# Sustainable Food Systems Hydroponics/Microgreens Project

## Natural Resource Internship

Summer 2016

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# Hydroponics systems

- What is hydroponics?
- Hydroponics is a subset of hydroculture and is a method used for growing plants using mineral nutrient solutions, using only water and no soil.
- Terrestrial plants may be grown with their roots in the mineral solution only, or in an inert medium, such as perlite, gravel, vermiculite, sand, clay balls and any non toxic, non leaching sterilized aggregate.

# Hydroponics systems

- What different kinds of hydroponics systems are there?
- There are 6 basic types of hydroponic systems; **Wick system**, **Water Culture Hydroponics, Ebb and Flow** (aka Flood & Drain Hydroponics), **Drip recovery and non recovery systems**, **N.F.T.** (Nutrient Film Technique) and **Aeroponics**.
- There are hundreds of variations used, but all hydroponic systems are a version and or combination of these basic six.

# Hydroponics systems

- Focus: Modifying a Drip recovery system to a Micro-Spray recovery system
- Drip recovery– This system is the most widely used hydroponic system. A timer turns on a submersed pump that propels the nutrient solution through a system of drip irrigation lines to each plant. Once the liquid nutrient solution is discarded from the plants growing medium it drains back to the reservoir to be used again. In a non recovery system the nutrient solution does not return to the reservoir but is instead discarded.
- Micro-Spray recovery system: using a higher pressure submersible pump to use a series of Micro-Spray Nozzles to provide optimal watering coverage.

# Microgreens

- What are they?
- They are the shoots of various vegetables and herbs harvested in the early stages of vegetative growth. Some common Microgreens are Arugula, Swiss chard, bok choy, beetroot, red cabbage, Broccoli etc.
- Average growth height for harvest: 1-3 inches
- Harvested just after the first Dicot leaves have developed.
- Harvest time: 3-10 days
- VERY high nutritional value: 40% more nutrients than their mature counterparts pound for pound of organic material.

# Proposed Research Experiment

- Purpose: To design and Construct an enclosed Micro-Spray recovery system customized for small scale Microgreen production using low cost materials. The need for culinary access to nutrient rich Microgreens to enhance flavors, textures, and color using tender seedlings and shoots is the basis for the project.

# Reasoning

- USDA- Agricultural Research Service scientists analyzed key nutrients in 25 different varieties of microgreens and found that red cabbage microgreens had the highest concentrations of vitamin C. These nutritious microgreens are ready to harvest just 10 days or less after planting. Research shows Microgreens contain 40% more nutrients than their mature counterparts pound per pound of organic material.
- Among the 25 microgreens tested, red cabbage, cilantro, garnet amaranth, and green daikon radish had the highest concentrations of vitamin C, carotenoids, vitamin K, and vitamin E, respectively. In general the ARS scientists found that microgreens contained about five times more nutrients than the mature counterparts.

# Reasoning

- The Micro-Spray Recovery Hydroponics system is a  continuous efficient watering system, automated, soilless and controlled.
- “LED lights are efficient and versatile, Because of their durability and long life, they are ideal for space missions where resupply of things from Earth is limited.”
- Using LED lights to grow plants was an idea that originated with NASA as far back as the late 1980s.

# Methods

## Microgreens Micro-Spray recovery system experiment

1. Experimental Design and Construction

- Using an industrial steel bakery rack frame to house enclosed system: Design and assemble continuous **Micro-Spray Recovery Hydroponics system** tailored for 5x5 inch square hydroponics grow pads to cultivate Microgreens
- **Tree Leaf Market** seed distributer: Microgreen seeds.

# Methods

2. Light Source/ AIR exchange

- A) a 50 watt LED Red/Blue Spectrum lights as a light source over growth chamber.
- B) Install small air purifier for continuous air circulation within the growth chamber

# Methods

3. Data Collection:

- Test and analyze results: 5- 10 days growth time
- Average Microgreen harvest time: 3 to 10 days depending on the species and growing conditions.

