Prospectus

Structural System Design of a Hydroponic Farm for Food Security
(Technical Topic)

How Businesses Can Exist in the Humanitarian Space:
Challenging Paternalistic Charity and Going Beyond the "One-For-One" Model
(STS Topic)

By

Henry Quach

November, 9, 2020

Technical Project Team Members:

Hannah Hiscott

Harrison Mazanec

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.

Signed: Henry Quach
Technical Advisor: Garrick Louis, Ph.D.
STS Advisor: Sean Ferguson

Introduction

The global population is projected to be 9.7 billion people by 2050 with 68% of people living in urban centers. Intensifying climate change is altering the distribution of water resources for irrigation as well as the frequency, intensity, and duration of extreme weather events such as floods, droughts, and hurricanes. As a result, the amount and fertility of arable land is expected to decrease significantly by that time. If unaddressed, these factors will lead to a global shortage of food by 2050 due to disruptions in conventional land-based agriculture.

Smallholder farmers and low-income urban residents are especially vulnerable to this type of food insecurity because they face limited access to productive land for food cultivation and limited capacity to relocate to more fertile ground. As these climate induced structural changes reduce yields and overall production, disruptions are passed along the food supply chain, resulting in higher food prices and scarcity, especially of nutritious fresh produce.

My technical project attempts to find a complement to conventional crop cultivation (CCC) by researching the viability of hydroponic crop cultivation (HCC) in securing the global food supply. In partnership with a Charlottesville start-up Babylon Micro-Farms, a HCC system has been developed and will be deployed in the Bahamas as a part of their National Emergency Food Plan. The Bahamas was chosen as the test case because small island developing states (SIDS) are among the most vulnerable to the effects of climate change as the Atlantic hurricane season has increased in duration and intensity in recent years.

The nature of this project is through a humanitarian lens; however, working with a start-up whose primary motivation is to maximize its financial bottom line greys the motivation of the work we do. The people who are most disadvantaged to the effects of climate change are low-income individuals who do not have the privilege to afford a means to mitigate its damages. A common worry when private enterprises enter the humanitarian space is that those who are the most necessitous of their product may be priced out of the market, and only those who can afford it will buy. This furthers disparities between the privileged and the disadvantaged. Another worry is that the interventions that socially minded enterprises choose to enact may have no effect in furthering a community's social welfare or, even worse, may hurt the target population. Due to these concerns, the STS portion of the prospectus will explore how businesses can effectively exist in the humanitarian space, the potential externalities of them occupying the space, and how they can sustainably further their social causes for the betterment of their target population's welfare.

Technical Topic

By 2050, the amount of arable land worldwide is estimated to be 0.19 hectares per capita—a 90% decrease of per capita arable land worldwide since 1960 when it was 0.42 hectares. In developing countries, the amount of per capita arable land will be reduced from 0.33 hectares to 0.14 hectares (Silva, 2018). It's also been estimated that "one-half of all people and cities and three-quarters of all irrigated agriculture now face water shortage risks as available water supplies have become nearly or fully exhausted in water-scarce regions," (Brauman et al., 2016).

Intensifying climate change will only exacerbate these two factors—truly threatening the global food supply in the coming years. Hydroponics offers a way to mitigate the risk of global food shortages by producing a yield that is 10.5 times greater than that of CCC methods per unit area per unit time and by utilizing 6.6 times less water per unit weight per unit time than CCC methods (Barbosa, 2015). Because HCC does not require any soil, its implementation is not bounded by the availability of arable land. By utilizing HCC in urban centers or in water stressed regions, the effective arable land per capita could increase significantly and could bolster the effort to secure the global food supply (Sheikh, 2006). Other applications of hydroponics have also been explored, and it's been shown that hydroponics can play an important role in domestic wastewater treatment which can be transformative as emerging contaminants in wastewater have stressed existing wastewater plants (Magwaza, 2020).

