SVFS
(Smart Vertical Farm System)

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Abstract

The unremitting trends of increasing population, urbanization, diminishing water supply, and continuing climate change have contributed to declining stocks of arable land per person. Land available for farming is shrinking, and the demand for food is growing. All of these lead to food insecurity. For the first version of Smart Vertical Farm System is designed to increase food productions by an automatic system. It built with shelves which support soil and hydroponic system, stacked vertically. The system first shovels the soil in the tray and sews the seeds. There is also additional watering system. The hydroponic parts are on the second and third trays. And the final version is based on Circulated hydroponic. The system is using LEDs lighting instead of sunlight. Smart Vertical Farm System is an innovation that helps to produce high-quality, clean food while reducing time and water resources. It brings greater yields in smaller areas, increases access to healthy food in the urban area, and helps save the environment since it allows farmers to monitor their farms with greater accuracy and plan how to maximize yields.

Introduction

I first got interested in this project when I discovered just how damaging modern agriculture is proving to be. In fact, so many environmental problems stem from industrial scale farming techniques that it's actually worth listing a few: take for instance destruction of ecosystems and biodiversity due to the advance of arable land, or soil erosion and loss of soil fertility due to intensive farming, Pollution of water systems by fertilizers, groundwater depletion, herbicide and pesticide pollution and others. And as the human population is projected to grow by another 2 billion by midcentury, the UN estimates the world will have to increase its food supply by 28%. On top of that the amount of suitable agricultural land worldwide has in fact been in decline for the past fifty years. The purpose of my research is to investigate the feasibility of an indoor vertical farming system as an alternative to traditional landscape farming techniques.

Research Question

Experimental Questions 1
- What are the result of 3 farming methods in term of seed germination and growth rate?

Methodology

1. We set up 3 trays and in each we sowed 30 seeds. During the experiment, which lasted 25 days, all three trays were situated outdoors and exposed to the same fluctuations in weather, temperature, and pests.


1.1 Soil substrate — This tray contained regular soil purchased from a garden center. With regards watering, We used an automated system which maintained a constant level of moisture in the substrate.

1.2 Static hydroponic — This tray contained no soil at all, instead the seeds were anchored in small sponges and submerged in water to begin with and a static hydroponic nutrient solution after germination.

1.3 Circulated hydroponic — This tray contained nutrient solution was circulated and aerated continuously using a pump.

2. Collecting and recording the seed germination and growth rates.
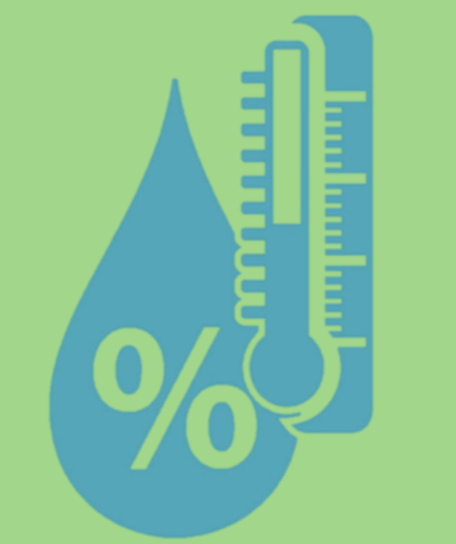
2.1 **Studying Seed germination** of morning glory plants from a different farming method as shown in figure 2. And calculated using this formula.

$$\frac{\text{Amount of plants} \times 100}{30} = \text{Seed germination (\%)}$$

2.2 **Studying Growth rate** of morning glory plants from different farming method. By measure using Vernier caliper from top to bottom every 5 day. And weighed after harvesting morning glory plants.

Results
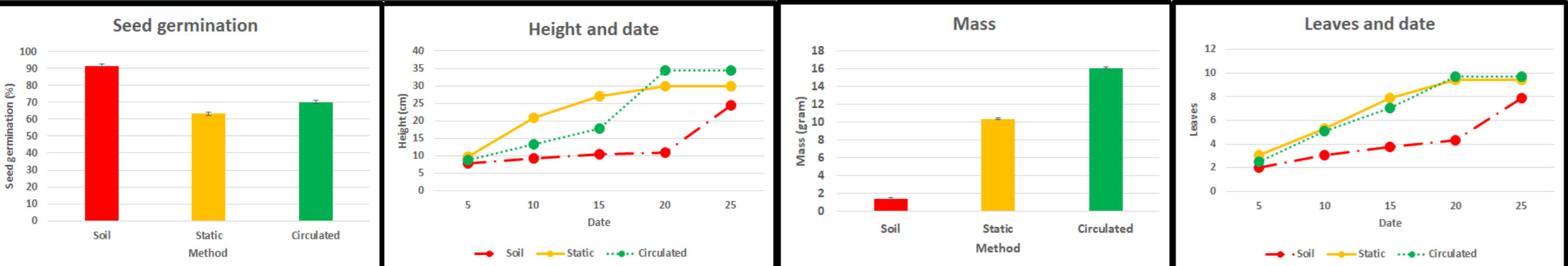
We found out that Circulated hydroponic is the best method in term of Growth rate, weight and amount of leaves. Therefore, Comparing circulated hydroponic to the others farming method it will produce more biomass with same given spaces. But all three trays were situated outdoors and exposed to the same fluctuations in weather, temperature, and susceptibility to pests. So we want to make an innovation to solve these problem.

Smart Vertical Farm System (SVFS)

Smart Vertical Farm System (SVFS) is our innovation based on vertical farming. Which productivity scales up with a stack of trays. Our farm consisted of four main systems.

