Project: Low pressure aeroponic system:

Overview: Aeroponics is a technique of growing plants in a soilless environment, it's an advanced version of the Hydroponic System. In aeroponics, nutrition to the plants is supplied by nutrient-rich mist.

Description: In the aeroponic system, plants are not contained in any soil or solid material such as Rockwool. The plant roots are hung in the air in a grow chamber and are sprayed with nutrient-rich water or mist containing nutrient-rich solutions at certain intervals.

Aeroponics is a more advanced system than traditional agriculture. The plants tend to grow faster and absorb more nutrients because the roots are exposed to more oxygen and CO_2. Because there's no place for debris or pathogens to reside, roots are less susceptible to diseases.

In a proper clean environment, aeroponics delivers pure fresh results, with zero pesticides, highest quality flavors, and maximum growth.

Pros and cons of aeroponics

Aeroponic provide more production due to followings:

- Water pH levels can be maintained,
- Nutrient can be optimized precisely by maintaining the PPM (parts per million) and spray time.
- The light required in growth phases (flowering, bloom, and fruiting cycles) can be maintained.
- In an indoor environment temperature and humidity can be maintained best for plant growth.

Pros:

- Requiring less space, Plants can be grown in vertically form with many levels.
- Mobility- Plants can be easily moved from one location to another.
- Less need for nutrients and water.
- Plants can be grown near the City, This is a significant saving in the supply chain because it needs less transport, storage and refrigeration.

Disadvantages:

- Technical knowledge required. The aeroponic system needs knowledge of to maintain the system and nutrients requirements for the plants.
- Regular cleaning of aeroponic systems is required to maintain disease free roots.
- Initial high cost.

Project Design:

The aeroponic system was designed to keep the cost low by using material already available.

Design:

Figure #1: Vinyl post for plants

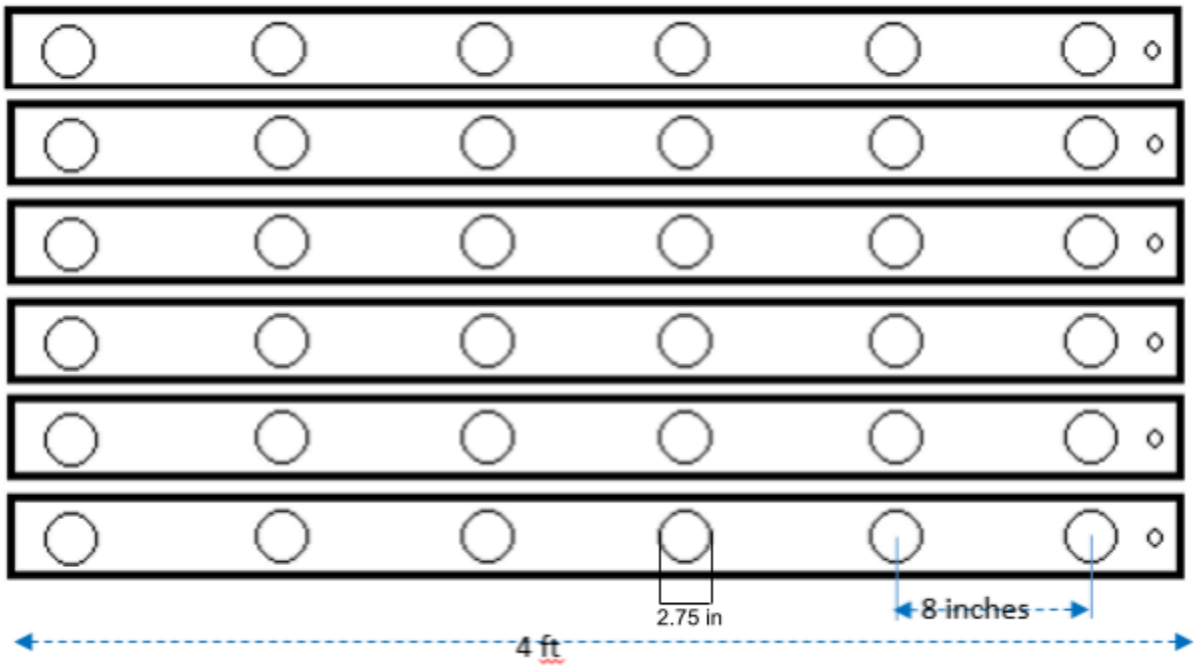
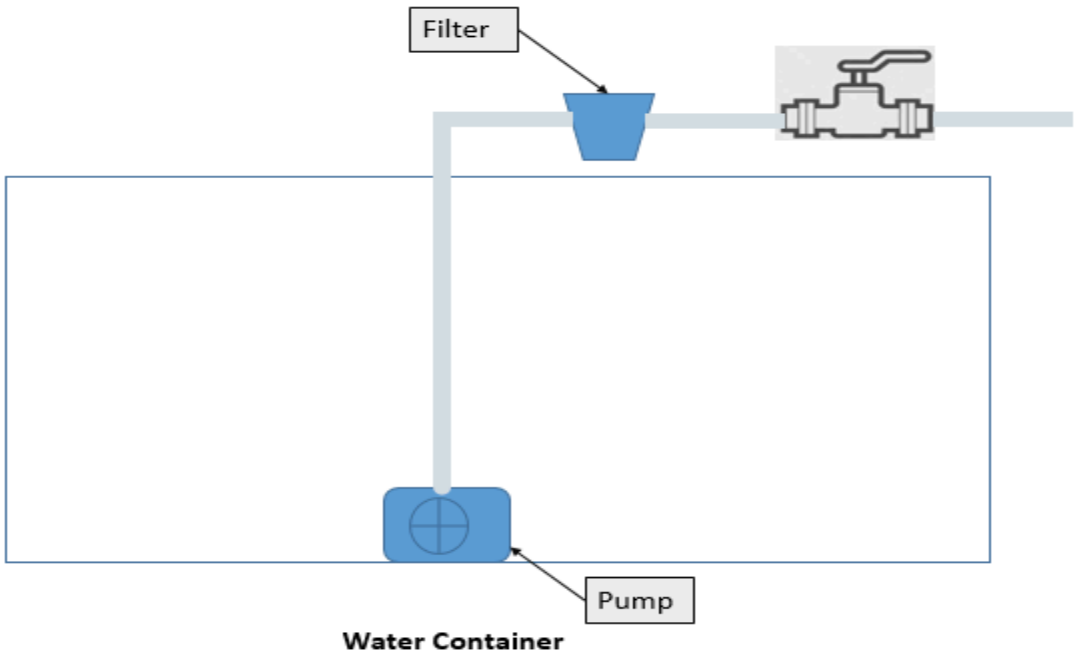


