Natural Ventilation Augmented Cooling (NVAC) Greenhouse

Introduction

Barbados is a small island developing state (SIDS) country, meaning that due to their small size, limited production capabilities, and limited arable land leaves them highly dependent on food imports. However, this raises the food import bill and makes life on the island more expensive. An upward trend in the number of new greenhouses along with increased local field production in Barbados would alleviate the steep prices faced by Barbadian consumers. Our project involved the first phase of construction of a small-scale model NVAC greenhouse on the Bellairs property. Phase two will involve covering the greenhouse with polyethylene sheeting, building the hydroponic plant growth system, and implementing the NVAC design components.

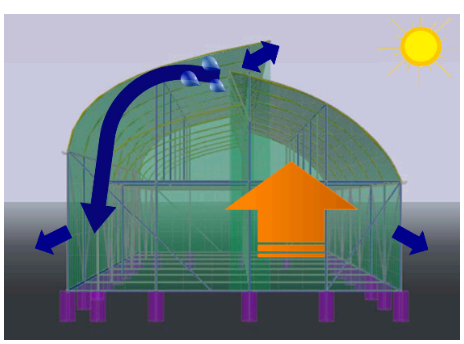

Figure 1: NVAC Greenhouse Airflow

The NVAC greenhouse design was patented by Lucas McCartney, doctoral candidate, and Dr. Mark Lefsrud of the Bioresource Engineering Dept. at McGill University. The Bellairs greenhouse build is integrated into Lucas's Ph.D. research and funded by McGill's Sustainability Project Fund. The Bellairs greenhouse will provide vegetables to be used in cooking at the Bellairs Research Institute and provide a hands-on learning tool for McGill students and faculty, as well as locals. The construction of the greenhouse provides a model that could be made available locally in Barbados.

In addition to the Bellairs greenhouse build, we worked at a commercial greenhouse that was retrofitted with the NVAC components by a former BITS group in 2014. We helped to fix the misting system that that was no longer operational. Fixing the misting system required taking it down and installing a new system to compare filter vs. non-filter spray nozzles.

Objectives

The promotion of greenhouses in Barbados is currently supported by the government in an effort to create a more sustainable and environmentally-friendly country. The Ministry of Agriculture has been pushing towards increased funds for the agricultural sector in order to support locals attempting to enter agricultural industries. However, due to the rise in tourism, attention to agriculture and the contributions that it provides for a country, have been forgotten by many. The owners of the commercial greenhouse support the proliferation of greenhouses in Barbados in order to improve food sovereignty and to encourage local production. In doing so, the importation of foodstuff would be lessened, and local production would stimulate local economic growth through domestic investment and spending.

Figure 2: Commercial Greenhouse

Activities

The team had two different projects, both requiring different activities and skills. The Bellairs greenhouse involved mapping the frame of the greenhouse and calculating measurements for the materials that would have to be purchased. Construction involved positioning angle irons into holes made by a rented bobcat, pouring concrete to create foundation piles for the positioned angle irons, and the attachment of all the components of the steel frame. This process involved a lot of measuring, calculating, and drilling. Additional activities involved the bending of the roof members to equal angles and attaching the roof members to horizontal cross beams.

The activities at the commercial greenhouse included coming up with a system for using 3 ladders and an angle iron to move along the roof of the greenhouse in order to unscrew the nozzles that clamped down the misting line. When the nozzles were removed, a pre-prepared misting line with 24 nozzles was put up. 12 nozzles had filters, while 12 did not. We again used the 3 ladder system to move along the roof of the greenhouse and attach all 24 nozzles to the hanging misting line. The rest of the activities done at the commercial greenhouse involved collecting data using HOBOware software and checking the rainwater collection tanks to monitor when we could turn on the misting system.

Conclusions

In terms of the Bellairs greenhouse, the conclusions drawn were that the split roof greenhouse design is relatively easy and feasible for those with no construction background to build, and at a reasonable cost. Some challenges with the construction involved limited tools and equipment available in Barbados, and the safety concerns that come along with not having proper safety equipment (such as ladders and scaffolding). For completion of the building project, our suggestion is that investment into the proper materials needed to more safely install the NVAC misting lines be purchased.

In testing the NVAC misting line at the commercial facility, we encountered some difficulties. First of all, there was limited rainwater available to run the automated system (which is completely reliant on rainwater harvesting for function), as well as limitations created by clogged nozzles in the misting line. As a result, there is preliminary data only. However, some conclusions could be made on the use and type of misting line for future NVAC greenhouses. We also discovered that using filters in the nozzles of a misting line caused material buildup and prevented the tube from spraying. Algal growth was decreased by using a black tube to limit the amount of light that could penetrate into the tube.

Acknowledgments

Throughout all the efforts taken during this project, success in building the Bellairs greenhouse and fixing the misting line of the commercial greenhouse would not have been possible without the support and help of many individuals and organizations, and we would like to extend a sincere thanks to all of them.

We are highly grateful for the support and cooperation from the Sustainability Project Fund at McGill, without which we wouldn't have been able to build a greenhouse at the McGill Research Facility at Bellairs. We'd also like to thank Lucas McCartney for his guidance, encouragement, and support as our mentor throughout the project, as well as his supervisor Dr. Mark Lefsrud.

Our thanks and appreciation go to Mr. and Mrs. Simon and Sandy Cannon for allowing us to work on their greenhouse and providing guidance and context surrounding greenhouses in Barbados. Lastly, our thanks go to the BITS team of Drs. Danielle Donnelly, Angela Fields and Mr. Chandler. We thank Donnelly for her support throughout the entire project, and for pushing us to keep striving for more. For all the other individuals who helped us out this summer, we are extremely appreciative of all the hard work and support you've given us!

McGill

THE UNIVERSITY
OF THE
WEST INDIES