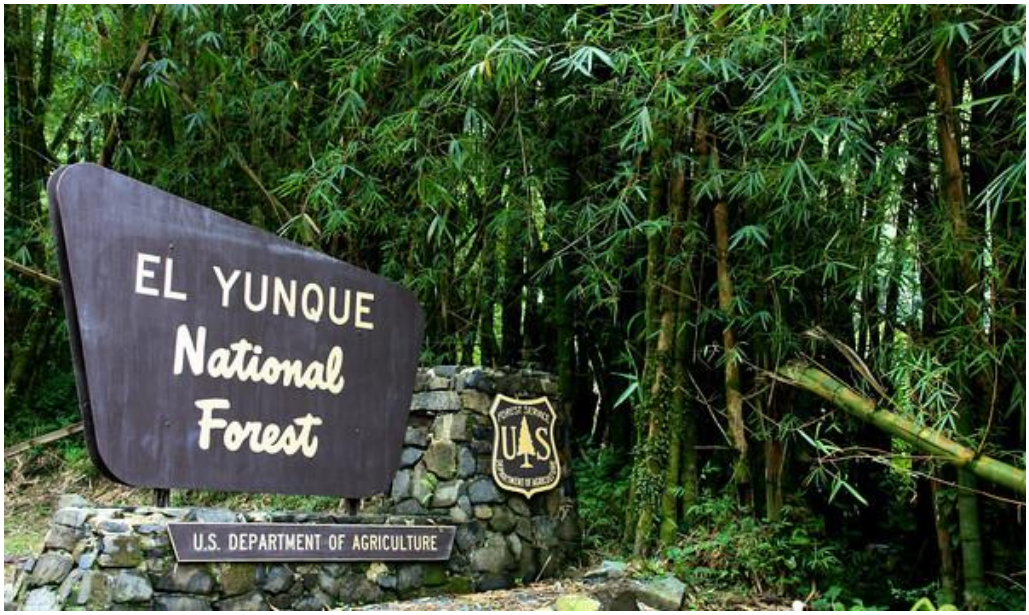
Creating an Agroforestry Based Economic Sector in a Tropical Rainforest

An Interactive Qualifying Project Report submitted to the Faculty of the WORCESTER POLYTECHNIC INSTITUTE in partial fulfillment of the requirements for the Bachelor of Science



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12/18/2013

Abstract

For several decades, Puerto Rico has struggled with food self-sufficiency, meaning that the island does not produce enough food to meet its consumption. The goal of this project was to recommend methods to establish a sustainable agroforestry industry in El Yunque National Forest. The establishment of this industry could contribute to the improvement of the food self-sufficiency of Puerto Rico. To determine the feasibility of a new industry, we conducted an agroforestry assessment and completed a market evaluation. In addition, we designed a business model as well as an education plan to spread awareness. In collaboration with the U.S. Forest Service and local experts, we provided a set of recommendations for continued research and implementation of a sustainable agroforestry plan.

Executive Summary

Puerto Rico is an island region in the Caribbean that currently struggles with food self-sufficiency, importing 85% of its food supply. To combat this problem, the project team worked with the U.S. Forest Service to help create an agroforestry based economic sector in El Yunque National Forest, Puerto Rico's tropical rainforest. Agroforestry is a method of land management that combines food crops, trees, and livestock in the same area. Since the 1800s, efforts in El Yunque have been focused on preservation of the environment. Due to these conservation efforts, the area is not currently used for any agricultural production. Agroforestry can provide an environmentally conscious method for farmers to cultivate crops without harming the forest's ecosystem, expanding the possible growing areas on the island.

Before the WPI team arrived, the U.S. Forest Service had held several meetings with community representatives from municipalities surrounding El Yunque to discuss what projects their respective communities would support. Their main concern was the conservation of El Yunque, which reinforced the idea that this project must focus on creating a profitable industry without causing any harm to the rainforest.

Methodology:

The goal of this project was to investigate and recommend methods to establish a sustainable agroforestry industry in El Yunque National Forest based on an analysis of the proposed location and the investigation of local markets. The project team developed the following objectives to achieve this goal:

1. Create and complete an agroforestry assessment based upon onsite investigations of the target area.
2. Determine market feasibility and factors that make a market successful.
3. Design a business model for the new industry.
4. Provide a source of education for farmers, vendors, and consumers.

