

# Indoor Farming Hydroponic Plant Grow Chamber 2 Layer

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**Abstract:** *Indoor farming is becoming the future of agriculture because it reduces the need for large farming lands. This project presents a two-layer indoor farming and gardening system using a programmed hydroponic method. Hydroponics is a technique of growing plants without soil, using nutrient-rich water instead.*

*The system includes an automated water supply and drainage setup, proper airflow, and artificial lighting to create a suitable environment for plant growth. Intelligent grow chambers monitor and provide the required nutrients, water, and light to ensure healthy plant development. This system allows organic food production indoors in any weather condition. By maintaining ideal growing conditions, it offers a simple and fully automated solution for modern farming..*

**Keywords:** *Indoor farming*

## I. INTRODUCTION

Hydroponics is a method of growing plants without soil, using water mixed with essential nutrients. The word hydroponics comes from the Greek words hydro (water) and ponos (work), meaning “working water.” The term was first used in 1937 by Dr. W. F. Gericke, who helped develop soilless plant cultivation methods.

Today, hydroponics is considered an important modern farming technique. Many people around the world do not have enough food due to population growth, poor weather conditions, low land productivity, and limited resources. Traditional farming also requires large areas of land and depends heavily on soil quality and climate.



Hydroponics offers a better solution by allowing plants to grow in a controlled environment using nutrient-rich water. It uses less space, saves up to 90% more water than soil farming, and allows year-round production. Because it does not use soil, it reduces soil erosion, fertilizer runoff, and soil-borne diseases. For these reasons, hydroponics is seen as a sustainable and efficient method to meet future food demands.



## **II. LITERATURE REVIEW**

Hydroponics is a method of growing plants without soil, using water mixed with nutrients. This system helps plants grow faster, produce higher yields, and is ideal for small indoor spaces. Indoor farming uses controlled environments where light, temperature, and humidity are carefully managed, allowing plants to grow all year. Multi-layer systems, like a two-layer setup, make it possible to grow more plants in the same area.

In two-layer hydroponic systems, proper LED lighting and nutrient circulation is essential to ensure both layers grow evenly. Studies show that leafy vegetables like lettuce can produce up to 35% more in a two-layer system compared to a single layer, and crops like tomatoes grow well when air circulation and light placement are managed correctly. However, these systems also face challenges, including lower light for the bottom layer, higher risk of pests and diseases due to close planting, and the need for careful design for easy maintenance and harvesting.

Future improvements may include the use of sensors to monitor nutrients, temperature, and humidity in real time, smart LED lighting for each layer, and compact modular systems suitable for urban home

## **III. PROBLEM STATEMENT**

### **1. Requires Large Land Area**

Traditional farming uses a horizontal method of cultivation. To grow more crops, more land is needed. Compared to vertical farming, it requires a much larger area to produce the same amount of food.

### **2. High Water Consumption**

Traditional agriculture uses nearly 70% of available freshwater. Methods like canal irrigation often supply more water than necessary. This leads to water wastage, soil erosion, and reduced soil fertility.

### **3. Use of Pesticides and Insecticides**

Farmers use pesticides to protect crops from insects, rats, snakes, and other pests. However, excessive use of chemicals lowers food quality and may cause serious health problems such as cancer, neurological disorders, and reproductive issues.

### **4. Environmental and Health Risks**

Although current farming methods produce food at a good rate, they may not meet future food demands. The heavy use of fertilizers and pesticides harms the environment and reduces food quality. It also causes soil degradation and long-term health risks.

### **5. Problems for Small Farmers**

Small farmers depend on limited land for their income. Drought, soil damage, or poor crop yield affects their livelihood. They often take loans to buy seeds, fertilizers, pesticides, and water. If crops fail, repaying these loans becomes difficult.

### **6. Soil Damage**

Excessive irrigation and chemical use reduce soil fertility and increase soil erosion. Over time, this lowers crop productivity.

### **7. Technical Knowledge in Hydroponics**

Although hydroponics solves many traditional farming problems, commercial hydroponic farming requires technical knowledge and skills. This knowledge can be expensive or difficult to access.



### **Benefits of Hydroponic:**

Hydroponic systems allow precise control of important growing conditions such as temperature, humidity, light, water supply, and ventilation. This control helps create ideal conditions for plant growth, leading to better yield and improved crop quality.

Because the environment is artificially managed, crops can be grown at any time of the year, regardless of outside weather conditions. This allows farmers to grow plants even in their off-season, increasing production and market opportunities.

Hydroponic farmers can supply fresh produce when it is not easily available from traditional farming. This reduces market competition and can improve income.

Although hydroponic systems depend on proper equipment and technical knowledge, and system failures may cause risks, the

overall advantages—such as year-round production, efficient resource use, and higher productivity—are greater than the disadvantages.

### **IV. METHOD DESIGN**

The Indoor Farming System continuously monitors temperature, humidity, soil moisture, and water level using sensors.

A DHT22 sensor measures temperature and humidity.

An analog soil moisture sensor checks whether the soil is dry or wet.

A float sensor detects the water level in the tank.

Sensor values are shown on a 16×2 I2C LCD and the Serial Monitor.

### **System Actions (Priority Based):**

Low Water Level:

The system stops the pump turn on buzzer and shows a Low Water Alert on the LCD.

