Hydroponic Crop Cultivation in Small Island Developing States

(Technical Paper)

Using CFA to Predict Technological Success in a Community

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree

Bachelor of Science, School of Engineering

Shayne Cassidy

Spring, 2020

Technical Project Team Members

Matthew Coulter
Tom Finkelston
Klara Hoherchak
Antonio Mendes de Almeida
Colin Patton
Griffin Ott
Kaila Stein

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

Signature Shayne C Shayne Cassidy

Approved _____ Garrick Louis, Department of Engineering Systems and Environment

Approved _____ Kent Wayland, Department of Engineering and Society

General Research Problem

What benefits could hydroponic crop cultivation potentially bring to small island developing states?

As global populations soar and natural resources remain stagnant, we are constantly in search of new agricultural technologies that can be leveraged to increase the food supply and food security for people around the world. One promising agricultural technology is hydroponics, which is a method of growing plants without using soil by instead using a supplementary nutrient mixture (Aires, 2018). Hydroponics may benefit places such as small island developing states (SIDS), which face immense food insecurity due to their geographic location. Examples of island states include Dominica, the Bahamas, and Samoa. As isolated islands, they rely heavily on food imports to feed local inhabitants and tourists (Thomas, 2017). Through the use of hydroponics, these island states will be able to increase domestic food production, thus decreasing reliance on volatile food imports that can be threatened by forces such as natural disasters. Through further research, I want to find out if certain states would benefit, if at all, from advanced agricultural technologies such as hydroponics. Additionally, the agricultural technology alone is not the only matter to consider. It is pertinent to examine the community itself to assess the likelihood of the locals sustaining hydroponics, which some may view as an obscure new agricultural technology. In my research, I will utilize Capacity Factor Analysis (CFA), which is a framework for determining whether or not a technical system can be effectively integrated and managed in a specific community. I hope to better understand what factors or combination of factors can lead to the successful adoption of a new agricultural technology, thus finding states and communities that are great candidates for a hydroponic initiative.

Hydroponic Crop Cultivation in Small Island Developing States

How can we redesign a hydroponic farming unit with a focus on natural disaster resistant features in order to reduce food insecurity in small island developing states?

SIDS can leverage new hydroponic crop cultivation techniques in order to provide a consistent food supply for their inhabitants, especially when food imports are compromised, such as in the aftermath of a natural disaster. Growing crops with hydroponics provides many benefits relative to traditional forms of agriculture, such as increased crop yield and conservation of both land and water (Aires, 2018). For SIDS, domestic agriculture is essential to maintaining a consistent food supply for its inhabitants, thus local islanders are a crucial stakeholder to any structural changes in the food supply chain. Islands states are often hit by major hurricanes that disrupt food imports for weeks to months after the incident. With a resilient and fruitful hydroponic unit, we hope to provide a consistent and reliable source of food to these isolated locations.

My team and I will be optimizing a current design of a hydroponic unit so that it can withstand natural disasters. Design ideas include placing the unit on a buoyant platform to withstand flooding and adding a spherical cover to redirect harsh winds and prevent wind damage. Additionally, we hope to construct the unit in such a way that locals could remove the component that houses the crops, so that the crops can be temporarily brought indoors in order to guarantee survival during more harsh storms, such as category 5 hurricanes. Through several design iterations, hopefully the structure of the hydroponic unit can be substantially improved to resist floods, hurricanes, and more. Besides the physical structure of the unit, other components such as the nutrient mixtures, seeds, and more will come from Babylon Micro Farms, a local Charlottesville startup that manufactures hydroponic units.

With a strengthened design, island states can utilize hydroponics to improve food security, harvest more abundant crops, and increase community resilience. Testing this new design will be done by a different group of students.

Using CFA to Predict Technological Success in a Community

How can I perform a CFA and use the results to determine factors that increase the likelihood of a certain community successfully adopting a new hydroponic technology?

Introduction

Capacity Factor Analysis (CFA) is a framework for determining whether or not a technical system can be effectively managed in a specific community (Bouabid & Lewis, 2015). The analysis incorporates eight different factors: institutional, human resources, technical, economic/financial, environmental/natural resources, energy, service, and socio-cultural factors. Through my research, I will investigate what a CFA identifies as predicted success drivers of a hydroponic unit in certain small island developing states. Success entails several factors, but I will be focusing on the ability of local islanders to maintain the hydroponic farming unit in order to provide a consistent and nutritious food supply. To narrow the scope of my research project, I will be focusing on Dominica, an island in the Caribbean, the Bahamas, a group of islands in the Atlantic Ocean, and Samoa, an island in the Pacific.