The team took the following steps in order to complete these objectives:

1. Met with local experts, analyzed data from previous workshops, and performed onsite investigations to determine successful methods of agroforestry and plants that would flourish in the area.
2. Conducted interviews and took inventory at local markets to narrow down the list of proposed plants for the agroforestry industry.
3. Researched marketing opportunities for the products of the proposed brand, El Yunque Natural, and made recommendations for the development of a farmers cooperative for this industry.
4. Conducted interviews with local experts to gather information for an educational medium that conveys information to the public.

Results:

This project yielded the following list of findings and results:

1. **Over 6,000 acres of land in El Yunque are designated for multiple uses, are undeveloped, and could support the cultivation of plants in an agroforestry setting.**

Based on existing conditions and local farmer opinion, it appears that agroforestry could be used successfully.

2. **An already existing market for products that can be grown under an agroforestry setting can be profitable for farmers.**

The team produced a single list of plants that encompasses what farmers are interested in growing, what there is already a market for, and what is easily cultivated in the forest. Harvesting and selling these crops in the existing market would be profitable for the farmer.

3. **Several promotional opportunities can be used to spread awareness and garner support for the new agroforestry industry.**

Branding, the use of a QR code, and online promotion would be the best ways to reach the target audience and spread information about the new industry.

4. **Successful markets are held at a consistent time and place on a weekly basis.**

This consistency creates the repetition and stability needed to draw in repeat customers and make the market a reliable part of the customer's weekly routine.

5. **Prospective farmers need to be educated on land use policies and farming incentives for the new industry.**

Education will increase farmers' awareness of these topics, potentially decreasing the number of law violations while also reducing the farmer's financial burden.

6. **The education of the public is an essential part of starting a new industry.**

The team found that both community forums and educational booths provide personal interaction with the community. However, websites and smartphone applications will appeal to the younger generations and reach a large number of people.

Recommendations:

Based on the findings explained above, the team developed the following set of recommendations:

1. **We recommend that the U.S. Forest Service use the forest farming method of agroforestry.**

   Forest farming, planting crops beneath a forest canopy, can apply to the majority of sites and should be the focus of the project. However, if a site is already developed, there is a possibility to use other agroforestry methods.

2. **We recommend that target sites at the forest boundary only be used by farmers who own the land adjacent to the sites.**

   These farmers have immediate access to the sites, therefore avoiding the need to secure easements and reducing overall costs.

3. **We recommend that chanterelles and oyster mushrooms be grown in the agroforestry industry.**

   Since these mushrooms are currently grown in the area surrounding El Yunque, they should readily flourish in the rainforest and grow successfully with little intervention from the farmer. Although these specific mushrooms were not found in the marketplace, it has been determined that they could be very profitable.

4. **We recommend that at this time, selling goods in an already established farmers market provides the best chance of success.**

Given the challenges of establishing a new agroforestry industry, it would be very difficult to simultaneously establish a new marketplace.

5. **We recommend the creation of a brand that represents El Yunque and identifies the agroforestry products as natural and locally grown.**

   The team concluded that the use of a brand with a signature name and logo would allow customers to distinguish this brand among others. In addition, a brand with a distinct background can foster brand loyalty and promote food self-sufficiency for the island by enticing consumers to buy locally grown food.

6. **We recommend that the U.S. Forest Service create a website that includes various sections about the industry and the markets.**

   On the website, we recommend the following sections: About the Project, Agroforestry, Agriculture in Puerto Rico, The Brand, Where Does your Food Come From?, Interested in Farming?, Land Management Policies, Agricultural Incentives, Organic Certification, Cooperatives, Farmers Markets, and Recipes.

