

Jordan Miller
Carrollton High School
Carrollton, MO
Puerto Rico, Sustainable Agriculture

Puerto Rico: A New Home for Sustainable Agriculture

Puerto Rico; country, commonwealth, tourist destination, and unfortunately, part of the vast list of places that suffer from food insecurity. After Hurricane Maria in 2017, most of the country was without power. This escalated the level of food insecurity for Puerto Rican families reaching to the highest levels, regardless of income or location. “In a matter of hours, Hurricane Maria wiped out about 80 percent of the crop value in Puerto Rico — making it one of the costliest storms to hit the island’s agriculture industry”, said Carlos Flores Ortega, Puerto Rico’s secretary of the Department of Agriculture (Robles, et Al. “Puerto Rico’s Agriculture”) Food insecurity within Puerto Rico must be addressed and begin to be eliminated.

According to the Food and Agriculture Organization (FAO), food security exists when all people, at all times, have physical, social and economic access to enough, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life. The four dimensions of food security as defined by the (FAO) are: food availability, food access, proper utilization and stability. (Bellido, “Food Security”)

Studies before Hurricane Maria showed 1.5 million Puerto Ricans were listed as food insecure. The child food insecurity rate was listed at 56 percent. (American Statistics for Income-Hunger Poverty Fact Sheet) Puerto Rico’s government assistance program called NAP-Nutritional Assistance Program issues a block amount of money per year regardless of need or changing circumstances within the country.

Emergency Relief efforts for importing food are hampered by restrictions from the Jones Act, which requires supplies imported by sea to Puerto Rico must originate from or be shipped through the continental United States. This increases prices of the products and lengthens the time it takes for supplies to arrive in Puerto Rico. Due to the hurricane, shipping regulations have been temporarily eased due to the hurricanes, but extra shipping costs are a permanent problem. (Hunger-Poverty Fact Sheet). The reliance of imported products is an issue as distribution of the imported items often does not reach the rural areas of the country, causing food insecurity to be near crisis levels.

On the global scale, Puerto Rico is a Caribbean Island of approximately 3500 square miles located in the West Indies, with a population of roughly 3.4- 3.6 million people. It is a self-governing commonwealth territory of the United States, led by a Governor, Ricardo Rosselló. Puerto Rico has a tropical climate and a predominantly urban environment, with 93 percent of the people living in urban areas. (“Living in Puerto Rico”)

The country relies more on imports for food than on agricultural products produced within Puerto Rico. Their main exports are chemicals, electronics, apparel, canned tuna, rum, beverage concentrates, and medical equipment. Their biggest agricultural industries are dairy, plantains, and poultry. (“The World Factbook”)

San Juan the Capital of Puerto Rico with a population of over 390,000 people located in a 77 square mile area has been a long-time tourist attraction. Located on the northeast side of Puerto Rico and bordered by the Atlantic Ocean, San Juan (San Juan facts)and its surroundings offer a wide variety of things to see and do. San Juan is a tourist attraction. Since Hurricane Maria much of the money spent in the country for

rebuilding has been spent in San Juan to further tourism. San Juan, being rebuilt does help provide jobs and serves as a bright spot in the country it does not represent the common living conditions for the country.

The average Puerto Rican residence is a medium-sized home made mostly of wood and brick, Homes of the upper class may be large and extravagant, while homes of the lower class are much less extravagant, much like homes within the United States. The typical diet of the population is a variation of nutrition types, due to imports from the United States, and other countries (“American Community Survey”). Some things they produce are grain crops, poultry, and some seafood, such as crab. Increased costs of food and lack of available food and clean water due to widespread destruction, has left a greater part of the population food insecure, since Hurricane Maria.

Puerto Ricans education systems were above average for an impoverished country. The education system is modeled after that of the United States, with compulsory education for all between the ages of six and seventeen (“American Community Survey”).

The unemployment rate from ages 15-24 is 26.6% (“The World Fact Book”). Unemployment rates, job availability, and wages are hard to determine in Puerto Rico as reports vary widely depending on which website you visit on the internet. (Indeed.com) listed average wages for English teachers at \$18,000, Registered Nurses at \$33,000 and Project Managers at \$56,000 per year. Looking at those pay scales it is not hard to see why people are leaving Puerto Rico.

Reports show Florida has been the most popular state within the United States for Puerto Rican immigrants to relocate in. Florida has gained approximately 5.5k people from Puerto Rico with 2.6 k people re-located to the Orlando, Florida area. The influx of Puerto Rico citizens added 11,500 children to the school systems of Florida. (“Sutter et AL-Exodus”)

Loss of electricity, loss of jobs, loss of schools, loss of hospitals and health care facilities. These are just some of the major impacts of Hurricane Maria devastation. The government of Puerto Rico already faced a huge amount of debt with little financial help within the country to be able to pay for improvements before or after Hurricane Maria.