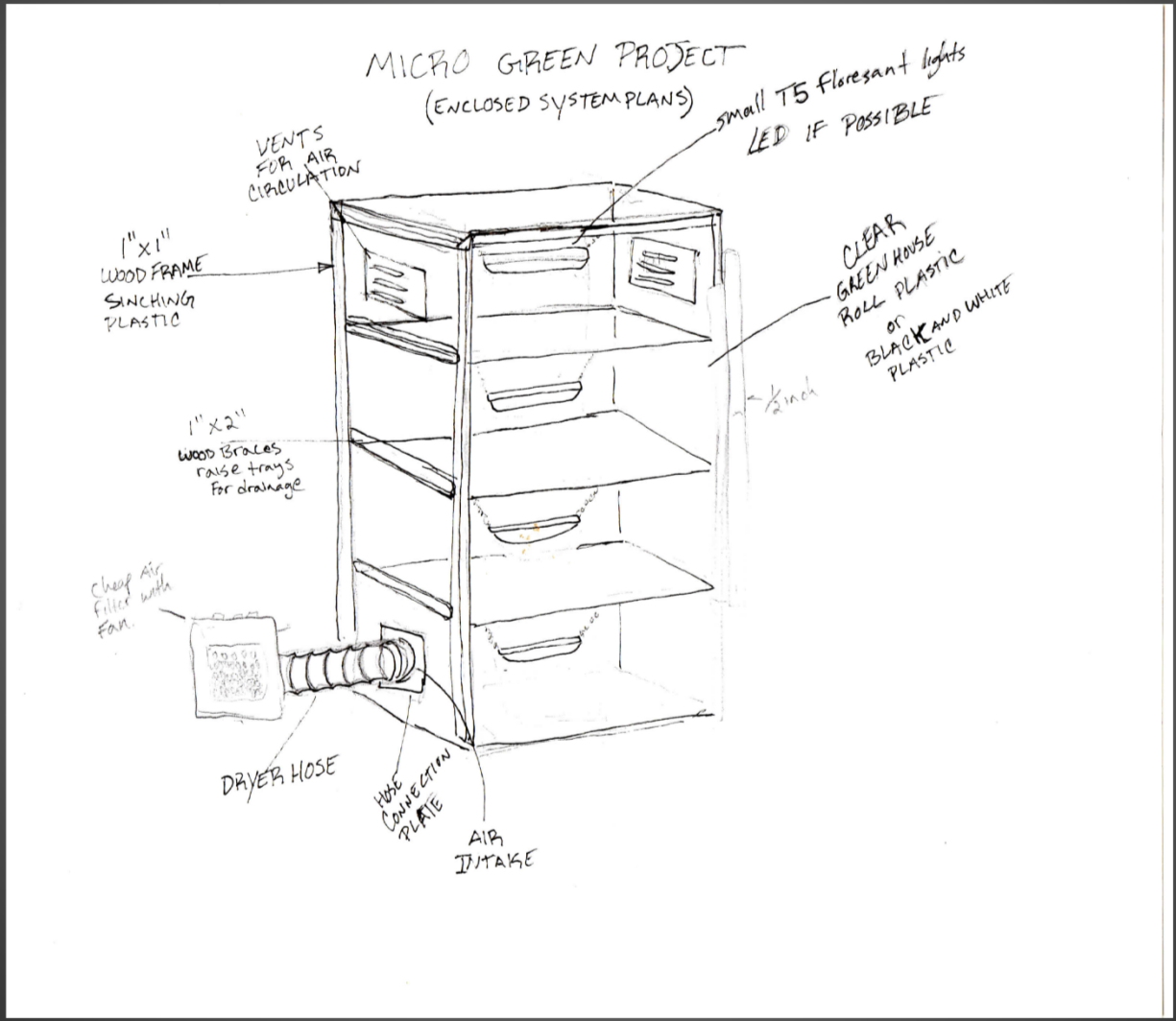
# Data analysis

- At the time of harvest, measure Microgreens: The plants' shoot length, the shoot diameter, total fresh mass or the weight of the plants at time of harvest, total dry mass of the edible plant matter accumulated during the growth cycle, and the dicot leaf area.

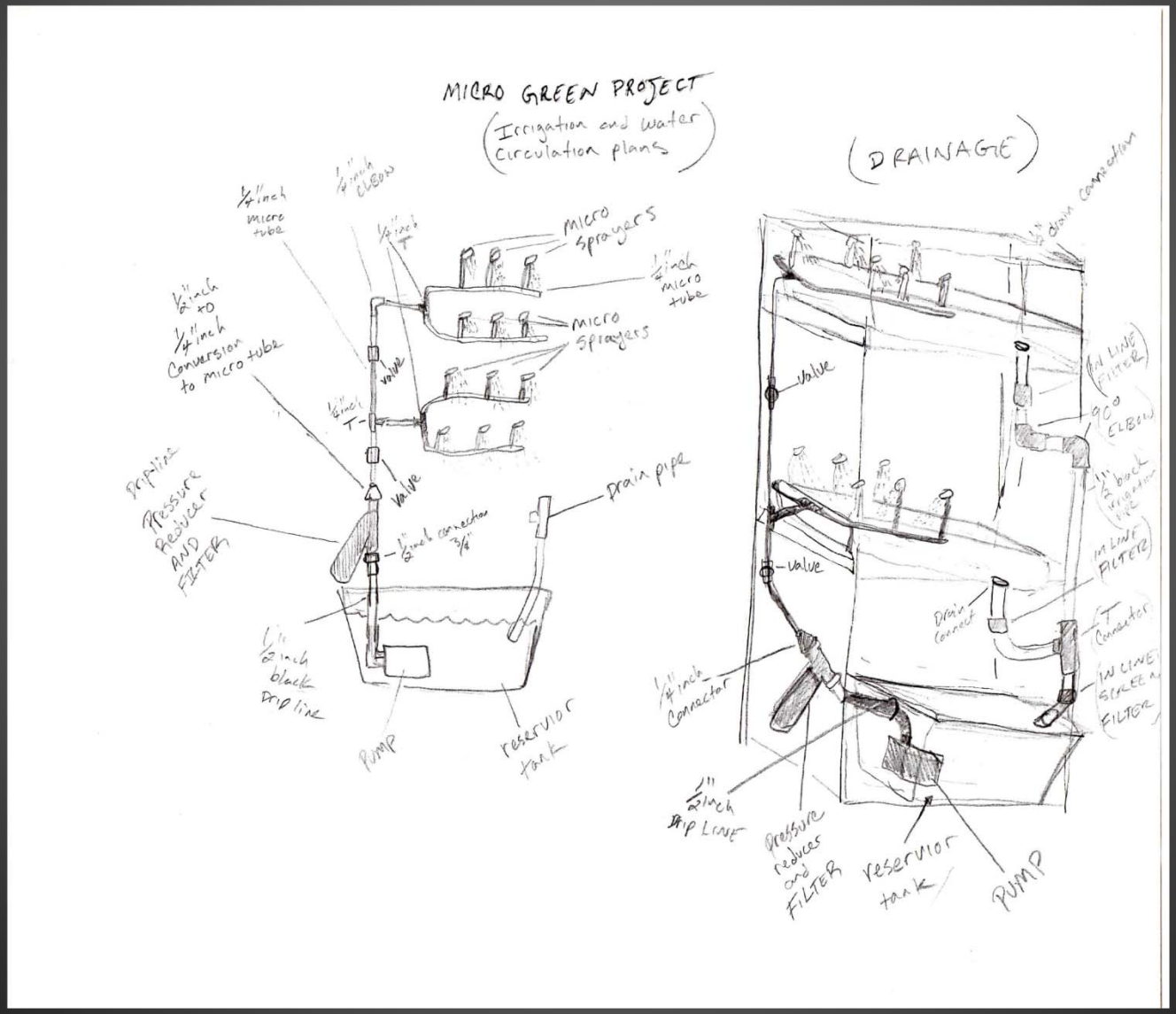
# Data analysis

- The final step of analysis is to flash freeze a sample the Microgreen plant material in liquid nitrogen and grind it into to a powder to perform an ***Adenosine triphosphate*** analysis, which measures stored energy in the plant tissue.