Acknowledgements

We would like to thank the following organizations, individuals, and institutions for their support, assistance, and contribution to the success of this project:

- The U.S. Forest Service for sponsoring our project and providing us with the resources necessary to complete this project.
- Our sponsor, Sr. Pedro Ríos, for his support and guidance throughout the entirety of the project.
- Luis Rivera, a forest botanist at the U.S. Forest Service, for his assistance in our agroforestry assessment.
- Felipe Cano, a biologist at the U.S. Forest Service, for sharing his knowledge of the forest and assisting us with determining local opinion of the proposed agroforestry industry.
- Anastasio Gomez Mattas, a forest technician at the U.S. Forest Service, for providing necessary transportation to complete the project.
- Bruce Drapeau, a safety officer of the U.S. Forest Service, for his assistance in the completion of our project.
- Carmen Santiago, a soil specialist at the Natural Resources Conservation Service, for her assistance in determining the characteristics of the soil in El Yunque.
- Edwin Más, a plant specialist at the Natural Resources Conservation Service, for his knowledge of the current conservation techniques in Puerto Rico.
- Hilda Bonilla, part of the Agricultural Extension Services, for her opinion on a new agroforestry economic sector.
- Magaly Figueroa, a natural resources specialist at the International Institute of Tropical Forestry, for her knowledge and opinion on an agroforestry economic sector.
- Laura Daen, the operator of the Old San Juan farmers market, for her insight on how a farmers market runs and how the industry functions as a whole.
- Mayra Nieves, the operator of the Placita Roosevelt Organic farmers market, for her insight on how farmers markets and cooperatives are run.
- Kirsten Dessert, for her help with the preliminary design of the seal.

- Professor Stanley Selkow, Professor Hugh Lauer, Professor Susan Vernon-Gerstenfeld, and Professor Lauren Matthews for their guidance and support throughout the project.
- Worcester Polytechnic Institute for making our experience in Puerto Rico and this project possible.

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Chapter 1: Introduction

Food self-sufficiency, the ability of a country or region to meet its food consumption needs through its own means of production, is a goal for countries throughout the world. A region that is dependent on importation places itself at risk if its supply chain is interrupted. Currently, 66 countries are not self-sufficient, relying on world trade to fulfill their agricultural demands. The total population of these 66 countries makes up 16% of the world population. While these numbers are not astronomical by any means, a study conducted by Potsdam Institute for Climate Impact Research projected the percentage of the world population that lacks self-sufficiency to increase from 16% to over 50% by the year 2050. This leaves multiple countries, including industrialized nations such as Japan and the UK, susceptible to any damage or disaster to their supply chain (Cramer, et al., 2012).

A lack of self-sufficiency is often attributed to water or land constraints. In particular, this is an issue for islands due to their limited space for food production and reliance on the shipping industry. Puerto Rico is one region that struggles with food self-sufficiency. In order to meet the food demand of the island, Puerto Rico imports 85% of its provisions (Ferré, 2011). This dependency on importation is often correlated with the lack of agricultural production on the island in modern times. Currently, the agricultural sector accounts for only 2.1% of the labor force in Puerto Rico and 0.7% of the island's Gross Domestic Product (GDP) (Central Intelligence Agency, 2013). Today's low agricultural rate is a result of an industry change that occurred in the middle of the 20th century.

For decades, Puerto Rico's economy was dominated by large agricultural industries such as sugar cane, tobacco and coffee; however, during the 1950s and 1960s, these industries plummeted (Parés-Ramos, Gould, & Aide, 2008). The demise of these industries led to a severe lack in agricultural independence for the island. The U.S. government attempted to rectify the poor economic situation by promoting industrial development through tax incentives. One major example of this was Section 936 of the Tax Reform Act of 1976, which detailed a tax credit given to qualifying corporations in an attempt to promote the growth of industry in Puerto Rico. It caused an influx of big name U.S. corporations that created new industries and opportunities for Puerto Ricans. It was repealed in 1996 by the Small Business Job Protection Act but was given a ten year grace period, giving corporations time to make changes before losing the credit (Staff of Joint Committee on Taxation, 2006). The industrialization created by these tax credits further contributed to the demise of the agriculture industry.

Urbanization also occurred with the industrialization of Puerto Rico, reducing the amount of land that could be used for agriculture, which was already scarce due to the islands dense population and rugged terrain. As a result of federal regulations and policies that banned development in the forest, El Yunque has remained untouched. Although there is an obvious need for establishing a new sustainable industry in agriculture to help make the island more food self-sufficient, implementation will be more difficult than in previous times due to the new global look towards conservation and restoration of forests and their ecosystems (Chazdon, 2008).

