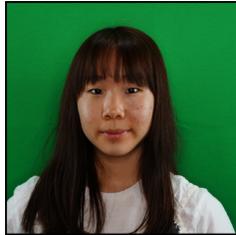
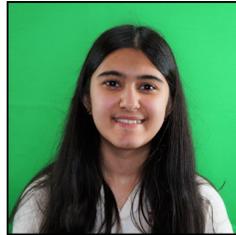


# Cost-Effective Compact Indoor Vertical Farming with Aeroponic and Hydroponic Systems



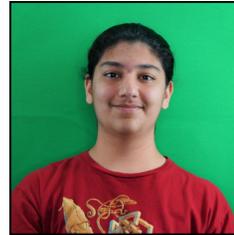
Aila S.



Avissa K.



Amartya S.



Baseem A.



Clare B.



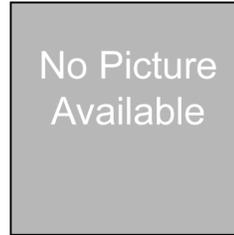
Fritz P.



Michele C.



Rhanya P.



No Picture Available

Sophie L.

## ABSTRACT

*Aila Shibao • Amartya Setty • Avissa Khoshsar • Baseem Abusneineh • Clare Bailey • Fritz Pullara • Michele Chan • Rhanya Perez • Sophie Loewner*

## PURPOSE

The purpose of this project is to find a more eco-friendly and sustainable way to grow food by reinforcing hydroponics and aeroponics plant cultivation methods. “-vertical farming can potentially emit 70% less CO<sub>2</sub> compared to open field agriculture, with additional benefits of 95% less land use and 80 to 90% less water use.... Vertical farming can substantially reduce the amount of food waste.” (Labrie) Knowing this, our project aims to help preserve and better the ecosystem around us and for the future generations after we are gone.

## BACKGROUND

The use of aeroponics and hydroponics systems for indoor plant cultivation has recently gained importance due to its promise of a soil-less and controlled growing environment. Compared to traditional farming methods, hydroponic and aeroponic systems allow for denser plant volume and utilize less land. “The use of less land provides forests and biodiversity hotspots space for animal populations to thrive, as about 40% of the Earth’s surface is currently

used for agriculture”, (Dongyu), and that number is growing. Vertical farming systems can be grown and properly maintained year-round even when outdoor conditions would not be ideal. Additionally, the use of large automobiles would be greatly reduced as vertical farms can be grown, which would immensely reduce carbon dioxide buildup in the atmosphere.

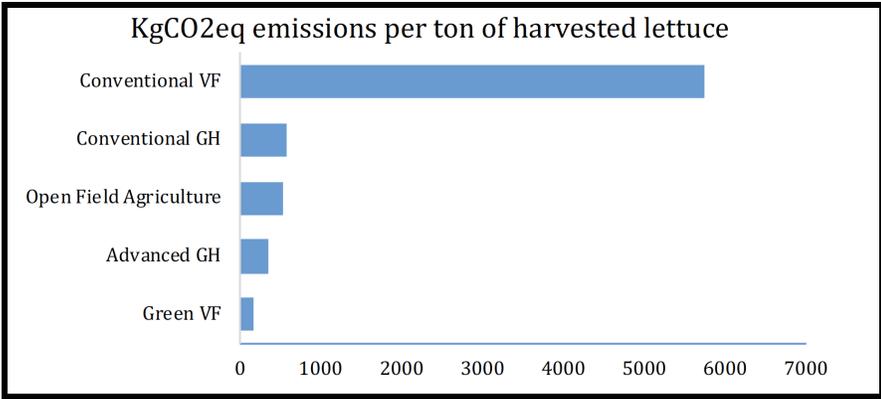
It is believed that hydroponics was first used in the hanging gardens of Babylon as well as the floating gardens made by the Aztecs of Central America. The first formula for a nutrient solution that could dissolve in water and support plant growth was successfully created in 1860 by Julius von Sachs. Dr. William F. Gericke created the word “hydroponics,” *hydro* meaning water, and *ponos* meaning labor. (*The History of Hydroponics*). The aeroponics systems for this project were based on the findings of Richard Stoner. He created the first aeroponically grown food sold in a national grocery chain. Stoner was inspired by the system’s capacity to conserve resources and efficient use of water. This research was noticed by NASA, who began funding Stoner’s research and eventually teamed with him to experiment with aeroponic systems on the Mir space station (Guy).

## PROCEDURE

Throughout this project, research was conducted to design an efficient and sustainable way to grow food. Two aeroponic systems were assembled to grow lettuce and spinach seeds using a sprinkler system that moistened and delivered nutrients to the plants’ foam holders and to their roots. After the seedlings grew their true leaves, they were moved into the hydroponic ebb and flow system, which flooded the seedlings in the rockwool with aerated nutrient-rich water that had been carefully tested. Both systems were situated in a PVC pipe structure that was properly measured, cut, and secured. The PVC structure included a place for lights to hang and a place for the bucket underneath the container the plants sit in.

This project is still ongoing and will be expanded upon in the near future to establish a new viable way of agriculture that benefits human health and the environment.

