Thesis Project Portfolio

Hydroponic Crop Cultivation as a Strategy for Reducing Food Insecurity

(Technical Report)

Hydroponics in Humanitarian Aid: A Review

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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Table of Contents

Sociotechnical Synthesis

Hydroponic Crop Cultivation as a Strategy for Reducing Food Insecurity

Hydroponics in Humanitarian Aid: A Review

Thesis Prospectus

Sociotechnical Synthesis

My technical project was a hybrid project between Systems and Civil Engineering, an extension of previous research done with the same grant under the same professor. Our challenge was to build a floating hydroponics farm that is capable of withstanding hurricanes and providing supplemental nutrition to local communities in small island developing states in the Caribbean. The Systems Engineering component was a systems analysis on two fronts: choosing the best agricultural technology to implement in small island developing states, and deciding the best application for hydroponics in humanitarian aid situations. We chose to conduct surveys seeking to answer each question separately. We used two different multi-criteria decision making models to analyze responses: a simple rate and weight calculation and the Analytical Hierarchical Process, which uses pairwise comparisons to create normalized weights. However, we did not receive enough data from either survey to make conclusions with any degree of significance.

The Civil Engineering component was to design and construct a floating platform capable of supporting the weight of a hydroponic crop cultivation (HCC) system. We created an 8'x8' platform supported by 6" of construction foam capable of supporting over 600 pounds of weight. Solar panels attached to folding storm doors power a pumping system that delivers nutrient fluid from a central reservoir to individual plant buckets, as well as providing enough surplus electricity for 3 days of communication, refrigeration, or continued system usage. In poor weather, storm doors fold shut to create a pyramid structure, protecting the plants and electronics from encroaching floodwater. We chose commonly available construction materials specifically with end users in mind – as academics, we may be able to purchase carbon fiber or high-tech floatation materials, but end users in small island developing states likely cannot. Additionally, we investigated a different method of HCC than previous research, called the Dutch Bucket

method. In this method, plants grow in five gallon buckets filled with a rocklike medium, and receive all nutrients from a system of tubing that sprays each individual bucket. Growing in separate buckets allows the system to grow multiple types of plants, so long as they have similar nutrient needs. We designed and constructed a small-scale prototype of the Dutch Bucket method, growing broccoli, basil, lettuce, and brussel sprouts. The system was very successful, and greatly outcompeted our control crops planted traditionally.

My technical project focuses on a singular application (floating hydroponic farms designed for deployment in small island developing states) due to the limitations of research grants and existing partnerships. For my Science, Technology, and Society research paper, I chose to examine other potential applications for HCC in humanitarian aid crises. I conducted a literature review of existing research on both hydroponics and humanitarian aid, specifically focusing on the intersection of both fields. I sought out social sciences sources alongside the more familiar science, technology, engineering, and math (STEM) research to balance out the potential strengths and weaknesses of each field and create a more holistic viewpoint. I discovered that HCC is a viable method of alternative food production and holds several advantages over traditional land-based agriculture, namely requiring fewer resources. Needing fewer resources means more people can use HCC, especially those who do not have access to the necessary resources for large-scale traditional agriculture. With increasing presence outside of academic circles comes the need for regulation and legislation surrounding hydroponics projects. However, the type and scope of said policies may vary wildly depending on the scale of the hydroponics project in question.

In STEM research the policy of removing any mention of people removes empathy for the people behind the data, particularly data related to mitigating humanitarian aid crises. Works

like anthropology or sociology papers that could either cover STEM blindspots or expose them to writers are written in unfamiliar formats and thus not fully understood. The overlapping blindspots in STEM and humanities fields create miscommunication in both hydroponics and effective humanitarian aid. This results in potential missed opportunities for new humanitarian aid applications or new avenues of research, as well as well-intentioned solutions rejected due to not fitting end users' needs. Overall, the role of HCC in humanitarian aid crises is one of long-term solutions intended to alleviate pressure on global food security and nutrition and not as disaster relief sent in the immediate aftermath of a crisis.