# Development of Aeroponics Stands Using Locally Sourced Materials

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***Abstract- In an enclosed environment of air, water, and nutrients known as aeroponics, plants grow quickly with little water and direct sunlight without soil. In Nigeria, some farmers are having a hard time farming because of frequent farmer-herders crises. Thus, the ultimate objective of this research is to offer a farming method that is free from Nigeria's difficulties with insecurity. This is what aeroponic farming represents. This article describes the fabrication of an aeroponic stand and water supply system utilizing locally available materials. This resulted in a cheaper but more effective aeroponic system at a large-scale level.***

***Indexed Terms- Aeroponics, Greenhouse Farming, PVC Pipe, Tomatoes Farming***

## I. INTRODUCTION

Aeroponics farming is a promising soilless farming method for solving future food crises and is relatively a new way of growing plants that is getting increasingly popular because of the speed, cost and novelty. Aeroponic farming is a form of hydroponic technique and a type of vertical farming. This farming system empowers the producer to precisely control root zone nutrients, water regimes, and environmental conditions and have complete access to the roots throughout the life of the crop. Aeroponics farming is superior in terms of excellent aeration, water use efficiency, less time and space requirement, seasonal independence, disease-free plant propagation, and large-scale plant production when compared to the conventional methods of propagation. Aeroponic techniques have proven to be commercially successful for propagation, seed germination, seed potato production, tomato production, leaf crops, and micro-greens (Kumar & Kumar, 2019; Reddy, Omprasad & Janakiram, 2022).

It is one of the techniques used in modern agriculture, which is widely used all over the world. In the system, a thin mist of the nutrient solution is used in place of soil to develop the plant in the growing chamber under completely controlled conditions. The nutritional mist is periodically ejected using atomization nozzles or mistifier. For healthy plant growth, it is important to pay close attention to several steps during plant culture, including temperature, humidity, light intensity, water nutrient solution level, pH and EC value, $CO_2$ concentration, atomization time, and atomization interval time (Lekhiar et al., 2018).

Aeroponics farming if introduced in Nigeria will be one of the biggest innovations that could be used to solve the problems of land scarcity and adequate fertile land to carry out agricultural activities in the face of lingering insecurity. With an aeroponic system, farmers need not go into the forest where they get kidnapped or have their farms plants/produce destroyed rather, they are engaged in an enclosed air and water/nutrient ecosystem that fosters rapid plant growth with little water and direct sun without soil (Al-Kodmany, 2018; Kumar & Kumar, 2019; Ragaveena, Shirly Edward & Surendran, 2021). But as opined by Adepoju and Olaseni (2021), there is a delay in farmers adopting new agricultural technologies despite their enormous potential to boost agricultural productivity and fulfil rising food demand. One of these cutting-edge technologies used for yam seed production is the aeroponics technique. The authors indicated that more than three-fifths of the farmers surveyed had never heard of aeroponic farming, but they were nonetheless open to using it to propagate yams and seed yams, despite the system's high adoption costs, which were a significant barrier.

Selected works related to this study are reviewed next. Intending to deliver important knowledge regarding early problem detection and diagnosis in aeroponics utilising intelligent techniques (wireless sensors), Lekhiar et al. (2018) published a review study. As a result, the farmer may remotely control the device and monitor many parameters without the use of laboratory equipment. Additionally, the method offers a wide range of data that may be crucial for plant researchers and offers a better knowledge of how the important aeroponics parameters relate to plant growth in the system. It enables complete system control, largely through wireless sensors rather than constant physical attention from the operator. Additionally, the introduction of intelligent approaches in an aeroponic system may lessen its usefulness because of the laborious manual monitoring and control procedures.
Investigation of the environmental impact have been done in climes like the United Kingdom (UK). The effects of the UK's aeroponic farm container system on the environment, taking into account various indicators was analysed by Rivera, Rodgers, Odanye, Jalil-Vega and Farmer (2023). The findings demonstrated that all impacts are driven by energy needs, with climate change projected at 1.52 kg CO2eq per 1 kilogramme of microgreens (pea shoots) utilising the UK grid in 2021. Climate change is decreased by up to 80% using renewable powered systems, making this method competitive with traditional agricultural systems. It was determined that food produced in aeroponic farm containers could have a smaller environmental impact than food imported into the UK and could also increase food security in terms of accessibility, stability, and availability.

According to Mithunesh, Gupta, Ghule and Hule (2015), a proven technique to raise the quality of agricultural products in a greenhouse is to utilise a control system based on agricultural data collected by field monitoring sensors. Thus, the authors presented a data collection/monitoring system, control system, centralised server, and multiplatform web-based controlling/monitoring application for agricultural facilities as an intelligent control system for an aeroponics-based greenhouse. Based on the open-source Raspberry Pi development board, a prototype system for creating a low-cost aeroponics-based greenhouse control system can be created. The system, which offers a vast array of controlling and monitoring functions for the greenhouse, may be utilised both locally and through the Internet. In an aeroponics-based greenhouse, the system is suggested to achieve the highest levels of optimisation, control, quality, automation, etc.

