

Thesis Project Portfolio

Hydroponic Crop Cultivation as a Strategy for Reducing Food Insecurity
(Technical Report)

Hydroponic Farming as a Sustainable Transition from Current Farming Practices
(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Emily Wiele

Spring, 2022

Department of Systems Engineering

Table of Contents

Sociotechnical Synthesis

Hydroponic Crop Cultivation as a Strategy for Reducing Food Insecurity

Hydroponic Farming as a Sustainable Transition from Current Farming Practices

Prospectus

Sociotechnical Synthesis

Current food systems in place face pressure from population growth, demand for animal products, and availability of fertile soil as well as shifts in climate regimes. Human induced climate change caused by carbon dioxide emission exacerbates the current stresses on the four pillars of food security – availability, access, utilization, and stability. It does so through increasing temperatures, changing precipitation patterns, and the increase in frequency, duration, and intensity of extreme weather events like floods, droughts, and hurricanes. Additionally, the negative effects of unsustainable farming methods include, but are not limited to, wasteful water consumption, soil erosion and degradation, pollution, excess nutrients, climate change, genetic erosion, and land conversion. The combination of all of these factors result in a rise in food insecurity faced by many groups across the world.

Hydroponic Crop Cultivation (HCC) is a method of farming in which crops are grown in a nutrient rich solution in order to decrease the amount of resources, time, and space needed to grow. The technical project is an evaluation of the potential applications for HCC, including: small island developing states (SIDS), refugee camps, food deserts, rooftop gardens and apartment units, ranking HCC against other technologies for global food security and nutrition (GFSN) risk mitigation, and building and testing a floating, storm-resilient HCC system for the special case of GFSN in SIDS. Our team grew broccoli, brussels sprouts, basil, and lettuce using a dutch bucket method – a form of hydroponic farming. Aside from this we built a wooden platform prototype which has folding walls that can shield the crops from extreme weather conditions and float in the event of flooding.

Using the sustainability transitions framework, my STS topic evaluates the potential of hydroponic farming to become the new conventional crop cultivation method. The paper explores different case studies where hydroponics have been used on smaller scales and in

specific settings, and it analyzes where and why hydroponics have been successful, but also where they fall short. Using this information, the paper evaluates the potential for society to transition to hydroponics as a more sustainable alternative to the current agricultural regime.

Through my STS research and technical project I have learned a lot more about the advantages and also drawbacks of hydroponics, a concept I was previously unfamiliar with. On the technical side, I really enjoyed working with both systems and civil engineering students and we are all really proud of our final product. Future groups will work on simultaneously combining the hydroponics component of the project with creating a more seamless and durable floating platform. The team should also work to include electrical components into the system and waterproof the system. In terms of my STS project, future studies could look deeper into already existing commercial-scale hydroponic firms and work to reduce capital costs to cater to those less fortunate. More case studies can be analyzed further to gain a deeper understanding of how hydroponics can be modified so that it can reach a wider range of consumers.