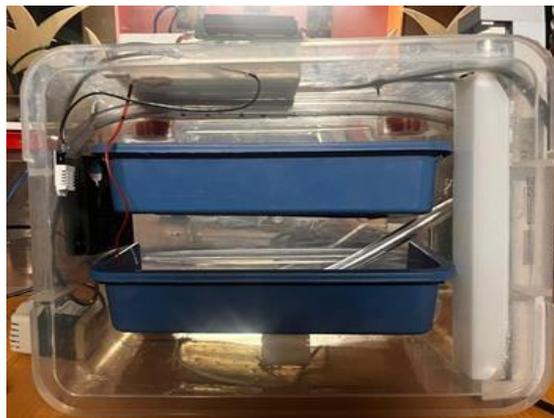
Dry Soil :The water pump turns ON automatically to irrigate the plants.

High Temperature: The fan turns ON to cool the indoor environment. Normal Condition:

All devices remain OFF and the LCD displays temperature and humidity. This system automates plant care, reduces manual

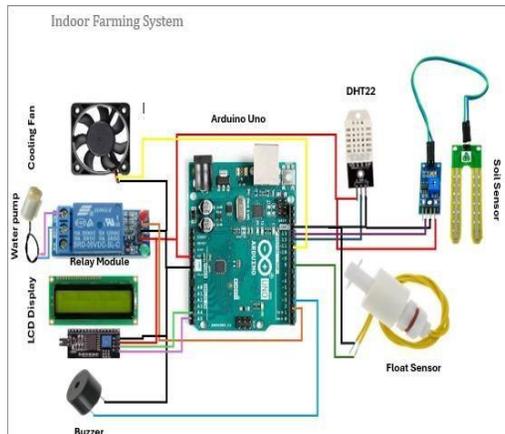
effort, and ensures healthy indoor plant growth.

### **Model design:**

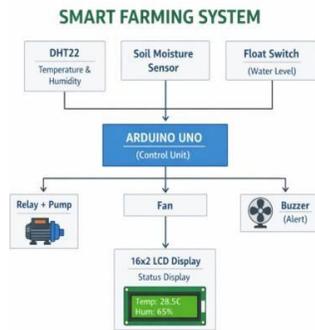




**A. Circuit Diagram:**



**B. Block diagram**



**Components Required:**

- Pump Motors
- Piping and Drainage Connectors
- Supporting Frame Rods
- Water Tank (Nutrient Reservoir)
- Temperature Sensor
- Water Level Sensor
- Moisture Sensor
- Controlling Circuitry (Arduino + Relay Module)
- LCD Display
- Keypad
- Transparent Casing
- Cooling Fans
- Pipes and Joints
- Mounts and Couplings
- Supporting Frame Structure
- Screw and bolts

**Working Principle:**

The automated hydroponic system uses sensors to constantly monitor the grow chamber's temperature, humidity, and water level, ensuring that the plants always have the right conditions to grow.

Users can program the desired temperature and moisture range, and the system automatically adjusts the environment to match these settings. Fans and ventilation maintain proper airflow and temperature, while water pumps add or remove water as needed based on sensor readings. Artificial lights are turned on and off automatically to provide the correct amount of light for photosynthesis, simulating natural sunlight. If the water level in the tank gets too low, a buzzer alerts the user so the water can be refilled promptly.

All of these functions are controlled by an inbuilt controller circuit, which manages the system according to the programmed settings. This fully automated approach reduces manual work, saves resources, and ensures healthy, consistent plant growth throughout the year.

**Overview of Automation:**

- Helps make more products faster.
- Reduces the need for workers, so labour costs go down.
- Increases productivity in the factory.
- Makes work easier for workers.
- Saves time in production.
- Speeds up the manufacturing process.
- Reduces handling of materials and making work simpler.
- Helps workers do more in less time.
- Needs less maintenance and keeps machines running smoothly.

**V. FUTURE SCOPE**

Hydroponics is one of the fastest-growing areas in agriculture and is expected to play a major role in future food production. As farmland decreases due to poor management and high land costs, hydroponics offers a modern solution for growing food.



Countries like Japan are already using hydroponics, mostly with NFT or sand/gravel methods. By controlling the environment, they can grow crops like rice four times a year instead of just once. In cities such as Indianapolis, hydroponics is being used for local food production, saving water (up to 90% less than traditional farming) and reducing the city's carbon footprint. Even desert countries like Israel use hydroponics to grow crops like berries and bananas in containers, achieving much higher yields than in normal conditions. Large companies, including Target, have started using hydroponic gardens to provide fresh vegetables and herbs with minimal water use.

## VI. CONCLUSION

Hydroponic systems allow plants to grow without soil, producing healthier, more nutritious crops. Artificial lights help plants grow fully even when sunlight is limited. Since no pesticides are used, hydroponics is also better for the environment.

Hydroponics is becoming an important method to grow food in a sustainable and eco- friendly way, especially as fresh water and farmland become limited. It is expected to grow rapidly in the future, particularly in countries like India, where urban growth is reducing available farmland.

This soilless method can increase crop yield, improve quality, and ensure long-term food security. Government support and research can further help hydroponics develop faster.

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