Background

In 2018, a group of UVA students and professors visited Delices, a community in Dominica, and installed a hydroponic unit that they had previously designed and constructed. The unit coined the name “fold-out-farm,” with the premise that the unit can be manufactured in the United States, shipped to an island state, unfolded, and then easily maintained by the island

locals. The team partnered with Babylon Micro Farms, who supplied the proprietary hydroponic technology for the unit, and will continue to do so for my group.

I will perform a CFA on the current hydroponic unit installed in Dominica and draw conclusions about the reliability and accuracy of the analysis. The CFA method involves assessing and scoring each of the eight factors, then the factors are assessed against international standards. Once I assess each of the capacity factors, the result is numerical score for the overall community's capacity level (Bouabid & Louis, 2015). I will then extrapolate this framework, with the hopes that the Dominica evidence can shine light on installing the system in the other SIDS locations. By carefully selecting which communities and island states would be a good fit for a hydroponic unit, we can optimize the success of the new units on a larger scale.

Used in conjunction with one another, the eight factors used in CFA are expansive enough to cover multiple domains, but adequately focused to structure my analysis. Socio-cultural factors will be assessed on criteria such as community organization and stability, population density, and participation from women (Bouabid, 2015). Human resources will be assessed on the presence of professionals, skilled laborers, unskilled laborers, illiterate locals, and more. Socio-cultural and human resources factors will definitely play a large role in my research, but I will have robust criteria for each of the factors to guide my assessment of a community. It is vital to consider these factors and the remaining six in order to conduct a credible and useful CFA on the hydroponic unit. In learning about Dominica, I plan to propose a list of communities in small island developing states that will be the most likely to adopt a new hydroponic technology.

Data Collection

A large portion of my research will involve the collection of evidence. I will conduct interviews with Professor Bevin Etienne, a Dominica native who works at the UVA McIntire School of Commerce, and Professor Laura Toscano, the Associate Director of Social Entrepreneurship at UVA. Both Laura and Bevin led last year's trip to Dominica.

Bevin has an inside perspective on the local community and the policies that have affected the deployment and maintenance of the hydroponic unit that was installed in Dominica last year. From our conversations, I hope to gain rich qualitative data to begin drawing conclusions on the eight factors from the CFA. Additionally, I hope to be connected with locals via Skype who are affected by the new unit, such as laborers who help maintain the system or locals who consume the produce. Through this communication I will gather data about how the unit's performance in order to inform the CFA and eventually to learn and grow from the success or failure of the Dominica unit.

Through my interviews with Laura, I hope to discuss the reaction of the local community to the new technology and the obstacles the crew faced during setup and maintenance. These conversations will be particularly helpful in assessing the socio-cultural and human resources factors for the CFA. Additionally, I will gather photographs, documentation, anecdotes and more from Laura, Bevin, and the other students present on the trip to Dominica in order to help assess the remaining factors. These components, coupled with research from online journals and databases, will provide me with a rich array of information to inform my research. The online research will include case studies of other hydroponic implementations as well as reports on the current state of local agriculture in Dominica.

Data Analysis

After conducting my research, I will gather and analyze the qualitative and quantitative data from my interviews with Bevin, Laura, and locals in Dominica who are affected by the hydroponic unit. These discussions will help me better understand each of the eight factors in CFA, which are institutional, human resources, technical, economic/financial, environmental/natural resources, energy, service, and socio-cultural factors. Backed with concrete information, I will perform my CFA, and hopefully I will be able to understand which factors led to the success or failure of the hydroponic unit in Dominica. My interviews will shine light on the success or failure of the unit and how locals played a part in these results (Wilson, Williams, & Hancock, 2000). By extrapolating this framework, I will develop a set of criteria so that future researchers can perform their own CFA in order to examine a community and assess the likelihood that locals will accept and adopt hydroponic crop cultivation. Thus, further pioneers and hydroponics researchers can target these communities with their own prototypes.

Conclusion

Hydroponic crop cultivation is an emerging agricultural technology that does not rely on soil, and thus can produce abundant and nutritious harvests in small spaces. Geographically isolated locations such as small island developing states rely heavily on food imports to feed locals and tourists. Therefore, the proliferation of hydroponics could boost domestic agricultural production, thus reducing reliance on external food imports. However, these island states also fall victim to an additional agricultural obstacle, harsh natural disasters. For these reasons, my group and I will be designing a hydroponic unit that is robust, easily deployable, and hurricane

and storm resistant. We will be modifying a current “fold-out-farm” prototype created by a group of UVA students and faculty in 2018 that is currently operative in the Caribbean island of Dominica. I will perform a Capacity Factor Analysis (CFA) on this unit in order to measure the success of the new technology within that particular Dominican community. To aid this assessment, I will be conducting several interviews and gathering supporting evidence from scholarly articles and journals. The end goal of my research project is to determine criteria that can be used to select communities that have a high likelihood of adopting a newly designed hydroponic unit and to lay guidelines so that future researchers can perform their own CFA on a new community.

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