Figure #2: Water and Nutrients supply container and pump:



Parts Used:

Plastic Storage container: 40 gallon

Water Pump: ½ hp, 1200 Gallon per hour

Vinyl fence post 5x5 inch – 24 feet length

½ inch CPCV (pex) pipe – 35 feet

½ inch tee connectors

½ inch elbow

3/4 inch Tee connector 3

3/4 inch CPVC pipe 6 feet

1 inch Straight drain with screw – 6

Plastic Mist Nozzle Sprinkler – 36

Shut off valve – 3

Water Filter

Timer – 2

Full Spectrum led light for plants 4ft - 6 Numbers

3 inch Net pot for plants – 36 nos

Water soluble plant Nutrients for Hydroponic/ Aeroponic

PH and TDS meter

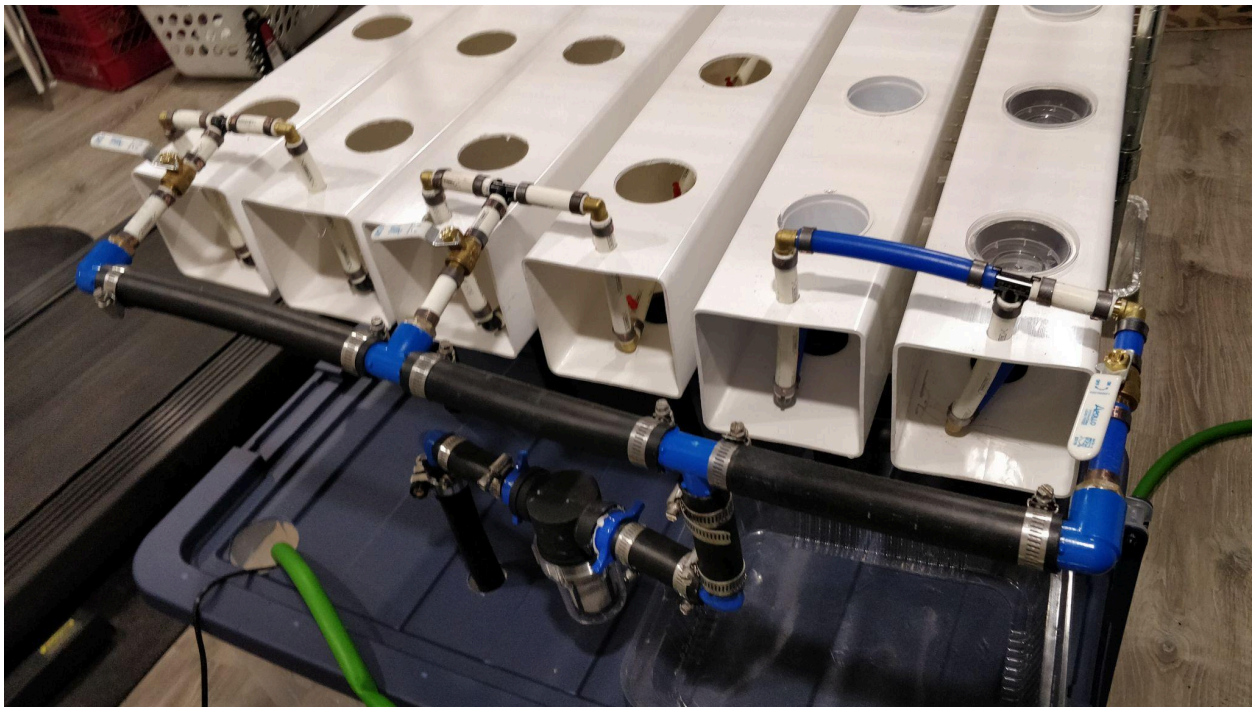
Tools used:

