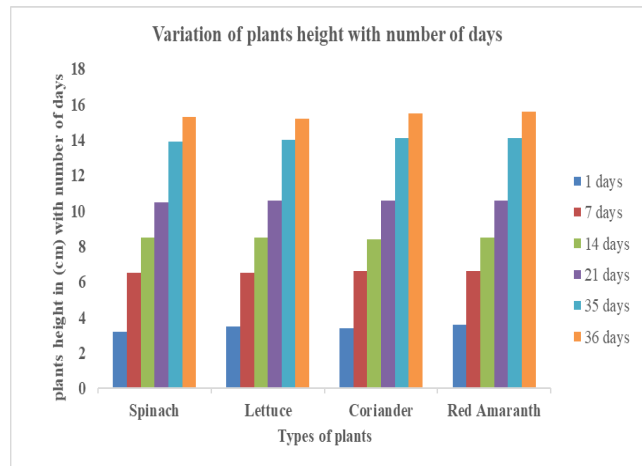
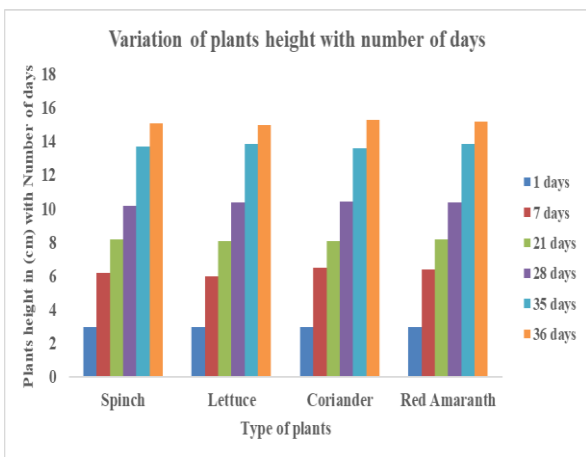


Fig 1. Conventional Method of plant height

Fig 2. Hydroponics Method of plant height

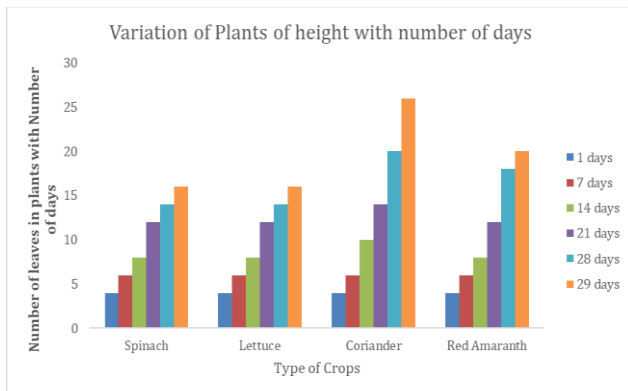
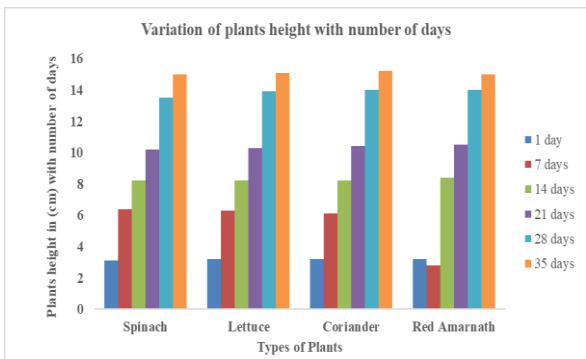


