Naturally Ventilated Augmented Cooling Greenhouse

Introduction

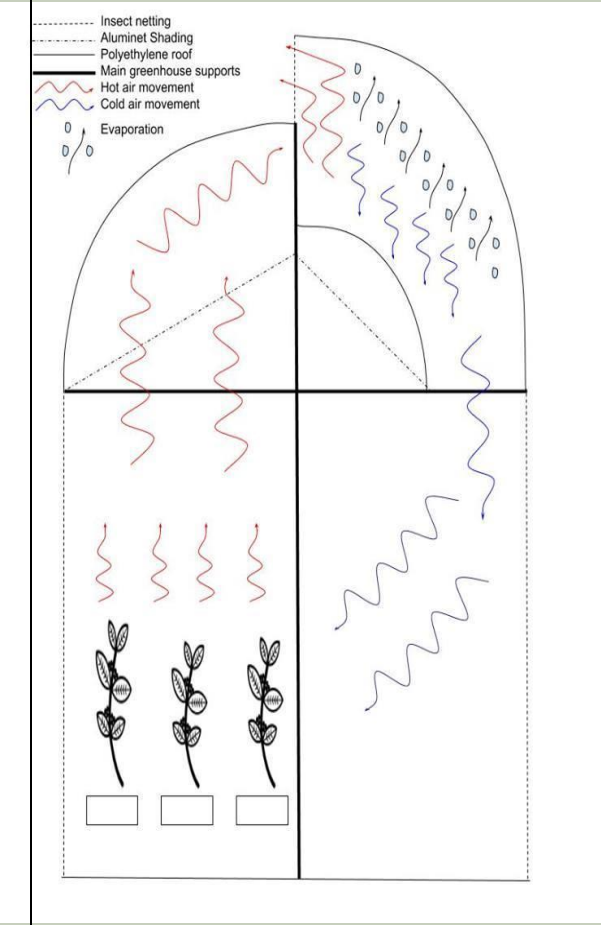
The Bellairs Naturally Ventilated Augmented Cooling (NVAC) Greenhouse Project started in summer 2016, when BITS students laid a cement foundation and assembled the skeletal framework. Our BITS 2016 team completed construction, and established the working systems, including the misting line and hydroponic system. We also grew the first hydroponic crops to produce food for the campus and The Green Lime cafe. Using a data logger and sensors, the temperature and relative humidity in the greenhouse were examined with and without the misting line in use.

The NVAC greenhouse design, patented by Dr. Mark Lefsrud and Ph.D. candidate Lucas McCartney, addresses issues relating to air circulation and high temperatures which are non-conducive to protected agriculture in the tropics. With energy efficiency in mind, the NVAC design replaces traditionally used fans with a novel split 3-roof design and misting system. The greenhouse misting system utilizes the evaporative cooling potential of water and convective properties of air. Air that has been cooled by the misting system will become denser, causing it to collapse into the growing canopy. While hot air, which is of a lower density, will naturally rise and exit the greenhouse structure via the split roof at the top of the greenhouse. This results in a cost effective mode of air circulation and promotes optimal conditions for plant growth in tropical climates.

The NVAC Greenhouse Project at Bellairs Research Institute will aid Bellairs Research Institute to produce its own produce for guests while creating an example of sustainable agriculture for the island as a whole. The hope is to model an efficient solution to food production in this isolated, energy scarce and tropical country of Barbados. The NVAC can respond to the country's high dependency on food imports, and contribute to a greater level of food sovereignty.

Project objectives

The overarching objective of this project was to complete construction and test the effectiveness of Dr. Mark Lefsrud's and Ph.D candidate, Lucas McCartney's, NVAC Tropical Greenhouse, while providing Bellairs with its first crop of home-grown, cost effective, produce. These activities were also done with the objective of prompting on-island interest with respect to local agriculture and food sovereignty.



Project activities

1. Completion of building phases of the greenhouse.

The first main focus of our project was to finish the construction of the greenhouse. This consisted of finishing construction of the roof and establishing systems in the greenhouse. Water was run from the Brinks building rainwater catchment to supply the hydroponic system, which was also built this summer. Electricity was run from the Brinks building to give power for the pumps in the greenhouse.

2. Test the NVAC's properties and overall utility in a tropical environment & Grow the first hydroponic crop in this new NVAC structure.

A number of plant species were grown hydroponically and will be used to supply food to Bellairs kitchens for the first time. These crops include tomato plants (*Solanum lycopersicum* 'Heatmaster'), cherry tomatoes (*Solanum lycopersicum* var. *cerasiforme*), cucumber plants (*Cucumis sativus* cv. unknown), Swiss chard plants (*Beta vulgaris* sub. *Vulgaris* cv. unknown) sweet pepper plants (*Capsicum annuum* sub. *annuum* 'King Arthur'), and chili peppers (*Capsicum annuum*). Testing the greenhouse involved collecting temperature, relative humidity, and solar radiation data using data loggers. A manual has been written for the purpose of continuing hydroponic food production in the greenhouse.

Conclusion

Overall, the greenhouse construction and implementation of all systems was successful. The NVAC system is able to cool the temperature by about 1°C, making the greenhouse a more hospitable environment for plants. Currently, plants are flourishing in the greenhouse and beginning to produce fruit.

Acknowledgements

We would like to extend a warm thank you to the Bellairs Research Insitute for providing us with the space to realize this project. We would also like to thank Lucas McCartney for giving us the opportunity to work with him on his Ph.D.'s focus and we hope we were able to positively contribute to the testing of his and Dr.Lefsrud's patented design. We are also reconaissant to McGill BITS Students, Brittany Curry-Sharples, Carmen Raffa and Dominic Silk, for their preliminary work on the greenhouse in the summer of 2015. Finally, thank you to M. Small, M. Rowe and Kevin for their support and interest in taking charge of the greenhouse and ensuring its continuation in terms of local food production.

Carry-Sharples, B, Raffa, C; Silk, D. 2015. Naturally Ventilated Augment Cooling (NVAC) Greenhouse: Operation and Construction Of The Modified Greenhouse Design. July 2nd 2016.

Department of Bioresource Engineering-McGill University. 12 August 2015. NVAC Tropical Greenhouses. http://nvactropicalgreenhouse.weebly.com/uploads/2/6/5/6/26565401/4325877_o rig.png

McCartney, L., Lefsrud, M. 2014. Natural Ventilation Augmented Cooling (NVAC) Greenhouse: Trials Of a Greenhouse Design For Tropical Climates In The Caribbean.June 24th, 2016.