International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Smart Fogponics Gardening System In Urban Cities

Prof. Prutha.G[1], Darshan U[2], Hemanth Gowda R[3], Manyaraj N[4], Meghan Gowda BS[5]

[1]Asst. Professor, Electrical & Electronics, RajaRajeswari College Of Engineering
[2,3,4,5]UG Students, Electrical & Electronics , RajaRajeswari College Of Engineering

A B S T R A C T :

The Smart Fogponics Gardening System is an advanced soilless cultivation technology designed to address the challenges of food production in densely populated urban cities. Fogponics uses ultra-fine nutrient mist to deliver water and essential minerals directly to plant roots, enabling faster growth, higher yields, and efficient resource use. This project integrates Arduino-based automation with sensors such as an EC sensor, DHT11 temperature–humidity sensor, artificial grow lights, and a nutrient control unit to maintain ideal growing conditions. Real-time monitoring and automated adjustments help reduce water consumption, minimize human intervention, and ensure consistent plant health. The system provides a sustainable solution for urban agriculture by enabling residents to grow fresh vegetables and herbs in limited spaces such as balconies, rooftops, and indoor environments. Overall, the Smart Fogponics Gardening System demonstrates a modern and eco-friendly approach to improving food security, reducing environmental impact, and promoting self-sustainable urban living.

Keywords:
- Smart fogponics
- Urban farming
- Soilless cultivation
- Nutrient mist technology
- Arduino-based automation

1. Main text

Urban cities face major challenges such as limited land availability, poor soil quality, rising food demand, and reduced access to fresh and healthy produce. To overcome these issues, modern farming techniques like fogponics offer an innovative and space-efficient solution. Fogponics is an advanced form of aeroponics where plant roots are supplied with a nutrient-rich mist, allowing them to absorb water, nutrients, and oxygen more efficiently than in soil-based farming. This leads to faster plant growth, higher yield, and reduced resource consumption.

The Smart Fogponics Gardening System combines this growing method with automation and sensor-based monitoring to create a reliable urban farming model. Using components such as Arduino Uno, EC sensor, DHT11 sensor, artificial lighting, and automated foggers, the system maintains ideal environmental conditions for plant growth. It continuously measures humidity, temperature, nutrient concentration, and light levels, adjusting the system in real-time to ensure optimal plant health.

This technology enables urban households, apartments, and communities to grow vegetables and herbs in compact spaces like balconies, rooftops, and indoor setups. By offering a clean, efficient, and sustainable approach to agriculture, the Smart Fogponics Gardening System supports self-sufficiency, reduces dependence on market produce, and contributes to a greener urban environment.

1.1. Problem Statement :

Although fogponics is considered one of the most advanced soilless growing techniques, its practical application remains limited due to challenges such as unstable fogger performance, inconsistent nutrient delivery, high energy consumption, and the need for frequent maintenance. Many growers also lack clear guidelines on optimal nutrient concentration, droplet size, and system design, resulting in variable plant growth outcomes. Without addressing these limitations, fogponics cannot reach its full potential as a highly efficient and sustainable method for modern agriculture. Therefore, a systematic investigation is needed to evaluate the efficiency, reliability, and practicality of fogponic systems in comparison with other soilless cultivation methods.

1.2. Literature review :

[1].A. S. Basker & A. S. Bhoey – "Hydroponics: A Promising Technology for Food Production" (2025)

This paper highlights the potential of hydroponics as an effective alternative to traditional farming. The authors explain how hydroponic systems can increase crop yield, conserve water, and require less space, making them suitable for modern urban agriculture. The study discusses the advantages of controlled nutrient delivery and the ability to grow plants without soil. Overall, the paper provides strong foundational knowledge for developing automated systems in soilless farming.

[2]. Subhas Adak – "Smart Agriculture with NPK Sensor" (2025)

This research focuses on incorporating NPK (Nitrogen, Phosphorus, Potassium) sensors in agriculture to improve nutrient management. The author explains how monitoring NPK values helps farmers maintain soil or nutrient solution balance, which directly improves plant growth and productivity. The paper also discusses automation in smart farming and shows how sensors can be used to optimize nutrient supply, reduce fertilizer waste, and enhance crop quality.

