

Hydroponic Gardens Battling Against Food Insecurity in Panama

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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

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The Negative Effect of Food Insecurity in Panama

For years I have experienced first-hand how grand the negative impact of food scarcity is in Panama. I have seen countless malnourished kids and families struggling to get food on the table and to no avail. There is a specific area called Cañazas located in a province named Veraguas where there is immense food insecurity as it is one of the most poverty-ridden areas in Panama. This is the reason why my research will focus mostly on this region. Some children native to Cañazas are so malnourished that they start losing hair pigmentation and their overall physical appearance makes them appear much younger than they are. This is called stunting, which is a condition where there is an impairment in a child's physical growth and mental development due to malnutrition. Countless hours of community service each year are realized in this area specifically to target this issue; however, there is still an incredibly long way to go. Fundraisers, campaigns, volunteers—those may help, of course, but this problem must be tackled from the root.

Food insecurity is a global issue that affects more than a quarter of the world's population (Huizar et al., 2020). Countless people suffer from food insecurity for several reasons; for instance, one of them being due to decreasing fertility in arable land because of climate-related reasons. Smallholder farmers and low-income individuals are especially vulnerable to this food insecurity since they face limited access to productive land for food. This is an immensely important topic to target because, due to an increasing population and other factors, food production may have to double by 2050 (United Nations, 2009). Lack of food security is followed by several negative side effects, with one of the most devastating being the enhanced probability of malnutrition in individuals. There are numerous ways to combat the matter in question and hydroponic farming is one of them. What is hydroponic farming, some may

wonder? In short, it is a method of agriculture where soil is not needed to grow crops—instead, they are grown directly in a nutrient-rich water (Vertical Roots, 2022). This procedure offers a way to mitigate the risk of food insecurity by producing crops using 90% less water and 75% less land space in less time than traditional farming (Sharma et al., 2019). It also allows crops to be grown in areas with limited farmland, low soil fertility, or on “floating farms” in areas with frequent sea level rise or flooding.

My thesis’s focal point is to define the viability of using hydroponic farming as a means of mitigating the effect of food insecurity in very low-income areas of the Republic of Panama. Furthermore, my research is focused on noting the benefits and drawbacks of implementing hydroponic systems in said regions and my inquiry is informed by Panamanian locals knowledgeable on the subject. In order to properly organize my research and findings, the sustainable transitions framework is utilized on this research paper. This framework can be defined as a transformation process through which established systems shift to more sustainable practices; in this case, traditional farming would be partly replaced by hydroponic farming, amore sustainable alternative.

Contextualizing Food Injustice in Panama

Though this research mostly focuses on Cañazas as mentioned before, there are more regions that could benefit from the findings included in this research project. For instance, according to a study realized on fifteen rural villages in Panama by Cambridge University, approximately 33% of households experienced lack of food due to floods or droughts or due to lack of resources to grow crops (Krause et al., 2019). On the other hand, at least 80% of households reported lacking money to buy food and buying fewer essential foods for children

sometimes. Almost 50% reported that adults and children had experienced eating less than desired, fewer meals, or less food in the principal meal due to lack of money, and these situations caused them to report a continuity of trauma (Krause et al., 2019). Another study conducted in a specific indigenous community on the San Blas Islands of Panama states that of the two-hundred and nine adults interviewed, 83% reported food insecurity (Walker et al., 2021).

Insight from Knowledgeable Locals

In the 2013 Primary School's Census, schools in rural areas of Veraguas were found to have some of the highest numbers of underdeveloped children. This was estimated by physically assessing the children's height in search of stunting indicators. Cañazas, located in Veraguas, is the poorest non-indigenous region in Panama, and the annual census has shown that 35.6% of children attending school from ages six to nine show stunting indicators (Panamanian Ministry of Health, 2013). Several organizations try to help the locals by donating food and monetary resources, with one of these organizations being the *Asociación Pro Niñez Panameña*, and the president of this organization supported my research by agreeing to be interviewed about specific matters regarding the living situation in Cañazas. The mission of this non-governmental organization is to promote and support programs that improve the living conditions of children local to Cañazas with an emphasis on nutrition, health, education, and recreation. Consequently, the president of the organization, Monica Sosa, provided prominent information for my research. She first explained that they choose to help children in this specific region because six out of ten locals live under extreme poverty conditions, and four out of ten children in first grade suffer from severe malnutrition. Miss Sosa continued by stating that the food insecurity problem in Cañazas essentially roots from a lack of proper knowledge in treating the land and insufficient