Included below is the KgCO<sub>2</sub>eq emissions for different types of agriculture. Green VF refers to vertical farming. An average of 62% emissions from open-field farming is linked to transportation of crops.



## Work Cited

Dongyu, Q. (2020, May 7). *Land use in agriculture by the numbers*. Food and Agriculture Organization of the United Nations/Sustainable Food and Agriculture. <http://www.fao.org/sustainability/news/detail/en/c/1274219/>.

Guy, Charlie. (2021, February 17). *Taking aeroponics back to its roots: The history of aeroponics and why it matters*. LettUs Grow. <https://www.lettusgrow.com/blog/history-aeroponics>.

*The Natural Farmer* Writers. (2018, January 9). *The History of Hydroponics*. The Natural Farmer. <https://thenaturalfarmer.org/article/the-history-of-hydroponics/>.

<https://www.greenforges.com/blog-index/how-different-types-of-agriculture-impact-on-co2-emissions>

<https://www.researchgate.net/publication/257776568> *Technical and Economic Analysis of Aeroponics and other Systems for Potato Mini-Tuber Production in Latin America*

<https://www.greenforges.com/blog-index/how-different-types-of-agriculture-impact-on-c02-emissions#:~:text=Based%20on%20the%20results%20from,the%20amount%20of%20food%20waste.>

Goals:

Create a successful hydroponic/aeroponic farm

1. Research phase
  - a. Finding parts such as PVC pipes and plant-safe containers
  - b. Studying plant biology to decide which plants to grow
  - c. Research examples of existing vertical farms and similar concepts
  - d. Choosing which types of farms to create
  - e. Finding electronics such as timers, lights, sensors, pumps, and powerboards
  - f. Research timings for lighting, misting, ebb and flow flooding, and other automated procedures
  - g. Creating an efficient design that kept the ideals of hydroponics in mind
  - h. Measuring the lengths of PVC and tubing for ordering
  - i. Figuring out the nutritional requirements the plants need to grow

# Abstract - ROUGH DRAFT

Due January 26, 2021 10:00 PM

## Instructions

The abstract is a concise summary of the key points of the paper. (Do not indent the first line).

The abstract is between 150-250 words. This is a BRIEF summary of your report, including the nutshell of your results and conclusions.

Write the abstract last, after all your results and analysis are finished.

Consists of 4 sections:

- The purpose of the research or research problem
- The general overview of the procedures used
- The principal findings from the data
- Conclusions

THE ABSTRACT SHOULD NOT :

- Include subheadings such as purpose, or results. You will simply have 4 indented paragraphs.
- Use the first person. Instead use 3rd person past tense (Ex: "the height was measured using...")
- Include information or conclusions that are not stated in the paper.
- Emphasize minor details.
- Contain bibliographic references, figures, or tables.
- Use jargon or abbreviations.

Attached are examples of the FORMATTING of your Abstract. PLEASE MAKE SURE THAT YOUR FORMATTING MATCHES THE EXAMPLES ATTACHED.

List of parts purchased:

2" Net Pots

submersible pump

Rainbow foam starters

Rainbow foam starters

Hole saw  
 Hole saw twist drill bit  
 120 cell seed starters  
 hydroponics plant nutrition  
 active aqua hydrofoam air stones  
 growlight hanger s-query  
 aquatic experts mesh  
 Ebb + Flow fitting kit  
 Redrock rockwool 4' growing  
 VIVOSUN 400 GPH  
 Wichbeen 3 way pvc window  
 QWORK 4 way PVC  
 Chairlin waterproof trays - 2 piece  
 Goabora Mini Hydrometer  
 Camco GardenPURE hose filter  
 Arduino Probe  
 Atlas Scientific Analog pH kit  
 Fosmon light timer x 2  
 Grodan rockwool mini plugs

Table for plant size and classification


Some links for examples of abstracts;

<https://www.tandfonline.com/doi/full/10.1080/17429145.2018.1472308>

<https://www.sciencedirect.com/science/article/abs/pii/S0269749120319333>

<https://www.publish.csiro.au/FP/FP09202>

<https://ieeexplore.ieee.org/abstract/document/8300782>

<https://onlinelibrary.wiley.com/doi/full/10.1002/pld3.312>

<https://scisoc.confex.com/crops/2014am/webprogram/Paper86883.html>

<https://www.proquest.com/openview/b9c41a7feaf215cca6d8591ce2a0d501/1?pq-origsite=gscholar&cbl=1596357>

^

Brakes down (a little) of what needed to be focused on for the abstract

<http://www.fao.org/sustainability/news/detail/en/c/1274219/> cites 38% land is for agriculture

<https://blog.zipgrow.com/water-use->

## Water loss in traditional systems

Traditional gardening requires **20 times the water use of a recirculating system**. *Why is that?* Agricultural flood irrigation in large fields loses water to simple evaporation, runoff, and dispersion beyond the reach of plant roots. The agricultural industry is changing its practices to be more water-wise, but even the best drip irrigation only cuts flood irrigation losses by about **one-fourth**, nothing close to hydroponics.

[efficiency-hydroponics-aquaponics/](#)

<https://www.nps.gov/articles/hydroponics.htm>

<http://environment-ecology.com/ecological-organic-agriculture/246-hydroponics.html>