[3]. A. Indu S. & Maresh Kumar – "An Approach for Monitoring Indoor Farming Systems Using DHT11 Sensor" (2022)

In this study, the authors use the DHT11 sensor to monitor temperature and humidity inside an indoor growing environment. The paper highlights the importance of maintaining stable environmental conditions for plant health. It explains how sensors help automate data collection and enable better decision-making in controlled agriculture. This research supports the use of IoT-based monitoring in systems such as fogponics, hydroponics, and aeroponics.

[4]. Tanvi Verma – "Optimizing Indoor Farming Using LED Lighting and Predicting Plant Biomass Using CNN Model" (2024)

This paper presents a model using Convolutional Neural Networks (CNNs) to predict plant growth and biomass. The author also studies the effectiveness of LED lighting for improving plant performance in indoor farms. By adjusting spectral light output and analyzing plant images, the system can optimize growth rates. This study is useful for projects involving light-based plant growth control and advanced data-driven monitoring.

[5]. C. Acurui – "Enhancing Underwater Image Quality for Monitoring Submerged Fogger Systems" (2012)

This research proposes techniques for improving underwater image clarity, mainly for systems where foggers or submerged devices operate. The paper introduces restoration methods to remove noise, blur, and distortions that occur underwater. Although older, the study provides valuable insights for those monitoring submerged foggers in fogponics or aquaponics setups. Clear imaging helps in diagnosing fogger performance, detecting blockages, and ensuring uniform mist distribution

Existing System

Existing urban farming systems mostly rely on traditional soil-based methods or basic hydroponics setups with limited automation. Many households use small hydroponic units that provide nutrient-rich water but lack precise control over humidity, nutrient concentration, and root oxygenation. Aeroponics systems are available in some advanced urban farms, but they often require high maintenance and skilled operation. Commercial indoor gardens like Plantaform use fog-based nutrient delivery, but these models are expensive and designed for small-scale home use. Vertical farming units exist in some cities, but they usually depend on hydroponics rather than fogponics. Current systems do not fully integrate sensors such as EC, temperature, and humidity sensors for real-time monitoring. Most setups lack smart controllers like Arduino or IoT connectivity for automatic adjustments. Water and nutrient wastage is still common due to inefficient circulation systems. Overall, existing systems provide basic soilless farming but do not combine fogponics with automation for optimal plant growth in limited urban spaces.

1.3. Proposed system

The proposed Smart Fogponics Gardening System introduces an automated soilless cultivation method that delivers nutrient-rich mist directly to plant roots for faster and healthier growth. The system uses an Arduino Uno as the main controller to manage sensors and actuators. An EC sensor continuously measures nutrient concentration and adjusts the solution automatically. A DHT11 sensor monitors temperature and humidity to maintain the ideal environment for plant development. Artificial grow lights ensure proper photosynthesis even in low-light urban spaces. Ultrasonic foggers generate fine mist, enhancing oxygen supply and nutrient absorption. The system includes a water pump and closed-loop reservoir to minimize water usage. Real-time monitoring and alerts can be enabled through IoT or mobile applications. This smart approach reduces manual work, increases efficiency, and supports sustainable food production in compact urban areas.

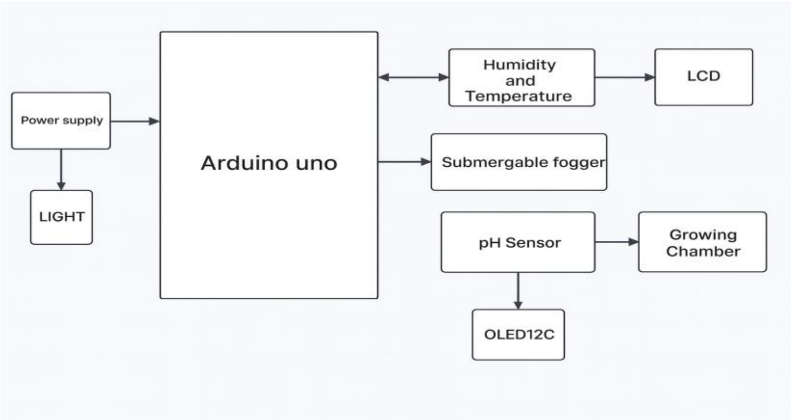
1.4. General guidelines for the preparation of your text

