NATURALLY VENTILATED AUGMENT COOLING GREENHOUSE:

A Step Towards Solving Food Security Problems in Barbados.

The Mentors

Dr. Mark Lefsrud, headed this project. He is an Associate professor in the Bioresource Department at McGill University. He is part owner of the patent for this greenhouse design.

Lucas McCartney is a Ph.D. candidate in the Bioresource Department at McGill University working under the supervision of Dr. Lefsrud. He is partially responsible for the NVAC design and a part owner of the patent.

Acknowledgments

We are extremely grateful to Sandy and Simon Cannon for trusting us to modify their greenhouse. We also appreciate their endless help and guidance in all project matters.

Introduction

This project consisted of building a modification to a tropical greenhouse design. The modification uses natural ventilation and a misting system as a catalyst to enhance this natural process and is called Naturally Ventilated Augment Cooling (NVAC). In contrast, the original greenhouse uses fans and power medium to lower the temperature and humidity and provide a microclimate optimal for hydroponic plant growth. The NVAC greenhouse design was created with cost-effectiveness and energy efficiency in mind.

Lucas McCartney created this design specifically for tropical climates under the supervision of Dr. Mark Lefsrud at McGill University. The current norm of using conventional fan-powered greenhouses is not sustainable for the long run in these areas (Lefsrud and McCartney, 2013). Barbados has a major food security problem with importation of food that could potentially be grown on the island. Related challenges are land and water scarcity (Wiltshire, 2009). Crop cultivation using the NVAC design deals with all these problems because greenhouses can be put up on all levelled surfaces and reduce water usage by up to 95% compared with field cultivation.

Project Objectives

Promotion of Greenhouse Agriculture has been high on the agenda of the Barbados Ministry of Agriculture and Rural Development. Local agriculturalists, Sandy and Simon Cannon were keen to let the team carry out this project on their premises in the hope of aiding greenhouse production on the island as a whole. The idea was to create an economic and environmentally- friendly design that would encourage more locals to take up crop cultivation in greenhouses, reducing dependence on foreign markets for food.

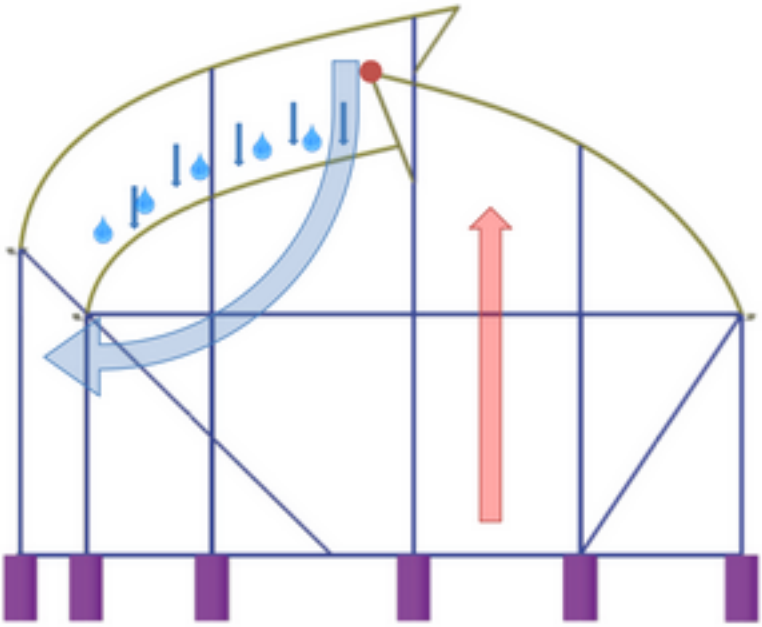
Project Activities

The team took a lay of the land, measurements of the greenhouse to be modified and set to work. An important part of the operation was to order supplies. The supplies were ordered in the first week with longevity and cost-effectiveness in mind. A rainwater storage and harvesting system was set up in order to provide water for the misting line. This catchment system was hooked up to the farm's total supply as a contribution. A vacant piece of land was cleared up for the building activities. The parts such as metal tubes and framing were modified outdoors to keep the plants' environment clear. Straight metal poles were bent to the curve of the existing roof using a metal jig.