FEMA received more than 1 million applications for people in need within Puerto Rico. Reports on just how much aide FEMA distributed to Puerto Rico is hard to determine, as reports vary so much from website to website it is nearly impossible to list an accurate amount.

For almost 50 percent of Puerto Ricans still living the country, clean water is still little more than a dream since 2017. The middle to lower class often does not have consistent access to clean water sources even in urban areas. Those in rural areas have an even harder time. Most homes have toilets, although the water in them isn’t always clean. (Babtiste, “Nearly Half”) The electrical situation in Puerto Rico is extremely rough. Many places have not had power since Hurricane Maria and have little hope power will be restored any time soon (Harris). (Sanchez, “Most of Puerto Rico”) This is causing severe hardships and these living conditions suggest it is just a matter of time until more problems arise.

New York Times reported the government of Puerto Rico has filed for a form of bankruptcy for reorganization listing the country as having \$74 billion dollars in bond debt and \$49 billion dollars in unfunded pension obligations to restructure. While the long-term goal of the plan is to make the country debt free the short-term effects include government workers who will not forgo their pension plans, lack of money for public healthcare and infrastructure funding. (Walsh-“New York Times, May 3, 2017”) With so many challenges in Puerto Rico, we need to look for more innovative ways to help bring Puerto Rico to a future with food security. There is no single “right” way to solve all the problems, and to devise

a solution, the utmost creativity must be used. Innovative ways for improvement may include aquaponics systems, finding alternative sources of power for places that are without electricity. Better education for growing more food in less space, to provide a more balanced diet. Using alternative power sources to provide clean water. These options could all help end the food insecurity challenges faced by the people of Puerto Rico.

I suggest helping the food shortage by the widespread implementation of aquaponics systems. An aquaponics system is an aquaculture system that has been adapted to grow plants as well as fish. The benefits the use of aquaponics could provide in Puerto Rico are immense. Aquaponics could help provide a well-rounded and nutritious meal, providing both fish and vegetables. Aquaponic systems are versatile and can be set up on a large scale in a city and provide for the entire community, or they can be reduced to a small enough scale for families to have personal systems in their homes to feed themselves. (“Encyclopedia of Aquaculture”) There are a variety of fish and food plants available to be grown. (“Encyclopedia of Aquaculture”) If cities had large scale systems, then the people of the town could work there, creating many new jobs. An additional benefit of aquaponics would be scheduling for fish and plants to be started in regular intervals, so they can be harvested year-round. The benefit of the small-scale systems would not go unnoticed either, especially in rural areas. Families could spend less on food and be more confident that they can have dinner on the table on any given night, by growing their own.

A benefit of aquaponics over regular aquaculture is the water can filter itself through the plant’s growing media, so the water in the fish tank will remain cleaner, resulting in less need for additional water and easier system care and maintenance. If aquaponic systems are not feasible in all cases, I suggest aquaculture systems be increased to create more fish-shrimp available to make up for the lack of seafood which is dwindling as an available food source. The biggest disadvantage to an aquaculture system as opposed to an aquaponics system is that you lose the vital vegetable production. Another disadvantage is that without the growing media to filter the water, there is a lot more care and maintenance including increased need for cleaning the tanks and changing the water. Aquaculture systems are easier to set up and can take up slightly less space than an aquaponics system.

The biggest challenge that faces both systems is they typically use electricity. This is a problem in Puerto Rico, since they have a lack of electricity in so many areas. There is a need to solve this problem by creating systems that are designed to filter the water back and forth by gravity with alternative power sources. The tropical climate of the county should provide enough heat to keep the fish and plants growing without need for tank heaters. Alternative power sources need to be utilized to replace power for water and air pumps.

To help get this started, the U.S. government could offer tax incentives and import and export advantages to companies willing to help set up aquaponic systems there as compensation for their services. Incentives or compensation for using alternative power sources such as a wind powered water wheel could be given within the country to help with the lack of available electricity.