In spite of these obstacles, the U.S. Forest Service is exploring new ways to create a sustainable agroforestry industry in parts of El Yunque's 28,000 acres while simultaneously

trying to conserve the protected area. As Felipe Cano, a biologist at the U.S. Forest Service explained, this system of agroforestry has previously not been researched for use in El Yunque (F. Cano, personal communication, October, 28, 2013). The development of a new agroforestry industry will not resolve the issue of food importation for the island; nonetheless it will be a small step in the direction to making the island more self-sufficient. Over time, if the industry is successful and expands, there will be the potential to create more job opportunities for Puerto Ricans, as unemployment is a large economic issue for the island. A feasible recommendation must balance the need for new industry with the need to protect the environment while avoiding the creation of any new problems for Puerto Rico.

The goal of this project was to investigate and recommend applicable methods to establish a sustainable agroforestry industry to help foster economic activity. The objectives included completing an agroforestry assessment, performing a market evaluation, creating a business model for the new industry, and providing a medium of education for consumers, vendors, and farmers. The final step was an analysis of the collected data resulting in a set of recommendations for the U.S. Forest Service regarding the most appropriate methods for establishing a sustainable agroforestry industry within El Yunque.

Chapter 2: Background

This section discusses the topics introduced in the last chapter in order to provide a better understanding of the need to address the economic problems of unemployment and poverty through the development of a sustainable agroforestry industry. It addresses the following five topics:

1. The major shift in Puerto Rico's leading industry
2. The history of high importation rates and how it manifests itself today
3. Current agricultural industries on the island
4. The concept of agroforestry, its benefits, and how it relates to the area
5. The importance of El Yunque and the environmental regulations on the island

The Major Industry Shift and its Social Implications

During the early half of the 20th century, Puerto Rico experienced a major shift in its leading industries. Previously, agriculture dominated the Puerto Rican economy, mostly due to the large and profitable sugar cane industry. However, because of the adoption of minimum wage by the federal government in 1938 (Grossman & Guzda, 1978), it soon became too expensive for many farmers to continue producing sugar (Augelli, 1953). This was a major contributor to the rapid urbanization and industrialization that Puerto Rico experienced. At first, this led to a reduction in the power of large sugar corporations, product diversification, and land reform. In addition, it also led to higher per capita income for many Puerto Ricans and improved social conditions such as housing, healthcare, and education. Nevertheless, this rapid industrialism led to greater unemployment, isolation from the labor market for a large portion

of the Puerto Rican population, and increased emigration to the continental United States. It also created a larger dependence of the Puerto Rican economy on the U.S. market and increased both private and public debt (Dietz, 1986).

In an attempt to reduce unemployment, the United States government made an effort to industrialize and develop Puerto Rico. To accomplish this, in the 1940s the government created “Operation Bootstrap”, a program that, among other things, offered incentives to corporations to move to Puerto Rico. As part of this program, the United States created a 100% tax exemption on profits for qualifying companies (Carrion, 2009). As companies arrived on the island, industrialization and modernization occurred simultaneously. However, unlike the industrialization of other nations such as the United States in the 1800s, there was little effort to modernize the agricultural sector, further contributing to its demise (Setrini, 2012).

This tax exemption was soon deemed to be too generous when the federal government found that the loss of tax money far exceeded their expectations (Eden & Kudrle, 2005). To attempt to rectify the situation, the U.S. government developed the Tax Reform Act of 1976. This act included Section 936, an extremely important tax incentive that still promoted the development of industries on the island while introducing more restrictions to the previous exemptions. It converted the tax exemption into a tax credit for eligible industries in Puerto Rico. This sheltered these industries from federal taxes and promoted job growth. However in 2005, Section 936 was eliminated by the Small Business Job Protection Act of 1996 after a ten year grace period was observed (Small Business Job Protection Act of 1996, 1996). The loss of tax incentives had a huge effect on Puerto Rico’s economy, as U.S. companies had less

motivation to remain in or expand to Puerto Rico; thus the rate of industrialization began to slow (Maldonado, 2002).