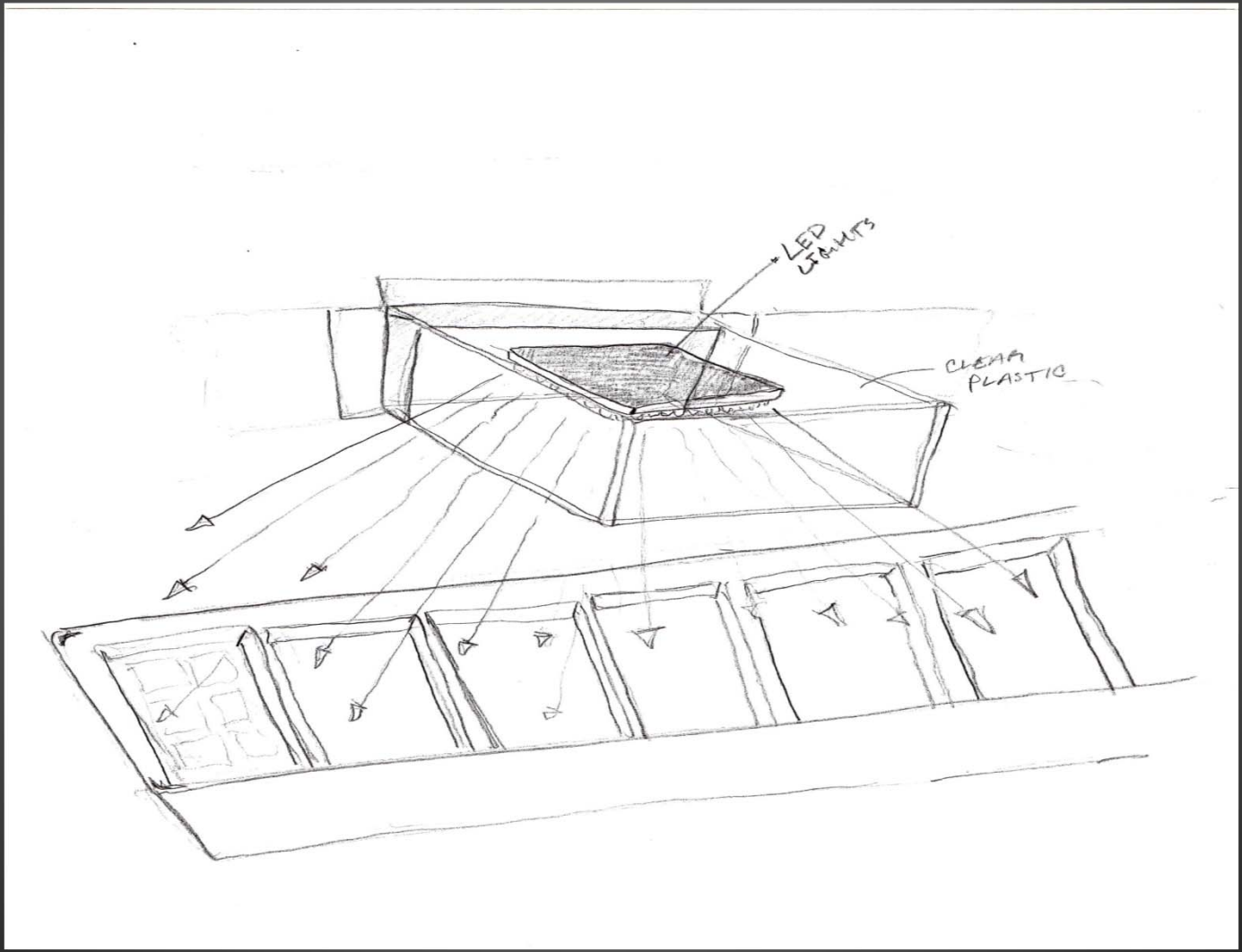
# Design #1: Growth chamber



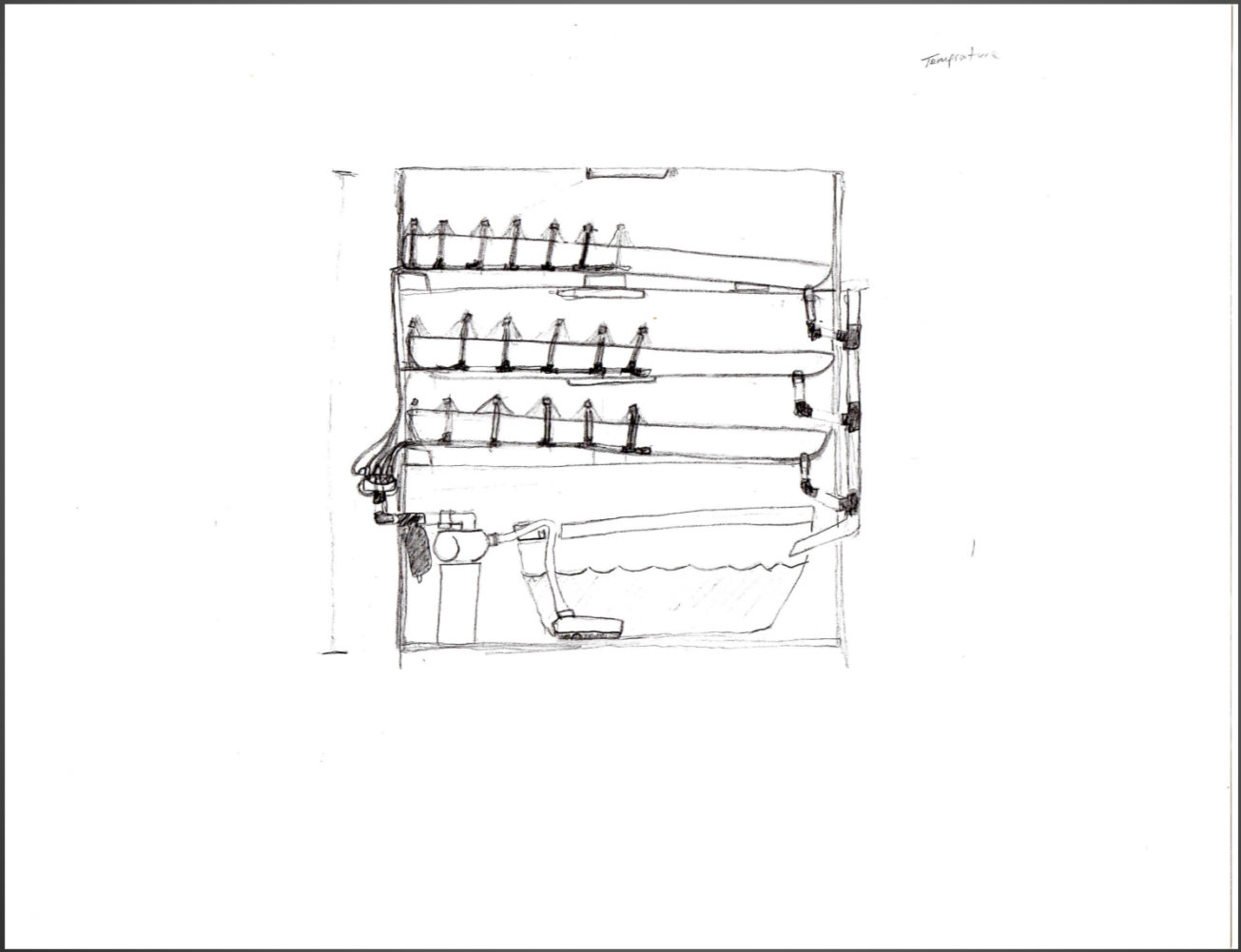
# Design #1: Irrigation system



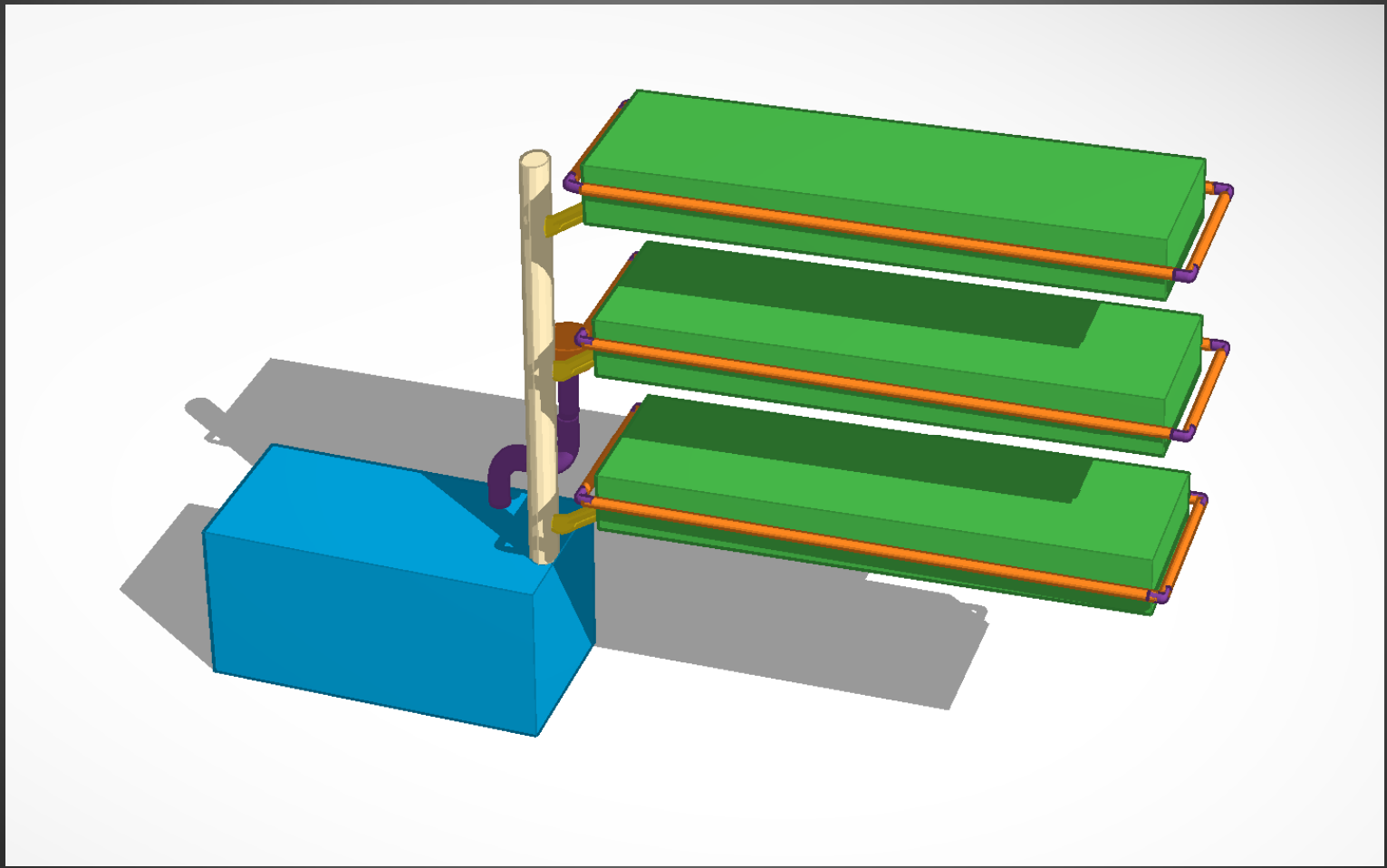
# Light source design



# Another irrigation design



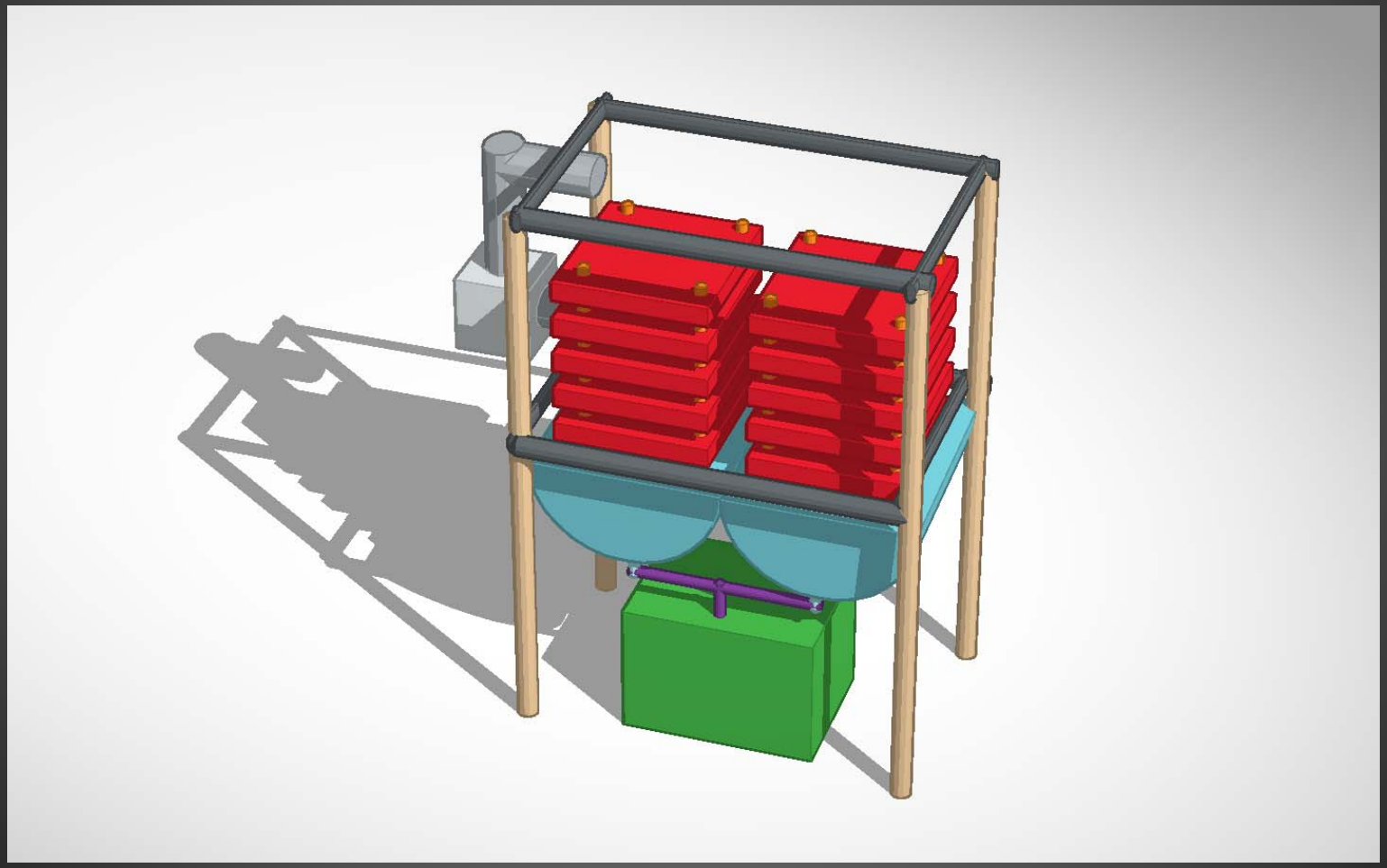