1. Light controller — This system will control the intensity and ratio between red and blue of the artificial light.

2. Humidity and temperature — Optimized for a different type of plants. Such as winter plants, summer plants and etc.

3. Nutrient mixer — Whether you wanted to use liquid or solid nutrient. This mixer will calculate and mix the nutrient

4. Internet of Things (IoT) — Monitoring your plants is easier with this system via internet.

Research Question

Experimental Questions 2
- Which indoor or outdoor farming method appropriates in term of seed germination and growth rate?

Methodology

We set up a single tray of morning glory plants using the circulated hydroponic setup that proved so successful in the previous stage. The plants were screened from all extraneous light - now the only light source is a 12 Watt equal ratio blue/red LED lamp programmed to illuminate for 12 continuous hours. We maintained an ambient temperature of 29-32 ℃ and a humidity level of 60-70%.
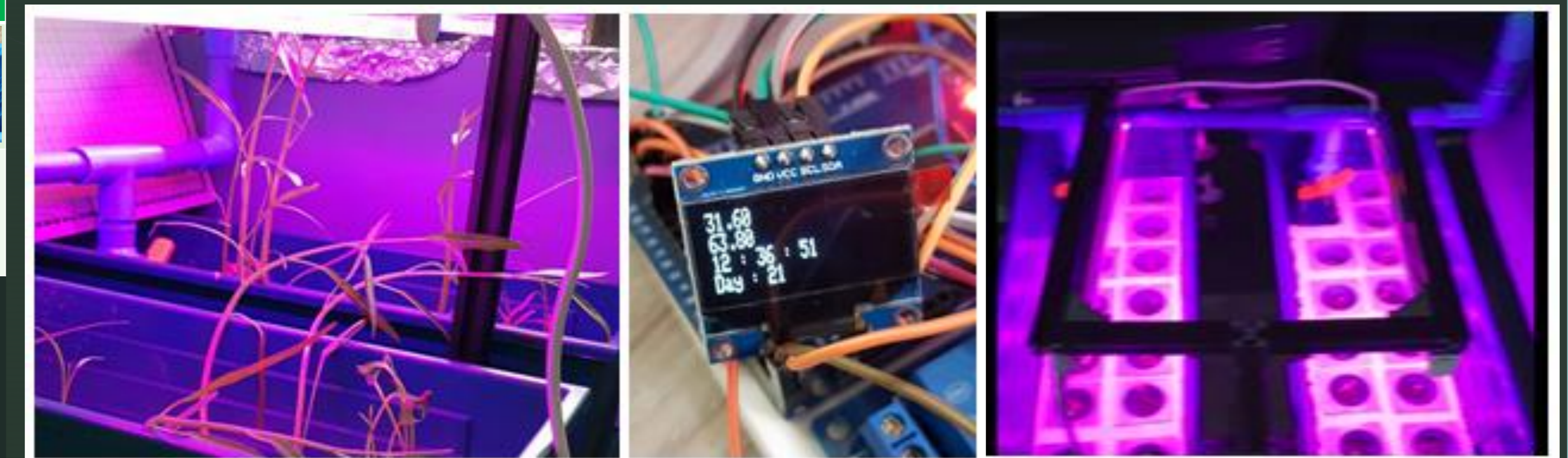
Results
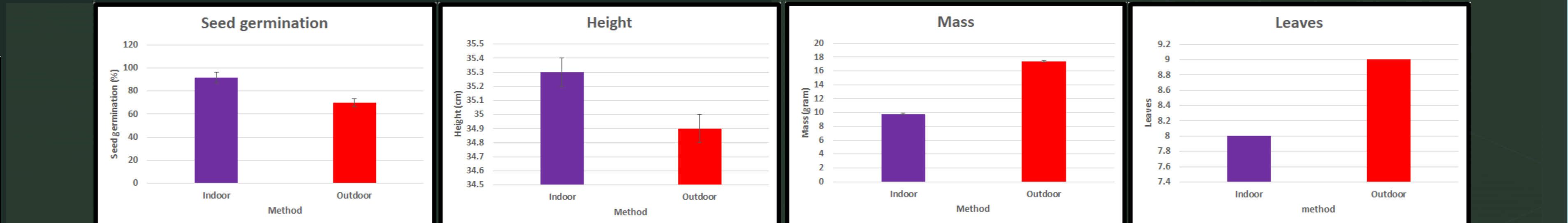
At the end, Indoor Morning glories grow slightly Higher than Outdoor Morning glories and better in term of seed germination too. The reason that Indoor Morning glories are higher is light that it got is controllable and stable. And the reason that the seed germination is higher is the rain might dilute the nutrient solution. But in term of mass and amount of leaves, Outdoor Morning glories are slightly better than Indoor Morning glories. That might be because of the light intensity is not the right lux for Morning glory. So in the given area Indoor farming is the best in term of biomass. Because the germination is much higher.

The advantages of SVFS

1. **It's more productive**, farms are designed vertically so that plants can be produced in as many levels as possible with the given spaces.
2. **It's more sustainable**, Since farms are indoor, no pest will be able to destroy our plants.
3. **It enables you to enjoy fresh produce all-year-round**, Each product from traditional farming naturally has its own season. But since the environmental and season factor is minimized to almost a zero. It is possible to harvest anything any time years round.
4. **It's simple.** The farming skill that is necessary for traditional farming, are being replaced with an automatic system that we design. All information about plants is stored in our database. And will be used according to plant selection.

What we learned

We learned a lot from this project. Such as :
1. We learned how to adapted scientific to innovation.
2. We learned how to use scientific method.
3. We learned how to turn our idea into the reality.
4. We learned how to work with each other.

Acknowledgments

Future Research

We have to improve SVFS so that it easier to use, cheaper or more accessible, use less energy and clean energy such as solar generator, water generator, etc. Then we have investigated more information about each different plant. Such as temperature needed, humidity, light intensity, spectrum ratio and many more.

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