Avoid hyphenation at the end of a line. Symbols denoting vectors and matrices should be indicated in bold type. Scalar variable names should normally be expressed using italics. Weights and measures should be expressed in SI units. All non-standard abbreviations or symbols must be defined when first mentioned, or a glossary provided.

1.5. Methodology

The methodology for developing the fogponics system began with identifying the essential environmental parameters required for optimal plant growth. Fogponics relies on nutrient-rich mist delivery; therefore, accurate monitoring of humidity, temperature, and pH levels was prioritized. The block diagram was designed to illustrate the interaction between the Arduino Uno, sensors, fogger, power supply, lighting system, and display units. Appropriate components—including a pH sensor, humidity and temperature sensor, submergible fogger, LCD, and OLED display—were selected based on their reliability and compatibility with the Arduino platform.

The next phase involved assembling and wiring the hardware according to the block diagram. The power supply was connected to both the Arduino Uno and the lighting module to ensure stable operation. The humidity and temperature sensor was positioned within the growing chamber to continuously monitor atmospheric conditions, while the pH sensor was placed in the nutrient reservoir to ensure the mist solution remained within the ideal pH range. The submergible fogger was installed to generate micron-sized droplets for root absorption, and all components were linked to the Arduino to allow centralized control.



Software development played a crucial role in automating the fogponics system. The Arduino was programmed to collect data from the sensors, process readings, and activate the fogger when humidity levels dropped below a set threshold. The pH readings were displayed on the OLED screen, while the humidity and temperature values were shown on the LCD for easy real-time monitoring. Control algorithms ensured efficient fog generation without oversaturation, helping the system maintain an optimal misting cycle.

Arduino UNO

The Arduino Uno is a popular microcontroller board used for building electronic and automation projects. It is built around the ATmega328P microcontroller and contains digital and analog pins that allow you to connect sensors, motors, displays, and other electronic components. The board operates on 5V and can be powered using a USB cable or an external power supply. It has 14 digital input/output pins, 6 analog input pins, and dedicated pins for power and communication. The Arduino Uno uses the Arduino IDE software for coding, where programs (called sketches) are uploaded to the board through the USB connection. In smart fogponics projects, the Arduino Uno can control foggers, pumps, sensors like EC and DHT11, and display data on an LCD screen. It is easy to use, cost-effective, and ideal for beginners and engineering projects.

Artificial light

Artificial light is used in indoor gardening systems to provide the light energy plants need for photosynthesis when natural sunlight is limited. In urban fogponics setups, artificial grow lights help plants grow faster and healthier by supplying the correct light intensity and wavelength. These lights usually include LED grow lights, which emit red and blue light—the most important colors for plant growth. They consume less power, produce low heat, and can run for long hours without damaging the plants. Artificial lights allow gardening in closed rooms, balconies, basements, or shaded urban environments where sunlight is insufficient. The Arduino-controlled system can turn lights ON/OFF automatically based on plant needs or a timer. This ensures plants receive consistent lighting, improving growth rate, yield, and overall system efficiency

DHT 11 Sensor

The DHT11 is a commonly used Temperature and humidity sensor. The sensor comes with a dedicated NTC to measure temperature and an 8-bit microcontroller to output the values of temperature and humidity as serial data. The sensor is also factory calibrated and hence easy to interface with other microcontrollers. The sensor can measure temperature from 0°C to 50°C and humidity from 20% to 90% with an accuracy of ±1°C and ±1%.

LCD Display

The term LCD stands for liquid crystal display. It is one kind of electronic display module used in an extensive range of applications like various circuits & devices like mobile phones, calculators, computers, TV sets, etc. These displays are mainly preferred for multi- segment light-emitting diodes and seven segments. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations.