# 3D model of initial design



# Challenges

- Could not find adequate trays to fit the model of initial design specs.
- Redesign trays and system
- Use low cost materials to fix design flaw
- Solution: cut a 50 gallon water barrel in half vertically and install drains to meet new design specs.

# 3D model of final design



# Submersible Water Pump/ attachments

- 1200 g/h sub pump
- 100 psi regulator
- 6 port relay
- 6 valves

# Frames/Trays/Micro spray Nozzle

- 50 gallon BPA free water barrel


Holmes

# Zipper door/ Plastic containment seal

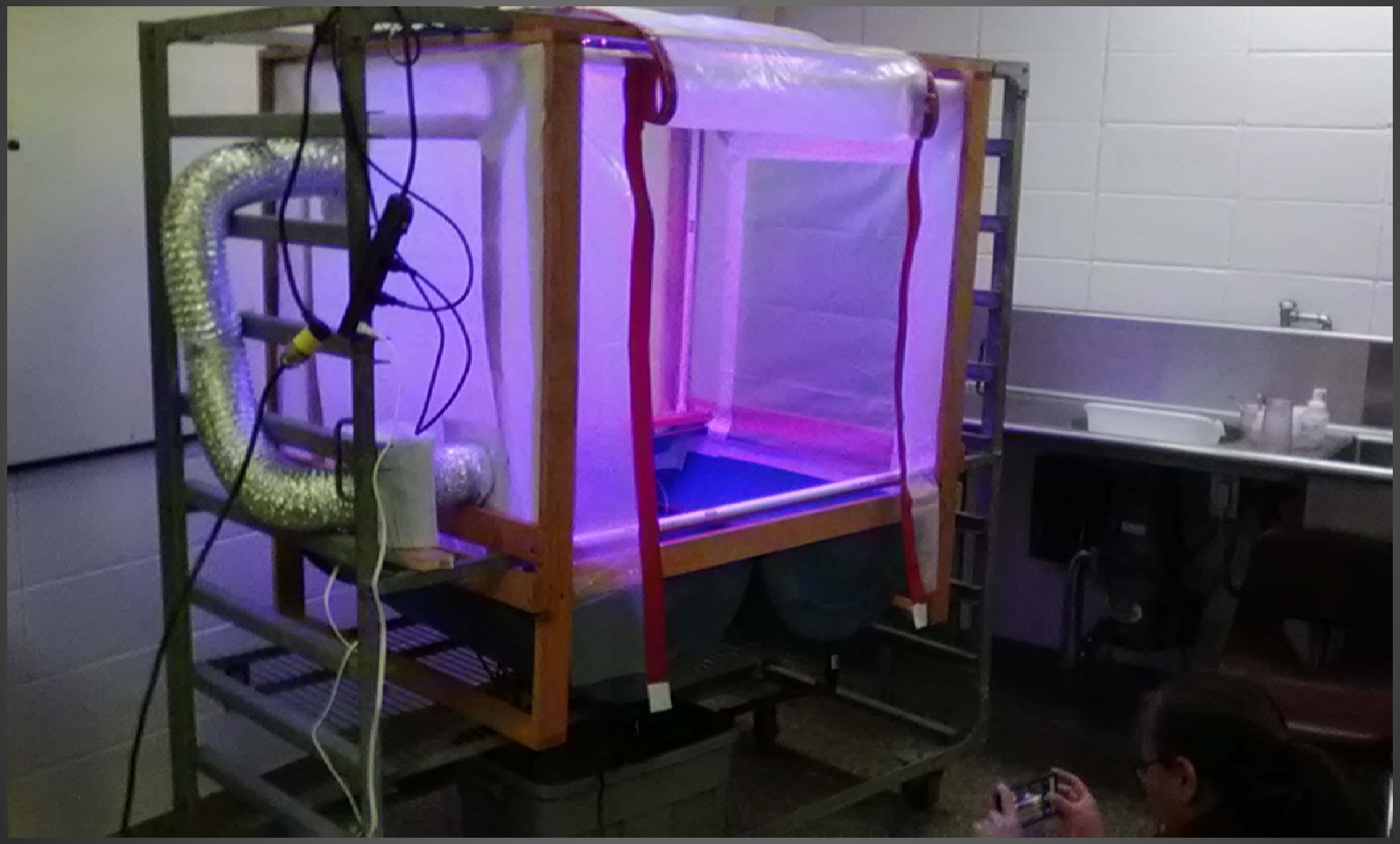
# Experiment Example

- What the final experiment will look like upon completion of system.