Fig 3. Aeroponic Method of Plant height

Fig 4. conventional Method of No. of Days

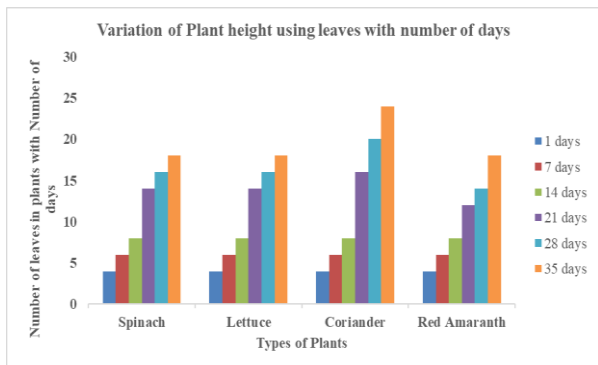


Fig 5. Hydroponics Method of Number of Days

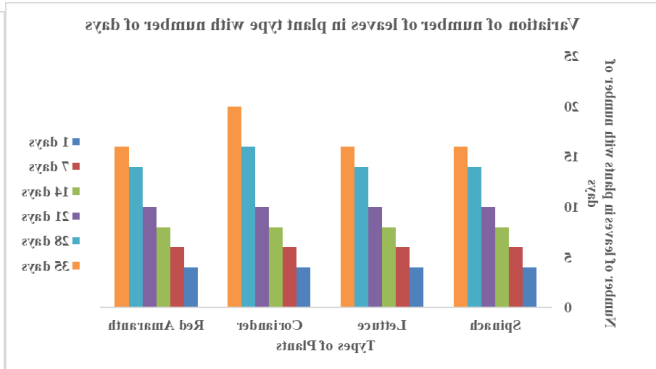


Fig 6. Aeroponic Method of Number of Days

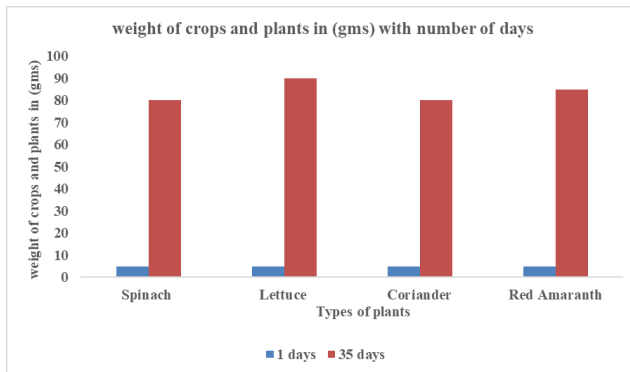


Fig 7. conventional Method of weight of crops and plants

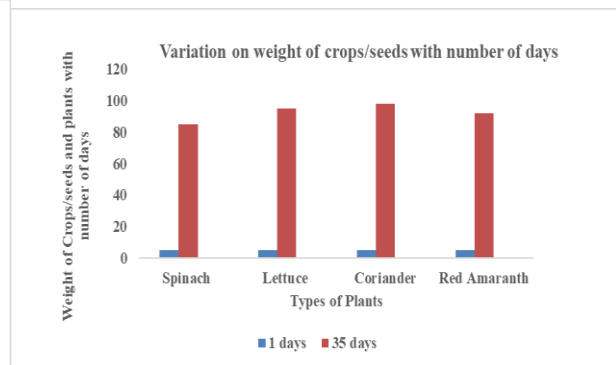


Fig 8. Hydroponics Method of weight of crops and plants

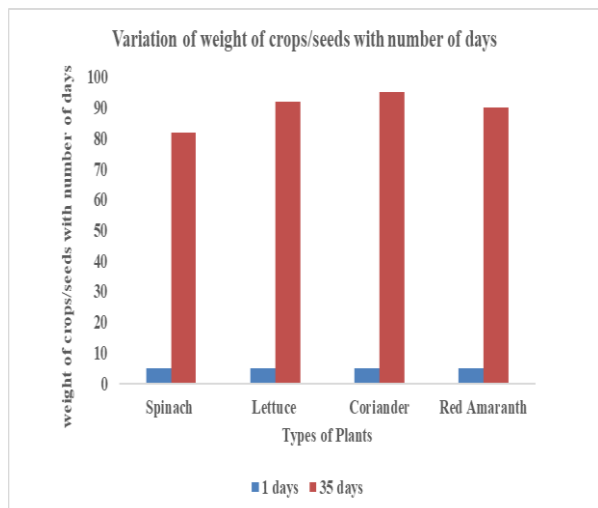


Fig 9. Aeroponic Method of weight of crops and plants

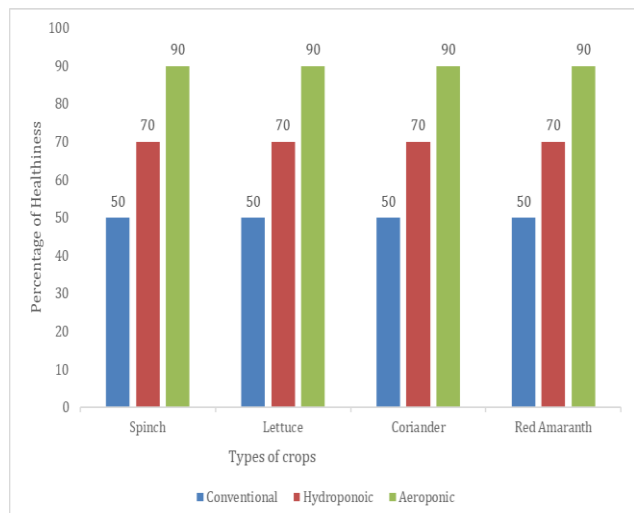
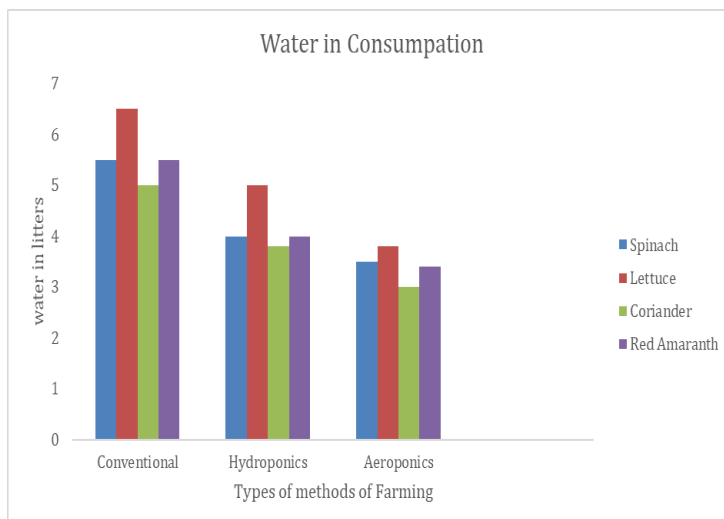


Fig 10. Plants Healthiness



**Fig 11. Water Consumption of plants by Conventional, Hydroponics & Aeroponics Method**

As per above graphical representation maximum height has been achieved by Coriander & Amaranth for the conventional, hydroponic & Aeroponic method of farming when use water as source at 35 days as shown in fig 1, 2 & 3 method using water. No. of leaves of coriander plant has higher number of leaves by Hydroponic and aeroponic as shown in fig 4, 5 & 6 method using water. The above chart shows the weight of lettuce seeds and Coriander crop/seeds has a highest weight than other crops in Hydroponic method using water as shown in fig 7, 8 & 9. The results of checking for plant healthiness in conventional farming, hydroponics, and aeroponics indicated consistently good to excellent health for spinach, lettuce, coriander, and Red Amaranth across all three cultivation methods, with the highest level of healthiness observed in the aeroponic system. The data reveals that hydroponics and aeroponics generally require less water compared to conventional farming for the same crops as shown in fig 11.

## V. CONCLUSION

From the experimental investigation which carried out for hydroponic, conventional and aeroponic farming method following conclusions can be drawn.

1. The study revealed that all three cultivation methods showed successive growth in the selected crops, with coriander achieving the maximum height after 35 days and spinach having the lowest height in conventional and aeroponic methods.
2. Across all cultivation methods, the number of leaves increased as plants matured, and coriander consistently had the highest leaf count, especially in hydroponics.
3. There was a significant increase in crop weight from the initial measurement to the final measurement in all methods, with hydroponics showing potential for higher crop weights, particularly in coriander.
4. All selected crops exhibited good to excellent health across cultivation methods, with aeroponics consistently resulting in excellent plant health, followed by hydroponics and conventional farming.
5. Water consumption varied significantly among the methods, with hydroponics and aeroponics displaying more efficient water usage than conventional farming, and the lowest water consumption was observed in aeroponics, highlighting potential for sustainable water use in alternative cultivation methods.



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