1) Saw
2) PEX Crimping Tool
3) PVC pipe cutter
4) clamp
5) Glue
6) Screw drivers
7) 2.75 inch drill

Steps:

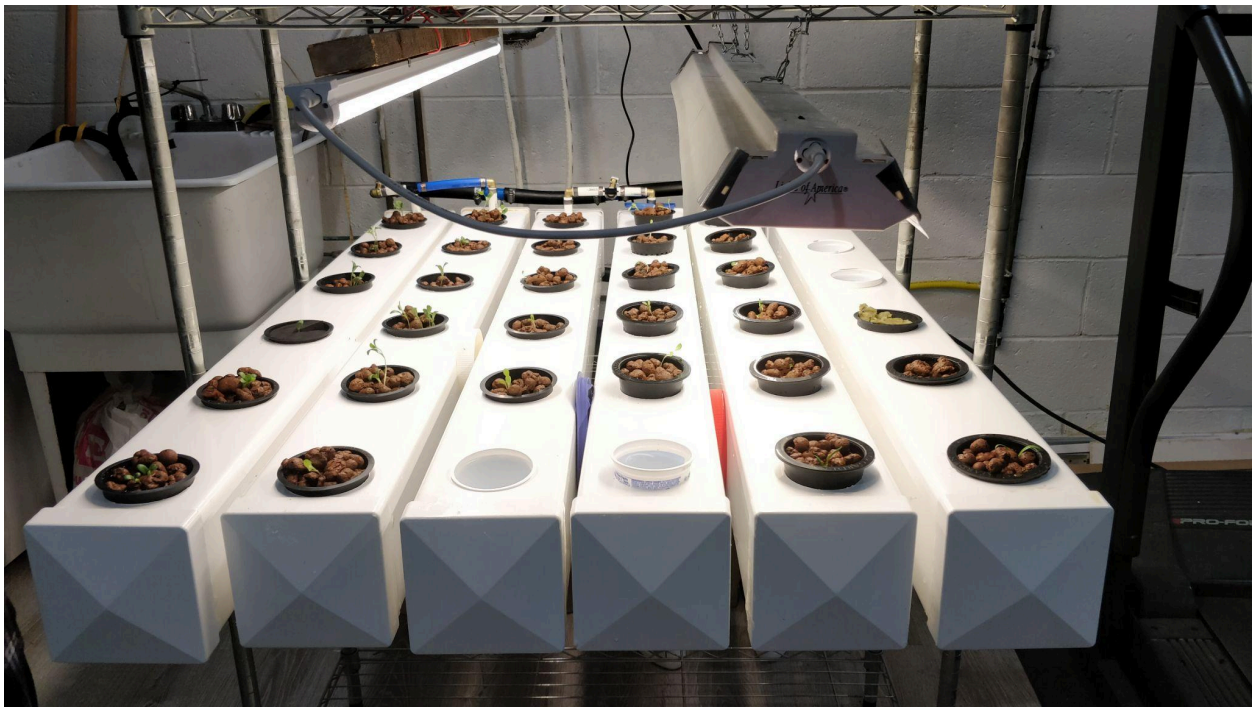
1. Six Vinyl fence posts of 5X5 inch are cut for 4 feet in length. On these posts, six holes of 2.75 inch diameter are made with a distance of 8 inches.
2. A one inch drain pipe is installed in each vinyl post for water drain.
3. Vinyl post ends are covered by a cap and glued with waterproof silicone glue.
4. A ½ inch CPVC PAX pipe of 3 feet 10 inch was cut. Nozzle Sprinklers are installed every 8 inches in this pipe. This pipe is placed inside the vinyl post and connected to the water supply line thru a valve as shown in Figure 2

and the picture below.



5. A 40 gallon plastic container is used for nutrients. A ½ hp submersible pump is kept in this container to supply water. The drain from each vinyl post is

connected to the water container.