# Experiment Example

# Final Construction

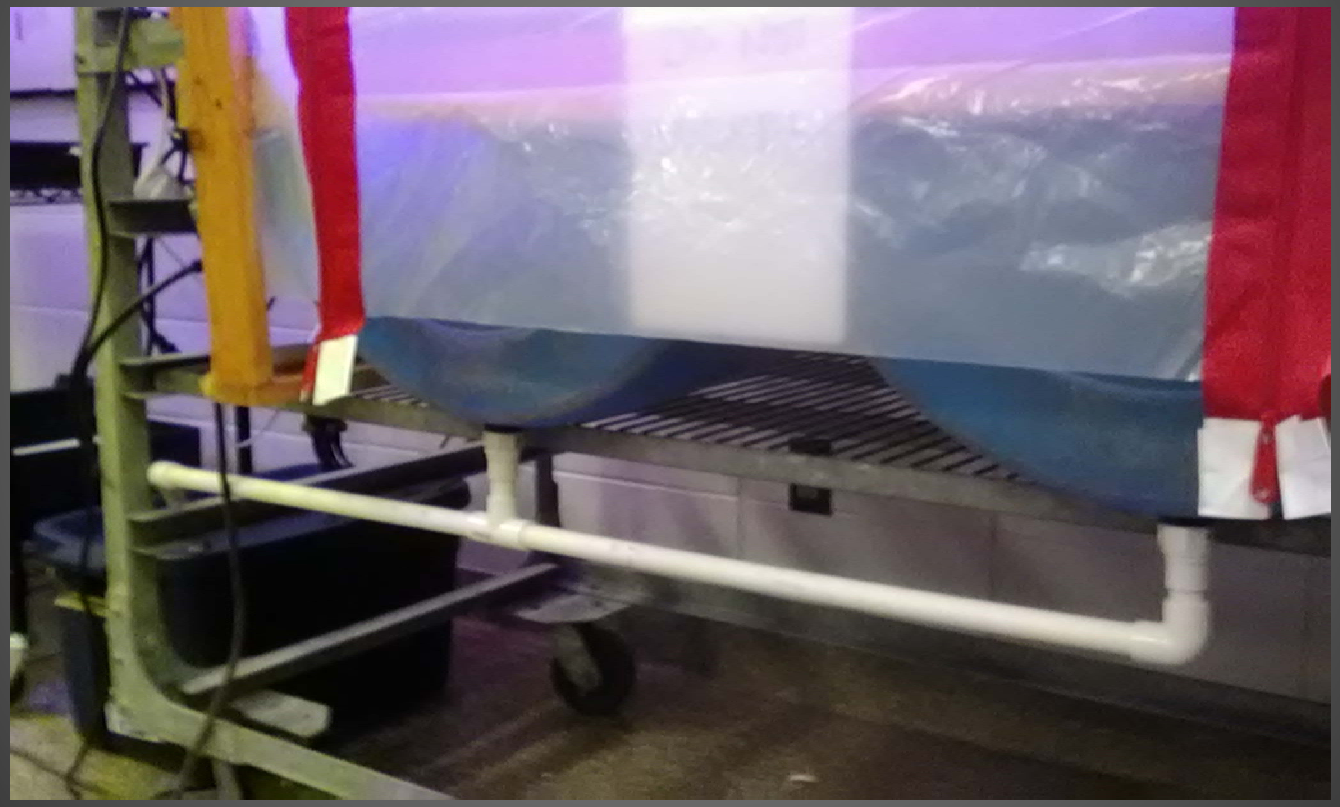
# Air filter attachment



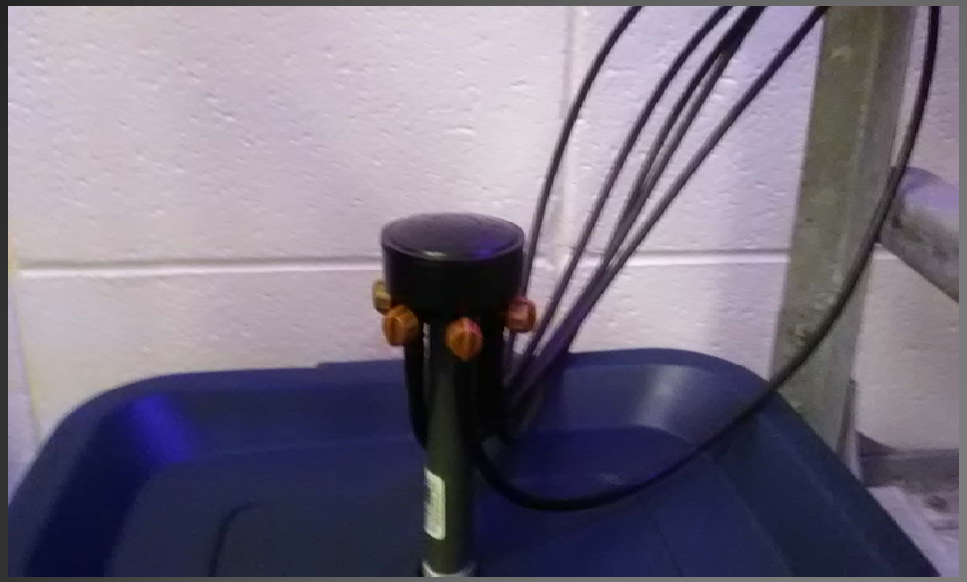
# Challenges

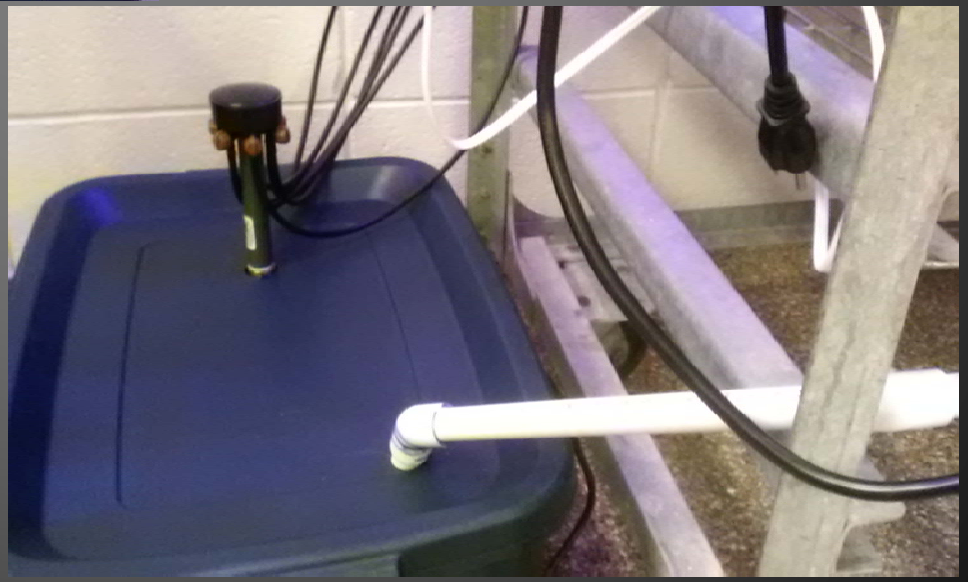
- Leaks in the drainage pipes required new design