As noted by Kerns and Lee (2017) many scientists and engineers are working to integrate internet of things (IoT) technology with conventional agricultural practices. Growing plants without requiring soil is possible with the efficient and successful method of aeroponic farming. It is anticipated that there will be several gains when IoT technology is applied to an aeroponics system, including a decrease in water usage, an increase in plant output, a reduction in the rate of growth, and a reduction in labour costs. In recognition of the foregoing Kern and Lee developed and put into use an innovative automated aeroponics system. Three key parts make up our system: an IoT device with sensors, a mobile application, and a service platform. The user of the mobile application can monitor and modify the aeroponics system using a graphical user interface. The service platform is a middleware system that offers data to the mobile application so it may store the data obtained from IoT devices utilising sensors inside the aeroponics system. To regulate each pump and access data, the IoT device makes use of sensors included in the aeroponics system. The author indicated that this proposal is a novel application in the agricultural sector and is anticipated to be a promising application that will aid farmers in raising agricultural output and lowering their carbon footprint. Niswar, Tahir and Wey (2022) explains an Internet of Things (IoT) system for regulating and monitoring evapotranspiration in an aeroponic setting. A microcontroller, a single-board computer, sensors, and actuators make up the system. The system's sensors gather information on variables affecting the plant environment, such as air temperature, humidity, total dissolved solids (TDS), pH, and water temperature. The system then uses a fuzzy algorithm to identify the best actuator action to lower the level of evapotranspiration in aeroponics after calculating the level of evapotranspiration using the Blaney-Criddle approach. The experimental finding demonstrates that our IoT system may lower evapotranspiration, which will enhance the quality of the plants.

Fasciolo, Awouda, Bruno and Lombardi (2023) outlined a framework for creating intelligent aeroponic systems based on IoT and artificial intelligence (AI) algorithms. The elements that influence plant development and their relationships to the plant performance indicators are found using the suggested methodology. The developed smart aeroponic system will be able to automatically balance crop productivity and resource use.

## II. MATERIALS AND METHOD

In this design, the authors sought to fabricate an aeroponic stand or tower and a water/nutrient supply system. The study was done in Offa, Kwara State, North Central Nigeria. The geographical positioning system (GPS) coordinates are; Longitude 8.1393$^0$ N and Latitude 4.7174$^0$ E.

The proposed product is described in Figure 1.

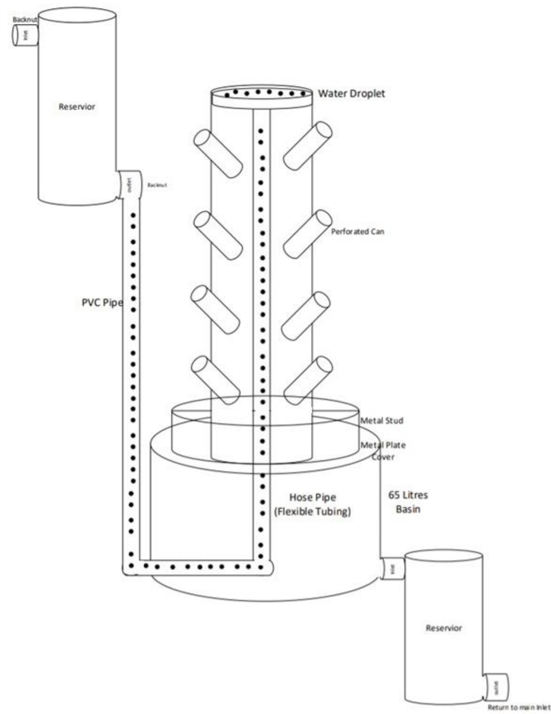


Figure 1: The proposed aeroponic stand with water/nutrient supply system

Some of the materials required included two 65 litres reservoirs for overhead and return sinks, polyvinyl chloride (PVC) pipes of various sizes and their accessories. At the top of the aeroponic stands are mistifiers to convert the water/nutrient solution to mist for use by the plants.

Tools and equipment used included a hack saw, and drill. We also made use of fire and round shape 10cm diameter objects in boring holes on the PVC pipes used for the stands.

Some of the materials used are shown in Figures 2-3

Figure 2: The reservoirs for overhead and return sink

Figure 3: 240 v, 0.5 HP surface pump used

Figure 3 shows the pump used. It is a surface pump. It is rated 240v, 0.5HP. With our configuration, it is capable of supplying water/nutrients to several aeroponic stands. The pump is used to pump the water/nutrient to the overhead reservoir. Then, gravity is used to send the water/nutrient to the mistifiers, which turns the solution into droplets. The second reservoir is used to collect the unused solution by the plant.

## III. RESULT AND DISCUSSION

The sub-process and the finished systems are shown in Figures 4-8.

Figure 4: Bored PVC pipes with 28 numbers 10 cm elliptical holes

Figure 5: Fixing of the plant cups on the bored PVC pipes

Figure 6: Fixing of the aeroponic stand to withstand wind loading

Figure 7: Interconnection of the system

The finished aeroponic system will be upscaled and deployed to tomatoes farming. At an enlarged scale, the locally fabricated system is cheaper than the imported ones. This resulted in a cheaper but effective aeroponic system at a large-scale level.

In the future, more of the aeroponic stand with water/nutrient supply systems will be fabricated and deployed for tomato cultivation.

## CONCLUSION

This manuscript briefly reports on the local fabrication of aeroponic stands. Locally available materials were sourced and used. Improvisation was done. For example, a 10 cm circular drill was not available but a heated round object with a diameter 10 cm was used.

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