resources to grow crops—there is limited water and the land is infertile. She explained that this is why the organization, since 2016, began utilizing part of their fundraiser money to create gardens in the schools they have built so the students can grow crops and later harvest them to eat. They teach the children and their parents how growing crops works, and later on give them seeds so they can build their own garden at home. Miss Sosa then shared that they already have twenty-five gardens at different schools where crops such as cucumbers, corn, tomatoes, and plantains, among others, are being grown. I carried on by asking if they had thought about implementing hydroponic farming, and she answered that “it had not yet come to mind, but it would be an interesting idea to consider since it does not require arable land, which is a major setback when it comes to growing crops in these areas of Panama” (M. Sosa, personal communication, November 27, 2021). This statement shows why it is so prominent to carry on research regarding the plausibility of building a hydroponic system in Cañazas.

After being provided with important information about the area of focus, an interview was conducted with agricultural engineer Maximiliano Vargas, who has been responsible for creating the gardens funded by *Asociación Pro Niñez* in Cañazas. He expressed that he has put a lot of thought into the possibility of installing hydroponic farms in these areas, but has not yet had sufficient time to make it a reality. There are certain concerns that must be taken into account when it comes to building a hydroponic system in a rural, poor area, and the interviewee clearly communicated the ones he deemed of most importance. Regarding climate-related limitations, he mentioned five that he believes must not be forgotten for this research. First of all, he mentioned that a hydroponic water pump is needed in order for the crops to receive the proper amount of oxygen; second of all, he stated that even though the system could possibly be mounted somewhere that does have electricity, there is a likelihood that this might not be the

case; third, he mentioned that the temperature must be monitored and properly controlled in order to obtain a propitious environment where the crops can sprout correctly; fourth, he explained that relative humidity must be regulated depending on the types of crops being grown; and fifth, he described that the nutrient solution used should be as inexpensive as possible since the monetary resources available for this project are limited (M. Vargas, personal communication, March 16, 2022).

Alleviating Hydroponic Farming Limitations in Cañazas

All of the limitations mentioned by engineer Maximiliano Vargas have plausible solutions, which were ran through during the interview. For instance, monetary resources to buy a single hydroponic water pump can be obtained through donations provided by organizations such as Pro Niñez, and his concern about electricity can be settled because the first hydroponic system would be built in one of Pro Niñez's schools that have access to electricity—if the first system were to succeed, solar panel or monetary donations would be requested later on to continue building hydroponic systems in the area. He expressed that the temperature and humidity do not concern him as much because he has succeeded in creating a propitious environment in similar areas before. Regarding the nutrient solution, he did express that a chemical solution is not the best option as some are expensive, and this project has to be as simple and inexpensive as possible. He then proceeded to give an alternative for this limitation, which is 'worm tea'. He expressed that he has the necessary knowledge to produce worm tea as it is a substance he utilizes on the regular; however, he noted that it is important to make a study regarding the nutrients that worm tea contains in comparison to other nutrient solutions, so a stock solution with the right amounts of nutrients can be created later on (M. Vargas, personal communication, March 16, 2022).

Regarding the maintenance and human support needed, I asked engineer Vargas if he thought the people of Cañazas would put in the effort to learn to build and maintain a hydroponic system. He stated that his past experience helped him realize that most locals are very interested in visual learning. Consequently, he told me that after successfully mounting the first hydroponic system in the area, a training should be realized while building other hydroponic systems in order for them to learn exactly how it works and how they should maintain it. He believes that as long as they get to see how it is done and how it works, they will be interested in taking care of the system and its crops. He also expressed that it is of uttermost importance for this system to be built with simple, affordable, and accessible materials. A possibility could be utilizing bamboo instead of PVC pipes, for instance. (M. Vargas, personal communication, March 16, 2022).