As stated earlier, my technical project attempts to find a complement to conventional crop cultivation (CCC) by researching the viability of hydroponic crop cultivation (HCC) in securing the global food supply. The objectives of this capstone are to: 1). Conduct a systems analysis to assess the feasibility of HCC systems; 2). Define the market for HCC; 3). Configure a prototype HCC system that minimizes land, water, and energy use while maximizing crop yield; 4). grow a crop from the prototype HCC system; and 5). Ship the system to the Bahamas and train farmers on how to use the system for their pilot National Emergency Food Plan (Ministry of Agriculture and Marine Resources, 2020).

Success for this project will be determined by whether or not the HCC system can produce crops per unit area per unit dollar spent at a greater rate than that of

traditional CCC methods. Success for this project will also be determined by the HCC system's ability to be adopted and utilized effectively by Bahamians and the number of participants who enroll in the Bahamas's National Emergency Food Plan. The final measure of success will depend on the capstone team's ability to identify other markets other than SIDS where HCC could thrive by conducting both systems analyses and market analyses to judge both capacity and demand.

In partnership with Professor Garrick Louis of the department of Engineering Systems and the Environment, Professor Bevin Etienne of the McIntire School of Commerce, Professor Manuel Lerdau of the department of Environmental Sciences, a local Charlottesville, VA startup Babylon Micro-Farms, Virginia State University's Sustainable and Urban Agriculture Program, and the Bahamian Ministry of Agriculture and with funding from the 3 Cavaliers grant program and the National Science Foundation, this capstone project is possible.

STS Topic

With intensifying climate change creating large structural and systemic changes, the disparity between the privileged and the disadvantaged is becoming more apparent as large corporations have profited. As the gap between the haves and the have-nots grows in America, the traditional model of business that is shareholder-centric is being challenged to become better stewards for society. When these businesses enter the humanitarian space, though, they often rely on a model of philanthropy by means of the "one-for-one" model where they donate some commodity to a community in need per one product sold. At first glance, this model seems like a promising means to address certain needs in a community, but

oftentimes, these interventions are done without any regard for the communities in which they inhabit. It's common to see negative unintended consequences arise from these. The most prominent concern that arises from the "one-for-one" business model is that these free donations can outcompete local artisans and destroy local industries thereby hurting the economies of the localities that they were supposed to help. Another concern is that this model of charity creates aid dependence from these communities on the donating companies for their free commodity (Tracey et al., 2005; Taylor, 2018; Wharton, 2015; Wydick et al., 2016).

One enterprise that has been heavily scrutinized for their brand of humanitarianism is the shoe brand Toms. From their inception in 2006 through the end of 2019, Toms's rise as a brand for good was built on their iconic "one-for-one" donation of a pair of shoes to a child in need for each pair of shoes sold in retail. In their study, Wydick, Katz, and Janet (2014) observed that Toms's shoe donations did show a negative, although modest, impact on local shoe markets in El Salvador. It's also been criticized that companies like Toms are solving the wrong problem and the problem that they're trying to solve is not sufficiently being solved either (Taub, 2015). In another study, the impact of donated shoes from Toms was measured in El Salvador, and the study failed to find any significant impacts on the welfare of the people who received the shoes (Wydick et al., 2016). While Toms was able to effectively solve the problem of shoeless children, they did not achieve their intended and stated goal of improving the welfare of those children in communities in need beyond that.

Moreover, double bottom line companies like Toms may not be achieving their life-changing goals fully, but they are certainly in the right direction. They're not ill-intentioned; rather, they're misguided because their interventions are not being assessed properly. What they lack are proper metrics with which they assess their interventions. Their "one-for-one" models are judged on a static measure of impact and their evaluations are not committed to transparency and learning (Wydick, 2015). Instead of understanding their impact, being transparent about the results, and learning from them to adjust their interventions and their assessment of them, companies often find themselves beholden to their initial intervention as they can be too profitable to alter in order to meet their social goal of improved human welfare (Wharton, 2015; Wydick, 2015). To their credit, in 2019, Toms applied this framework of adaptive metrics and decided to move on from the "one-for-one" business model that they pioneered. After 13 years of donating shoes for each pair of shoes sold commercially, executive leadership decided that their interventions were not enough and that they have to do more for these communities (Stych, 2019). While more so financially motivated than through introspective analysis of their "one-for-one" model, Toms committed to donate one-third of their profits to humanitarian organizations that work on the ground in these communities—arguably funding a more impactful intervention that engages with community members.