PH Sensor

A pH sensor is an electronic device used to measure how acidic or alkaline the nutrient solution is in a fogponics or hydroponic system. It helps ensure that the plants receive nutrients at the correct pH level, usually between **5.5 to 6.5** for most vegetables. The sensor has a glass probe that detects hydrogen ion concentration in the solution and converts it into an electrical signal. This signal is read by a microcontroller like the **Arduino Uno**, which displays the pH value or triggers adjustments if needed. Maintaining the right pH is very important for proper nutrient absorption, healthy root growth, and maximum plant yield. The pH sensor allows the system to stay stable and reduces manual checking.

Fan

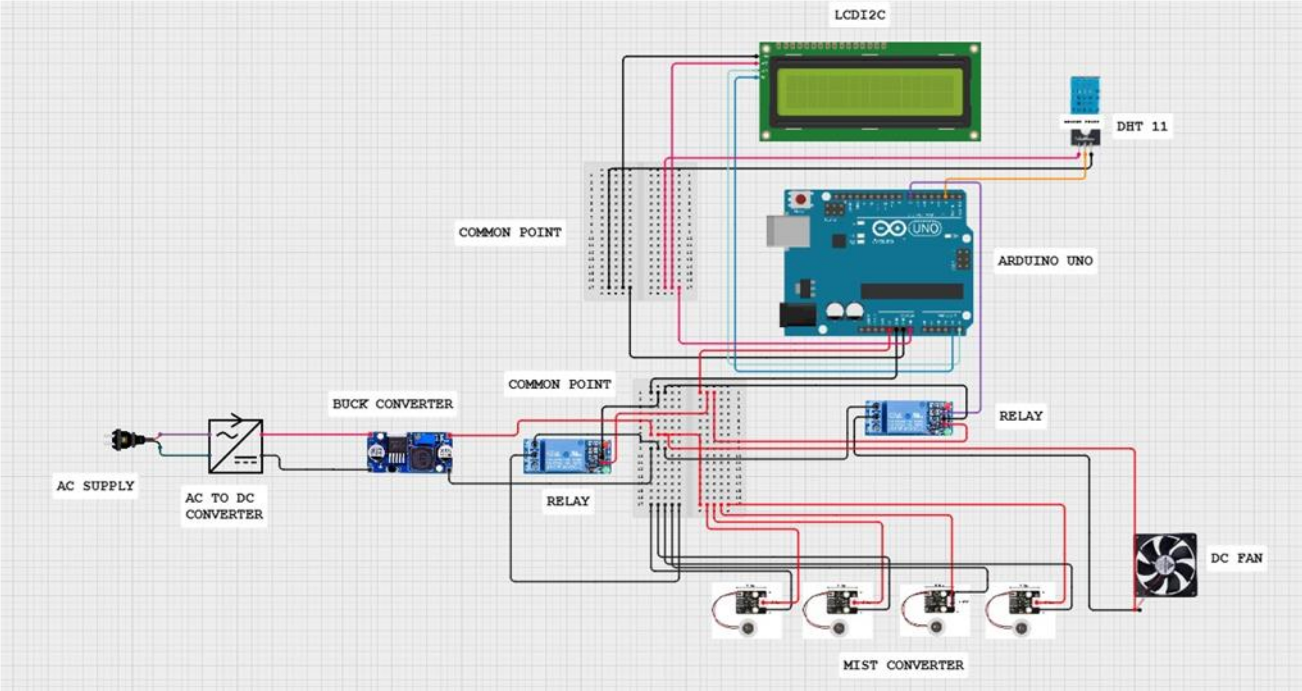
In a fogponics system, a fan plays a crucial role in maintaining proper air circulation and ensuring that the nutrient-rich fog is evenly distributed around the plant roots. Without airflow, the fog can settle at the bottom of the chamber, creating uneven nutrient exposure and reducing system efficiency. A fan helps keep the fog suspended, allowing the fine droplets to reach all parts of the root zone for better absorption of nutrients and oxygen. Proper ventilation also helps prevent the buildup of excess humidity, which can lead to mold growth, root diseases, and poor oxygen availability. In addition, fans help regulate temperatureinside the fogponic chamber, preventing heat from foggers or lights from stressing the plants. By promoting consistent airflow, fans improve nutrient delivery, root health, and overall plant growth, making them an essential component of an efficient fogponics setup.