It is clear that the hydroponic system to be built must be as uncomplicated as possible with attainable materials. This is why a simple Dutch bucket system is an understandable option when it comes to choosing the type of hydroponic system that should be implemented in these underdeveloped regions of Panama. This method utilizes buckets or containers that connect to the same irrigation and drainage lines. This is a very water-nutrient-efficient method which grows a variety of crops (Storey, 2018). Two of the most challenging aspects of this system will be teaching the locals how to maintain it, as well as teaching them how to build it. For this type of system, the most important materials needed are a pump, buckets, a type of media, tubing, drippers, fittings, and clamps. (Storey, 2018). There are countless manuals on how to build simple Dutch bucket systems online—the building is no problem; the challenge is plainly the conditions under which it would be built in this specific situation.

Plausible Outcomes of the Implementation of Hydroponic Farming

Current food systems in place face pressure from climate stressors, as well as non-climate stressors such as population growth, demand for animal products, and availability of fertile soil. These stressors negatively impact the four pillars of food security—availability, access, utilization, and stability (IPCC, 2021). Food insecurity naturally has a grander effect on low-income, rural areas such as Cañazas. There is a need to provide these areas and these people with sustainable farming techniques that are both accessible, in terms of materials required, and affordable, given the lack in monetary resources. This is where hydroponic farming comes in—it alleviates the likelihood of food scarcity because it utilizes less water resources and does not rely on arable land. Though building a hydroponic system can initially be more challenging than traditional farming, hydroponic farming can provide: higher yields, independence from fertile soils, possibility to grow in small spaces, improved plant nutrition quality, lower incidence of soil-borne diseases, and reduced contamination of soil and water by adoption of closed cycles (Orsini et al., 2010). Hydroponic gardens would allow the people living in these areas to produce crops for their own consumption, which directly helps with the food scarcity problem being faced. These systems could be developed following the example of past successful gardening projects—they could be placed in schools first so students as well as their parents can learn how it works, providing teachings for them to recreate in their own homes afterward.

There have been similar cases where hydroponic farming is implemented as a method for providing food security. In Peru, for instance, there is an area with non-arable land where basic services such as public water, sewage system, and electricity are only partially provided,

similar to Cañazas (Orsini et al., 2010). Results found regarding the achievability of undertaking malnutrition through vegetable production using hydroponics indicated that it is an adequate approach to food insecurity. Though this area in Peru has several similar aspects to Panama as they both count with maximum temperatures of around 32 Celsius and with a high humidity, this area of Peru does count with colder winters while Cañazas has similar temperatures all year round, with the exception of rain making a more frequent appearance from April to December. The climate in Peru is much more varying as it has warm summers followed by colder and highly humid winters with infrequent precipitations (Orsini et al., 2010). Furthermore, this would make it easier to choose crops in Cañazas as its climate is more consistent. Regarding locals and their culture, both areas suffer from a lack of proper education and would need training and workshops in order to continue implementing hydroponic gardens on their own.

Conclusion

For this research project, I learned a lot about the severity of the food insecurity many individuals face in my country every single day. As a volunteer for food security campaigns, I had known that this issue was much grander than what many thought, but had no idea about just how grand. I feel very accomplished about my research findings provided by Monica Sosa, the president of *Asociación Pro Niñez* because from her I learned that there is still a lot that has not been considered or thought of when it comes to mitigating this food insecurity issue. In the case of this thesis, hydroponic farming being a goal yet to be attempted or achieved. Afterwards, thanks to agricultural engineer Maximiliano Vargas, I took into account certain unexpected limitations regarding this specific hydroponics case that I had not thought about before. He

explained his concerns and we were able to mitigate the worry of these limitations by brainstorming plausible solutions together.

Though important research has been acquired and taken into account for this research project, there could be other factors that have yet to be mentioned because they simply have not come to mind. I was not able to reach a few professionals in hydroponics that could provide even more prominent information to further enhance this research. I too wish that I had the chance to visit Cañazas and find a more concrete and exact spot where a system could be first built and tested to see how electricity concerns could be arranged. I do want to reach out to other organizations aside from *Pro Niñez* that could be interested in helping with my research and plausibly use my findings to help with this food insecurity issue in order to gain more insight of past attempts at mitigating food insecurity. In the future, I look forward to possibly working with a team and coming up with an adequate design for the hydroponic system in Cañazas. If it were to work, many low-income individuals in my third-world-country could benefit from this, and if it did not work, then there would be a lesson learned and another method could be attempted.

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