I have been working on designing a gravity flow system for aquaponics which would increase the usability of these types of growing systems by eliminating the need for electricity to make the water flow effectively. This would be a huge help in the places in Puerto Rico where electricity is scarce and/or unaffordable. The design I am working on ways to provide enough oxygen to the fish while eliminating the need for an electric pump attached to air stones to provide oxygen. (“Encyclopedia of Aquaculture”) I am also working on alternative ways to cycle the water efficiently without the use of an electric pump. (“Encyclopedia of Aquaculture”) If those two parts of the system can be designed to work without the need for electricity aquaponic systems can be utilized in areas where electricity is not readily available. (“Encyclopedia of Aquaculture”)

The area and types of materials available should be considered while designing such system. Water

pressure needs to be calculated to make sure the water flows within the parameters calculated for the system and continues a constant flow avoiding air locks within the pipes and assuring timely cycling to maintain satisfactory oxygen levels in the fish tanks. The theory is simple, in that it all depends on keeping the water pressure levels where they need to be. The application of applying the theory to an aquaponic is challenging in the ability to create a stream of water that flows continuously through the fish and vegetable grow tanks-water and media beds with the correct pressure to allow for optimal plant and fish growth. The water must flow consistently without disturbing the media in the vegetable grow beds while providing enough oxygen to the fish.

Studying the climate and water supply information in the area where the systems are to be built in also plays an important role in the design of larger or multi-functioning systems, which would need to be specially designed. ("Climate of Puerto Rico"). I am hoping to build a simplistic aquaponic system using gravity flow pressure as a working model which could be adapted to individual use or amplified and adapted for larger scale use.

Aquaponics utilizing an alternative power source, would be an excellent option for use in Puerto Rico, due to the advantages of providing a lot of food, the lack of need for electricity, and the ability to be implemented on any scale, from a small home, to provide sustenance to a single family, or in an industrial size warehouse to provide food for an entire community. The customizable nature of this system makes it the perfect choice for a country of such diverse circumstances as Puerto Rico

There are several possibilities for moving water without electricity in areas where electricity is not available for a pump or oxygen tubes for aquaponics systems. Interestingly, most of the systems I have studied that seem efficient for moving water without electricity have a water wheel-based system to power them; much like the theory of the old water wheel mills used before electricity. These have been improved with the addition of generators, which store energy and help the water-wheel pumps be more efficient. ("The Anatomy of a Gravity Flow") Methods such as these can be implemented to bring power to the people of Puerto Rico.

During my research I have found the easiest and fastest fish to grow to maturity are Tilapia, which can be hatched and harvested within 9 months and are extremely hardy fish. They can withstand the most water fluctuation in PH balance, out of the fish I have tested, as well as having the quickest growth rate under those varying conditions. The only detractor is they cannot live in water temperatures much under 60 degrees. I have had them survive in water temperatures as high as 90 plus. Temperatures much under 60 or much above 90 will cause the fish to get sluggish and die easily if the temperatures do not regulate within a few hours. Still, this is a huge advantage, as this is a wide temperature range in which they will grow well. I have successfully grown shrimp in the filtration tanks in my aquaponics system which, adds additional cleaning elements to the water as well as an additional food source. Growing vegetables in media beds or water tubes/tanks adds food sufficiency.

Once systems are set up and people are educated on how to use them these systems could help a lot of food insecure places find ways to grow a steady supply of food. Agriculture education can be added with agricultural based lessons and skills taught in their standard education. The implementation of aquaponics in vocational-technical schools, would be beneficial. Companies that market aquaponic equipment could hold training seminars on how to effectively use the equipment and adapt the systems to the various conditions of the area the system is being set up for.

After an aquaponic system has been started, it is possible to maintain breeding fish to have a variety of ages and sizes of fish so that the harvesting of them is essentially continuous. The ability to plant a variety of vegetables expands the nutritional possibilities greatly. Tilapia is an excellent fish to grow in the climate of Puerto Rico because they are a freshwater fish, and an extremely hardy species. Adding many

varieties of vegetables such as leaf lettuce many varieties, tomatoes, leeks, green peas, the list is extensive, is a tremendous benefit.

Although there is no one size fits all system for helping places with food insecurities, I believe the addition of aquaponics systems in Puerto Rico would be beneficial to the overall welfare of the people. Finding how to utilize alternative energy sources where electricity is not available is essential in making these systems work, improving living conditions, health care, and ending food insecurity. The ability to produce more food within the country would also ease the problem of importing nearly all their food supply.

Puerto Rico faces many challenges. Hard work, determination, educational and financial assistance are needed to help the people there be food secure. Raising awareness of the need for Puerto Rico to the people and organizations that wish to help solve these issues would be instrumental in conquering the challenges that Puerto Rico faces. Each person should remember before you can help everywhere, you must start somewhere. Puerto Rico could easily be the perfect place to start. For Puerto Rico, implementation of aquaponics and or aquaculture systems, and alternative power systems where electricity is not available; could provide a monumental step toward the solution to their problem with food insecurity. The road to food security in Puerto Rico and places all around the world needs to be solved step by step. It's time to take those steps.

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