Buck converter

A buck converter or step-down converter is a DC-to-DC converter which decreases voltage, while increasing current, from its input (supply) to its output (load). It is a class of switched- mode power supply. Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that dissipate power as heat, but do not step up output current. The efficiency of buck converters can be very high, often over 90%, making them useful for tasks such as converting a computer's main supply voltage, which is usually 12 V, down to lower voltages needed by USB, DRAM and the CPU, which are usually 5, 3.3 or 1.8 V

Jump wire

Jumper wires are simply wires that have connector pins at each end, allowing them to be used to connect two points to each other without soldering. Jumper wires are typically used with breadboards and other prototyping tools to make it easy to change a circuit as needed. Fairly simple. In fact, it doesn't get much more basic than jumper wires. Though jumper wires come in a variety of colors, the colors don't mean anything. This means that a red jumper wire is technically the same as a black one. But the colors can be used to your advantage to differentiate between types of connections, such as ground or power.



Circuit diagram

Hardware & Software Componente

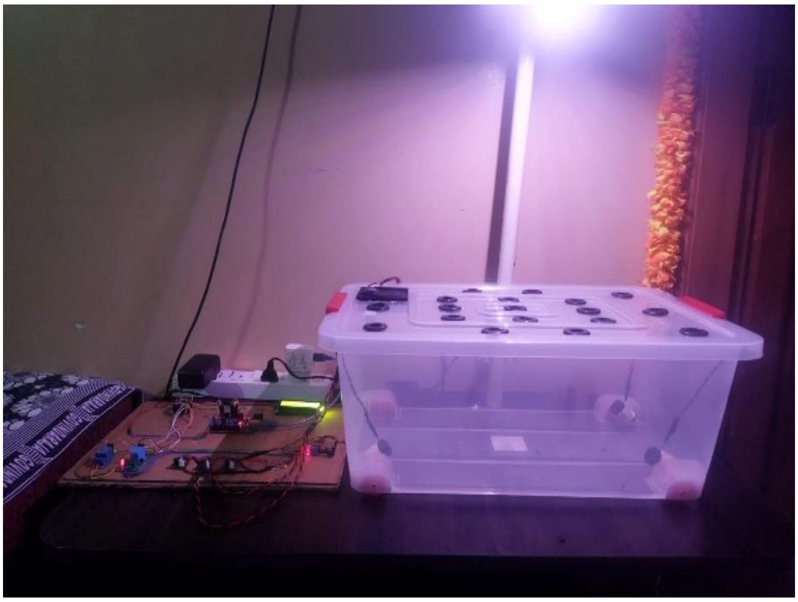
The Smart Fogponics Gardening System in urban cities uses a combination of advanced hardware and software components to create a fully automated and efficient soilless farming setup. The Arduino Uno microcontroller acts as the brain of the system, receiving sensor inputs, processing data, and controlling all output devices. The system uses an EC (Electrical Conductivity) sensor to measure nutrient concentration in the water reservoir, ensuring plants receive the correct amount of minerals required for healthy growth. A DHT11 temperature and humidity sensor monitors the surrounding environment, helping maintain ideal atmospheric conditions needed for fogponic plant growth. The system also includes an ultrasonic fogger that converts nutrient solution into a fine mist, allowing roots to absorb nutrients and oxygen more efficiently. A water pump is used to circulate the nutrient solution and maintain a stable water level in the reservoir. To support plant photosynthesis, LED artificial grow lights are installed, which provide proper light intensity when natural sunlight is limited, especially in indoor or shaded urban environments. An LCD 16×2 Display is used to show real-time values of temperature, humidity, EC level, and system status, making it easier for users to monitor the setup. A reliable power supply unit ensures uninterrupted operation of all electrical components.