Plants:

I have successfully harvested romaine Lettuce, Butter lettuce and kale. Spinach did not grow properly.

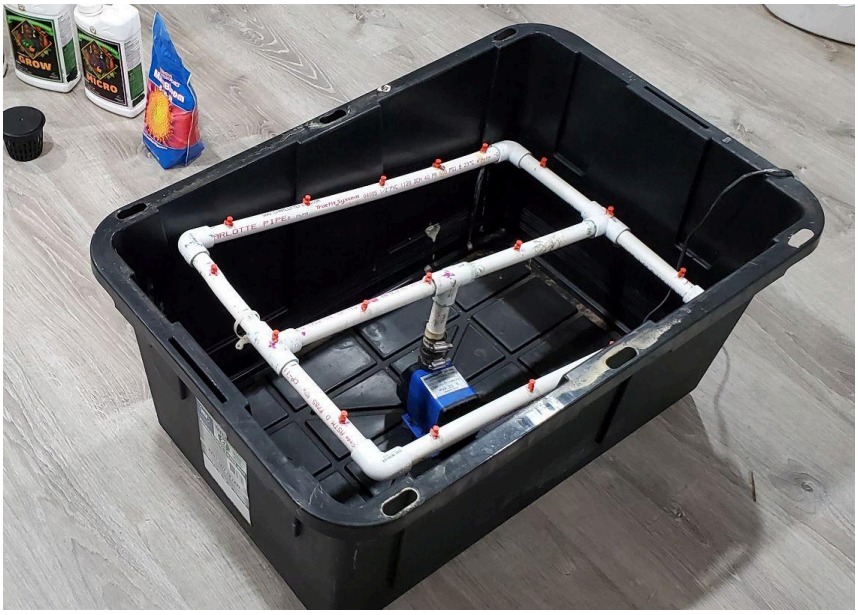
Operation and Maintenance:

In an aeroponic system, it's required to maintain the proper supply of nutrients to the plant roots. For this clean neutral water is taken with 7PH. I have tried some combinations of concentration and found that 600PPM to 800 PPM nutrients is good for plant growth when they are seedlings and about 800 to 1000 ppm concentration when plants reach the bud stage. PH level of 5.6 to 5.8 seems good for batter plant growth.

20 hours of light is given to plants for good growth. Room temperature is maintained about 70 to 72 degree F with 50 to 60% humidity.

It is required to check the water level and nutrients once in every week to maintain the concentration and PH level.

Tests:
In order to test and experiment I also created a smaller system in a simple plastic container. It consisted of a smaller water pump in a 27 gallon container. It had a pipe system made from PVC with spray nozzles. As shown in the image below:



Problem faced:

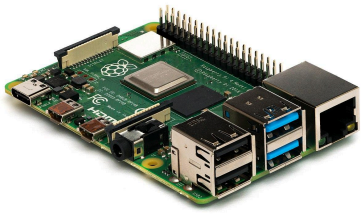
1) The Vinyl post caps are not properly fixed and there was water leak from the ends. It was fixed with waterproof silicone glue.
2) The roots and debris clogged the spray nozzle. To stop this a filter was added in the water supply side. Filter has to be cleaned weekly to remove deposits and maintain water pressure to create mist from the nozzle.
3) Plant roots grow and tangle to other plants and develop bacteria on roots. A routine maintenance chart is created to clean the aeroponic water system and sanitize it once in a month. When plants grow near to full size, roots are inspected every week to maintain proper growth and avoid growth of bacterial infection.
4) Once the plant grows, the leaf touches the light bulbs. It is required to maintain proper height between the plant and light bulbs. Height is maintained by ropes which hang 4 feet long full spectrum LED tubes.

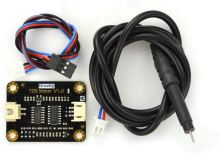
Next enhancement:

1) Automatic nutrients dispenser: To maintain proper plant growth it is required to maintain proper nutrients concentration in water. An automatic

nutrients dispenser with a water level monitor sensor can be managed by a software program. Followings will be needed for this project:

a. raspberry pi
b. A software to control liquid dispenser (nutrients)
c. TDS meter
d. PH Sensor
e. Temperature and Relative Humidity Sensor





Future prospects of :

Aeroponic or Hydrophobic allows for a controlled environment for growing plants.

There are numerous advantages to being able to control the environment. The whole aeroponic system can be automated with sensors and automation software. There is a large scope of automating plant growth by using data analysis and machine learning. The data related with plant growth can be with environmental factors (temperature, humidity, light, nutrients etc) can be easily collected. This will lead to machine learning for plant growth. With the help of robotics and automation, cost of production can be brought down to a minimal level. We should continue researching systems like this to attempt to solve our agricultural problems.