# New Drainage Design



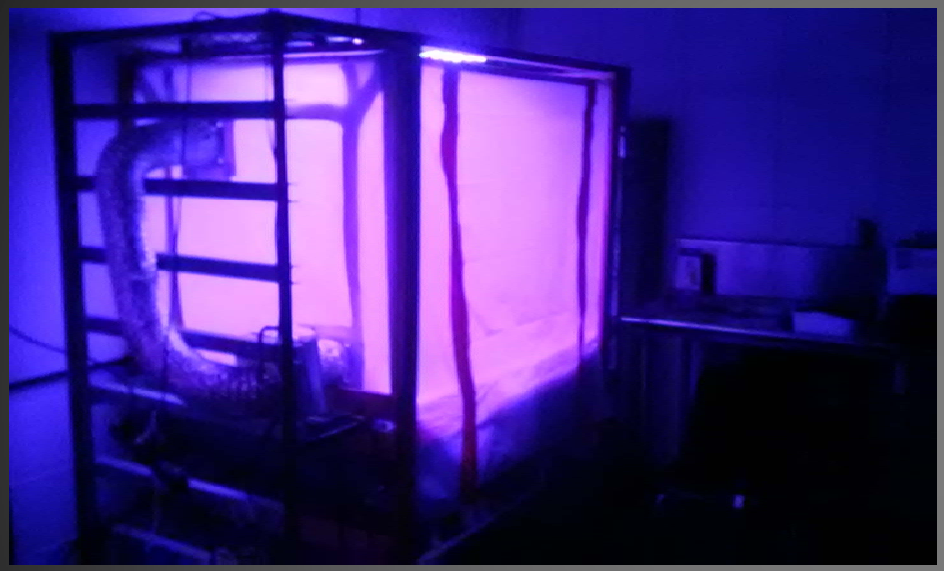
# Reservoir

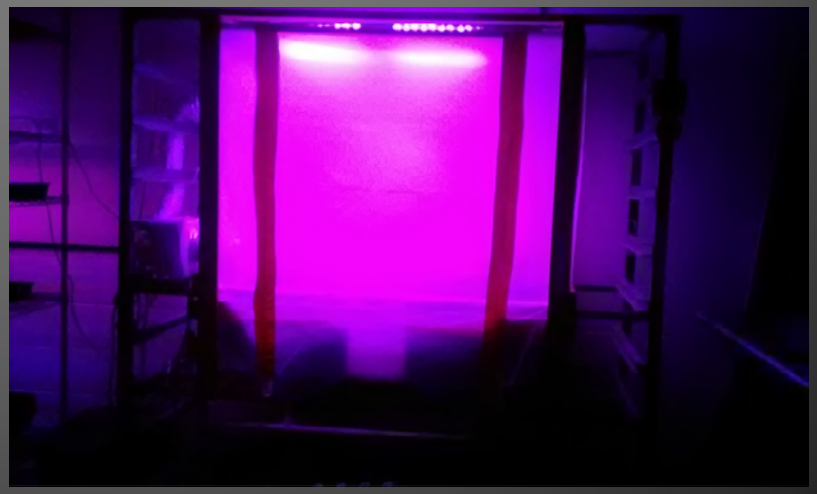


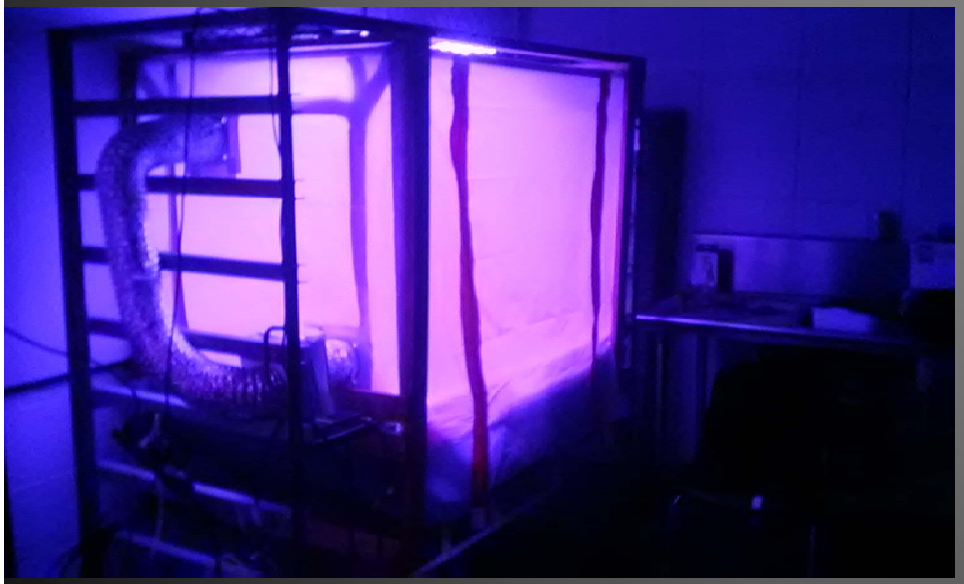


# System condition sensors

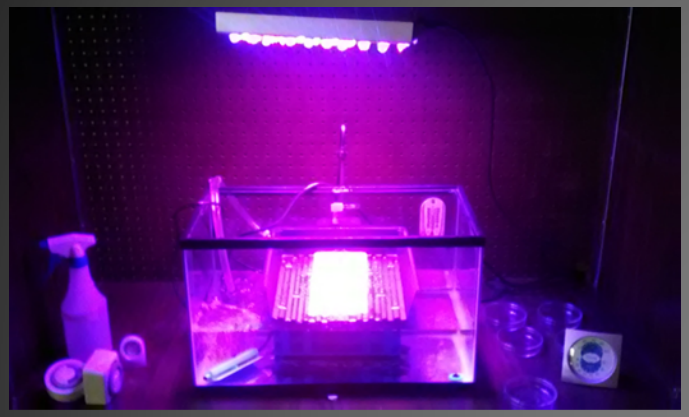
# Finished System

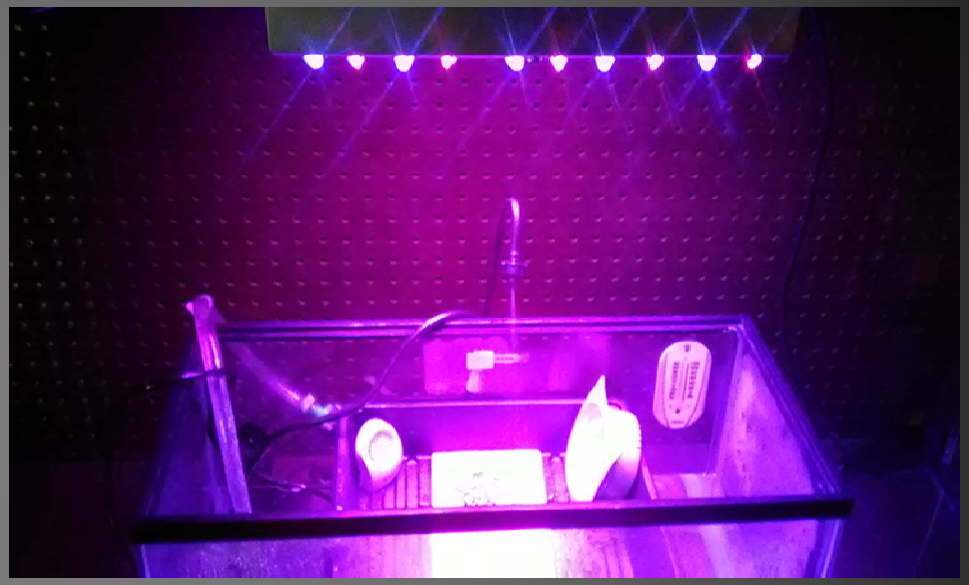