On the software side, the Arduino IDE is used for programming and uploading the control code to the Arduino Uno. The system uses Embedded C programming to run automation tasks such as reading sensor values, activating foggers, switching pumps, and controlling grow lights. Various libraries such as DHT.h, LiquidCrystal.h, and EC sensor libraries are used for smooth communication between hardware components. Optional IoT platforms can be integrated to enable real-time monitoring through a mobile app or cloud dashboard, allowing users to access system data from any location. Together, these hardware and software components create a smart, energy-efficient, and user-friendly fogponics system suitable for modern urban agriculture.

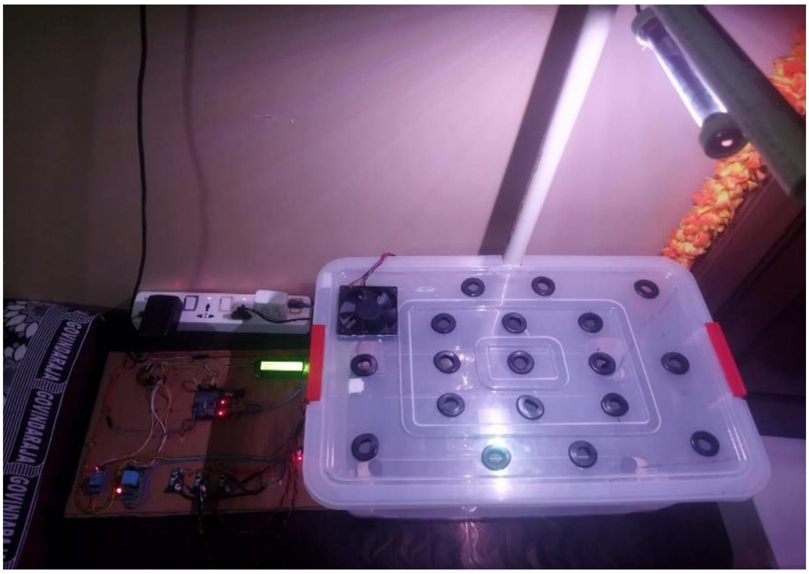
Result

The Smart Fogponics Gardening System successfully created a fully automated and efficient soilless cultivation environment suitable for urban areas. The Arduino-based control system accurately monitored temperature, humidity, and nutrient levels using the DHT11 and EC sensors. The ultrasonic fogger produced a consistent nutrient-rich mist that improved root oxygenation and accelerated plant growth. Plants showed faster growth rates and healthier root structures compared to traditional soil methods. Water consumption was significantly reduced due to the closed-loop system, making the setup eco-friendly and economical. Artificial LED lighting ensured continuous plant development even in low-sunlight conditions. The LCD display provided real-time system updates, and the automation reduced manual work. Overall, the system demonstrated that fogponics is a practical and effective solution for urban gardening, allowing fresh vegetables and herbs to be grown in limited spaces with high efficiency and reliability.