A gutter system was installed to collect the water for the misting line. All the pieces for the sprinkler system were laid out to get a visual of the additional roof outdoors before construction started. Once the present crop inside the greenhouse was harvested, the team started construction inside. Using step ladders and extension ladders the team put up crossbeams, drop down bars and bent tubes for each individual section as well as the misting line and the gutter system. There were six sections in total. These sections were assembled and then covered with a UV-resistant plastic sheet. A crucial part of this project was data collection. An Onset HOBO data logger was set up and sensors put in place to strategically measure light, temperature and relative humidity. This system was set up for 30 days in a control greenhouse with a conventional two-roof design. Following construction, for approximately 21 days, data collection was shifted to the modified greenhouse.

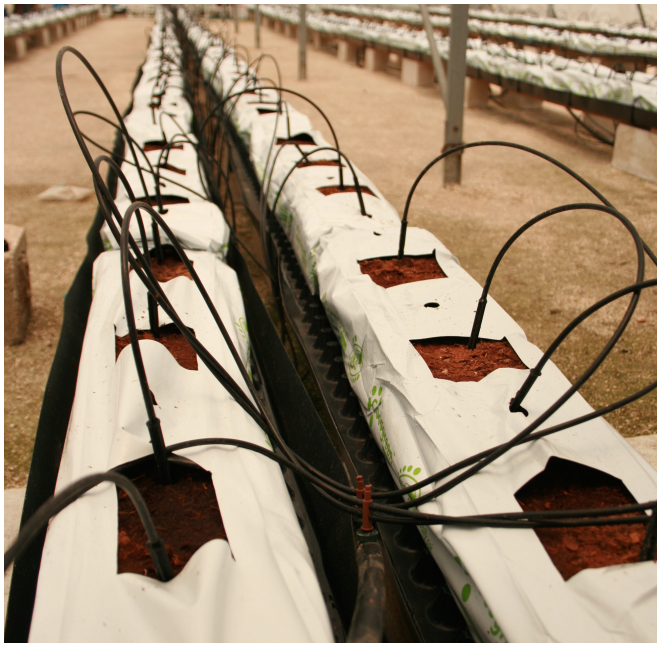
How the NVAC Greenhouse works

The NVAC system's unique design combines a triple roof structure with water to create a cool and controlled climate within the Greenhouse. By spraying mist over the lowest of the three-roof system, the structure reduces damage to plants by replacing warm air with cool air.
The diagram demonstrates how cool air is driven to the lower part of the structure forcing warm damaging air to rise. This cyclical process ensures a continuous flow allowing ideal conditions for plant cultivation.



Conclusion

Overall, the experiment was successful. Building on the island was a rewarding experience. Hardware stores and experts were keen to help the team once they heard about the project and what it intends to do. The owners were glad they allowed the modification to take place in their greenhouse. The new installation itself, built by our project team, reduced the temperature inside the greenhouse by 2-3 °C. The temperature sensors inside and outside of the greenhouse confirmed this change. The misting line was especially effective in cooling the incoming air and caused a good rate of airflow in and out of the greenhouse. Almost all the water used by the misting line was recovered through a gutter system hooked to the hydroponic water-recovery system. We clearly demonstrated that this new NVAC design is a viable option for hydroponic growers in tropical environments such as Barbados.



References

Wiltshire, C. (August, 2009) "Greenhouse Operations Manual." Editorial. *Leeds University*

McCartney, L. Lefsrud, M. (2013, December 12th). “Natural Ventilated Augment Cooling Greenhouse”, Department of Bioresource Engineering: Greenhouse Seminar, Montreal.

The Team: Dillon Fields, Zainab Iqbal, and Ryan Knight with mentor Lucas McCartney.