One of the biggest critiques of the "one-for-one" model is that it only adds an asset, or a stock, to a community, and it fails to address the flow of these stocks in the community. The "one-for-one" model and other forms of corporate charity fail to address the systemic root causes that led to the conditions that they're

attempting to alleviate. A possible explanation is that these companies are not in the communities to which they're donating to truly understand the problem that they're trying to solve (Taub, 2015). They're attempting to solve a complex problem without any input from the afflicted community.

Exemplary business models put the community members at the center of the conversation with philanthropic corporations. As discussed by Tracey, Phillips, and Hugh (2005), by changing the dynamics of socially driven businesses from a paternalistic one to a community partnership, community enterprises allow for more sustainable forms of interventions. These models empower community members and put them in the forefront. These community partnerships "build capacity and enfranchise communities"—allowing them to bring about sustainable and meaningful change in their communities.

The ideal business model builds on the idea that community members are valuable to the success of a corporation's social mission and furthers their scope to environmental causes as well. The link between social welfare and environmental conditions are inextricable (Pearce, 1995; Pearman, 2016). A deteriorating environment driven by intensifying climate change has exacerbated social vulnerability, and without addressing the environmental stressors, then social safeguards will never be sustainable (Bohle et al., 1994). One company that seems to execute a triple bottom line well is the chewing gum company Project 7. Their model is focused on seven actions in communities in need: planting new trees, providing malaria treatments, shelter, food, clean water, education, and antibullying programs (Feldman, 2017). Much like Toms, Project 7 donates a share of their profits to organizations that work to alleviate any of the seven focus areas.

What differentiates them is that their business model also addresses environmental concerns and understands how an improved and sustainable social welfare cannot exist without addressing the structural changes brought upon by climate change.

It is becoming more and more imperative that businesses start with a social mission at its inception to be stewards of the communities in which they operate. It is also essential that these corporations engage with community members and create partnerships in order to create a socially sustainable relationship that addresses the ailments that actually afflict these communities. Furthermore, it is crucial that the linkage between social welfare and the environment is put to the forefront for long term sustainability and success of these communities. Without all of these considerations and redefining of current power dynamics, socially driven businesses will continue to inefficiently use their resources and potentially cause more harm than good in the communities they hope to help.

Next Steps

As suggested by the previous sections, the work of stakeholder-centered enterprises is not perfect as unintended consequences and externalities will occur. For the second half of this assignment, I will focus on the efficacy of social enterprises and how they can compete in a landscape that is dominated by single bottom line focused entities. I will also look into the valuation process of social and environmental service and commodities. The following social and environmental factors have been linked to a monetary value: social price of carbon, payment for ecological services, the monetary value of reducing fatalities and injuries set by the U.S. Department of Transportation. Exploring these will give insights on how

nontraditional factors of business can be contextualized for commerce. Alternatively, it could lead to a discussion of how the current commercial landscape needs to be upended and reformed to account for environmental and social factors and safeguards because it may not be sustainable.

References

Barbosa, G. L., Gadelha, F. D. A., Kublik, N., Proctor, A., Reichelm, L., Weissinger, E., Wohlleb, G. M., Halden, R. U. (2015). Comparison of land, water, and energy requirements of lettuce grown using hydroponic vs. conventional agricultural methods. International journal of environmental research and public health, 12(6), 6879-6891.

Bohle, H. G., Downing, T. E., & Watts, M. J. (1994). Climate change and social vulnerability: toward a sociology and geography of food insecurity. Global environmental change, 4(1), 37-48.