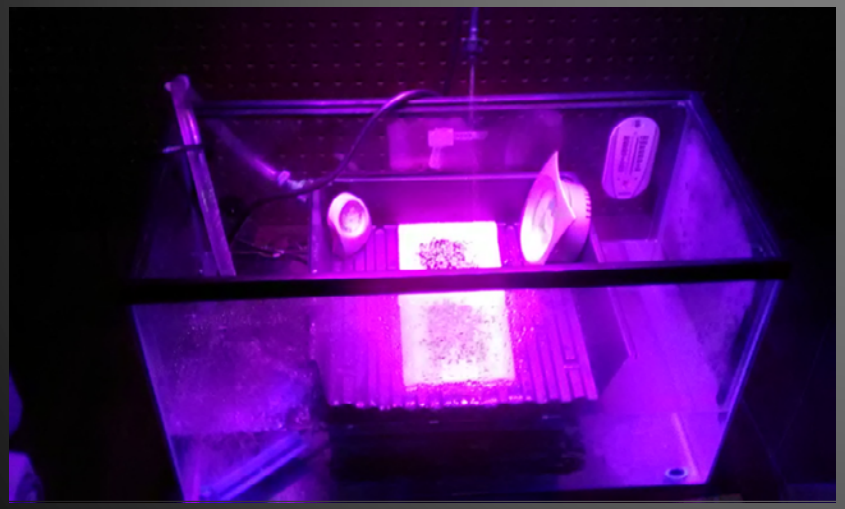




# LED Light experiment







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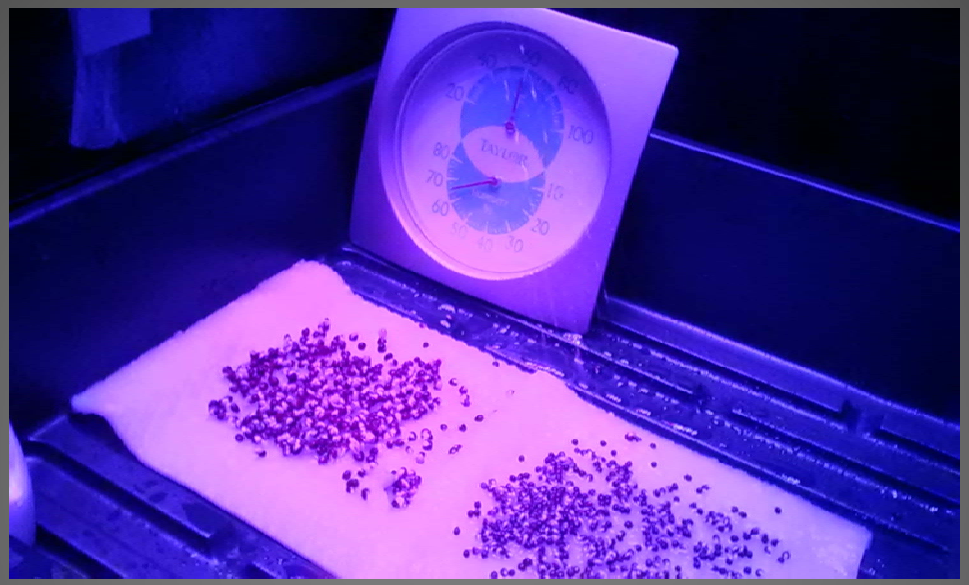
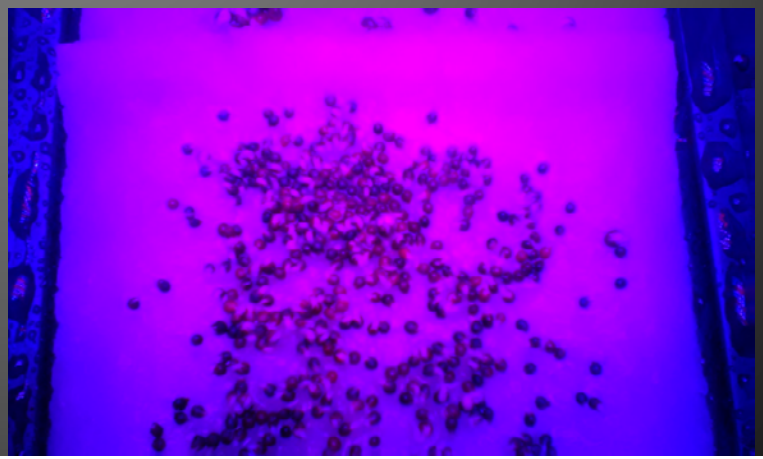


**Red Cabbage Vs Red Russian Kale**



# Micro-Spray Nozzle


Basil
- light quality
- growth rate