2. Illustrations



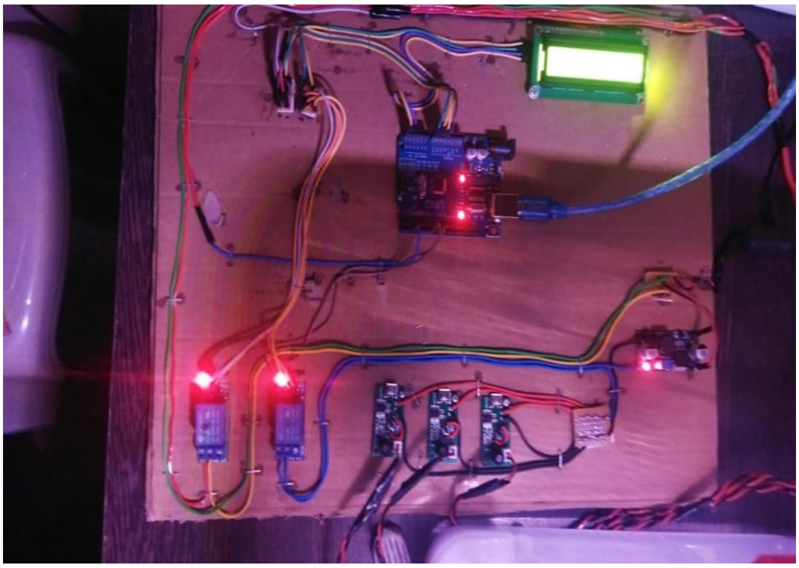
Front view of fogponics system



Top view of fogponics system

Germination of seed

Monitring of temp and humidity in growing chamder



Circuit connection

Acknowledgment

i would like to express my sincere gratitude to everyone who supported and guided me throughout the completion of this project titled *"smart fogponics gardening system in urban cities."* i am extremely thankful to my project guide for providing valuable suggestions, technical assistance, and continuous encouragement. i would also like to thank my faculty members and the institution for offering the necessary resources, laboratory facilities, and a supportive learning environment. my appreciation extends to my classmates and friends for their cooperation, discussions, and feedback during the development of the system. lastly, i am grateful to my family for their constant motivation and support, which helped me complete this project successfully.

REFERENCES

1. Reneau, A. Introduction to Space Exploration. In Moon First and Mars Second; Springer Briefs in Space Development; Springer International Publishing: Cham, Switzerland, 2021; pp. 1–5, ISBN 978-3-030-54229-0.
2. Dionela, M.J.; Tan, J.M.; Paran, L.M.; Concepcion, R.; Bandala, A.; Gennaro, L. Design of a Hyper gravity Simulation Plat form with Speed and Axis Stability Control Systems. In Proceedings of the 2022 IEEE 14th International Conference on Humanoid , Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), Boracay Is land, Philippines, 1–4 December 2022; IEEE: Piscataway, NJ, USA, 2022; pp. 1–6.
3. Monje, O.; Stutte, G.W.; Goins, G.D.; Porterfield, D.M.; Bingham, G.E. Farming in Space: Environmental and Biophysical Concerns .Adv. Space Res. 2003, 31, 151–167. [Cross Ref]
4. Huston, C.; National Aeronautics and Space Administration. Growing Plants in Space. 2023. Available online: https://www.nasa.gov/exploration-research-and-technology/growing-plants-in-space/ (accessed on 10 May 2024).
5. Musgrave, M.E. Growing Plants in Space. CAB Rev. Perspect. Agric. Vet. Sci. Nutr. Nat. Resour. 2007, 2. [CrossRef].
6. Qin, J.; Monje, O.; Nugent, M.R.; Finn, J.R.; O'Rourke, A.E.; Wilson, K.D.; Fritsche, R.F.; Baek, I.; Chan, D.E.; Kim, M.S. A Hyperspectral Plant Health Monitoring System for Space Crop Production. Front. Plant Sci. 2023, 14, 1133505. [CrossRef]
7. Mohanta, T.K.; Mishra, A.K.; Mohanta, Y.K.; Al-Harrasi, A. Space Breeding: The Next-Generation Crops. Front. Plant Sci. 2021,12, 771985. [CrossRef] [PubMed]
8. Hall, L.; National Aeronautics and Space Administration. NASA Is Everywhere: Farming Tech with Roots in Space. 2019.Available online: https://www.nasa.gov/technology/tech-transfer-spinoffs/nasa-is-everywhere-farming-tech-with-roots-inspace/ (accessed on 31 October 2023).
9. Böhmer, M.; Schleiff, E. Microgravity Research in Plants: A Range of Platforms and Options Allow Research on Plants in Zero orLow Gravity That Can Yield Important Insights into Plant Physiology. EMBO Rep. 2019, 20, e48541. [CrossRef] [PubMed]

10. Harvey, B.; Zakutnyaya, O. Orbiting Space Stations. In Russian Space Probes; Praxis: New York, NY, USA, 2011; pp. 301–374, ISBN 978-1-4419-8149-3.