Brauman, K. A., Richter, B. D., Postel, S., Malsy, M., & Flörke, M. (2016). Water depletion: An improved metric for incorporating seasonal and dry-year water scarcity into water risk assessments. Elem Sci Anth, 4.

Feldman, A. (2017, July 12). "How Project 7's Tyler Merrick Channeled His Inner Willy Wonka To Turn Around His Gum Startup". Retrieved from https://www.forbes.com/sites/forbestreptalks/2017/07/12/how-project-7s-tyler-merrick-channeled-his-inner-willy-wonka-to-turn-around-his-gum-startup/?sh=3ccd35d4658e

Magwaza, S. T., Magwaza, L. S., Odindo, A. O., & Mditshwa, A. (2020). Hydroponic technology as decentralised system for domestic wastewater treatment and vegetable production in urban agriculture: A review. Science of the Total Environment, 698, 134154.

Ministry of Agriculture and Marine Resources. (2020). Hydroponic Farming Program [Brochure]. Retrieved from

https://www.bahamas.gov.bs/wps/wcm/connect/53a93fcf-ef60-4cea-9042-8d5bc7a43fbf/hydroponics+flyer.pdf?MOD=AJPERES

Pearce, D. W., Cline, W. R., Achanta, A. N., Fankhauser, S., Pachauri, R. K., Tol, R. S., & Vellinga, P. (1996). The social costs of climate change: greenhouse damage and the benefits of control. Climate change 1995: Economic and social dimensions of climate change, 179-224.

Pearman, O. (2016, November 1). " Can states' welfare programs be indicators of environmental injustices?". Retrieved from https://environment-review.yale.edu/can-states-welfare-programs-be-indicators-environmental-injustices-0

Sheikh, B. A. (2006). Hydroponics: key to sustain agriculture in water stressed and urban environment. Pak. J. Agric., Agril. Eng., Vet. Sci, 22(2), 53-57.

Silva, G. (2018, December 3). "Feeding the world in 2050 and beyond – Part 1: Productivity challenges". Retrieved from https://www.canr.msu.edu/news/feeding-the-world-in-2050-and-beyond-part-1

Stych, A. (2019, November 25). "Toms changes its 'buy one give one' charitable model". Retrieved from https://www.bizjournals.com/bizwomen/news/latest-news/2019/11/toms-changes-its-buy-one-give-one-charitable-model.html?page=all

Taylor, G. A. (2018). One-for-One Companies: Helpful or Harmful?. IU Journal of Undergraduate Research, 4(1), 63-72.

Taub, A. (2015, July 23). "Buying TOMS shoes is a terrible way to help poor people". Retrieved from https://www.vox.com/2015/7/23/9025975/toms-shoes-poverty-giving

Tracey, P., Phillips, N., & Haugh, H. (2005). Beyond philanthropy: Community enterprise as a basis for corporate citizenship. Journal of business ethics, 58(4), 327-344.

Wharton. (2015, February 16). "The one-for-one business model: Avoiding unintended consequences." Knowledge@Wharton. Retrieved from https://knowledge.wharton.upenn.edu/article/one-one-business-model-social-impact-avoiding-unintended-consequences/

Wydick, B. (2015, July 27). "What's Missing in Vox's Negative TOMS Piece". Retrieved from http://www.acrosstwoworlds.net/whats-missing-in-voxs-negative-toms-shoes-piece/

Wydick, B., Katz, E., Calvo, F., Gutierrez, F., Janet, B. (2016). "Shoeing the Children : The Impact of the TOMS Shoe Donation Program in Rural El Salvador". Policy Research Working Paper;No. 7822. World Bank, Washington, DC. © World Bank. Retrieved from https://openknowledge.worldbank.org/handle/10986/25133

Wydick, B., Katz, E., & Janet, B. (2014). Do in-kind transfers damage local markets? The case of TOMS shoe donations in El Salvador. Journal of Development Effectiveness, 6(3), 249-267.