Puerto Rico's History of Importation

Prior to the major shift in Puerto Rico's main economic sector from agriculture to industry, the majority of the food consumed was grown on the island. In 1938, 65% of food crops were grown locally. Fifty years later, the percentage of locally produced food plummeted to 15%, requiring the importation of 85% of provisions (Febles, 1992). An example of this decrease in agricultural production can be seen in Figure 1. During the aforementioned change of leading industry, agricultural production decreased, resulting in rising prices of food due to the lowered local supply. In an attempt to keep the food prices low, the Economic Development Administration (EDA) supported the growth of supermarkets in Puerto Rico. These supermarkets replaced the small local shops that did not have access to the low-cost imports that the large chain supermarkets had. As these chains became more popular, the local population of Puerto Rico began to grow accustomed to having certain produce and products year round, and their diets changed to reflect this. This deepened the dependence that the island had on imports, as the large suppliers bypassed most local channels to acquire the desired products (Carro-Figueroa, 2002).

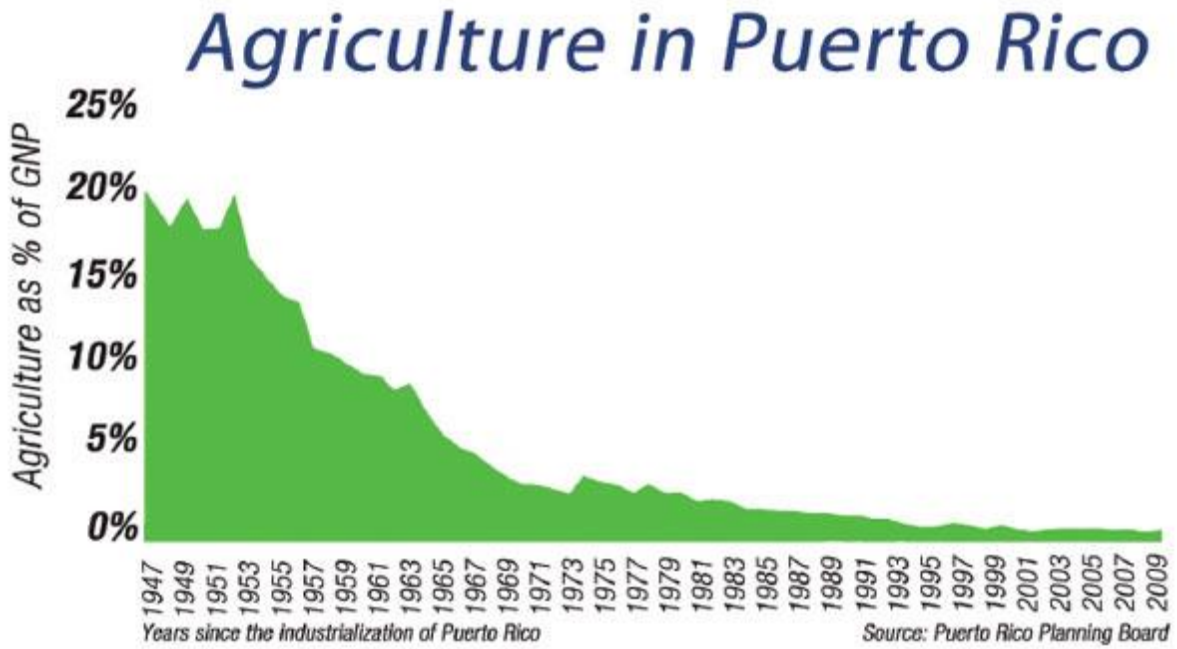

Figure 1: The decline of agriculture in Puerto Rico since the 1940s, shown in percentage of the gross national product

Between the 1960s and 1970s, the agricultural output continued to decrease on the island at a rate of -1.9% while the population continued to grow (Dietz, 1986). Two-thirds of the meat consumption of the island was imported while other processed foods such as cereals were completely imported. By 1994, local production of tropical root crops was only 33% of the total consumption and that of meats was down to 24% (Carro-Figueroa, 2002).

While the lack of local production and food self-sufficiency has obvious detrimental effects, it is generally not a major priority for the government. One of the most prominent issues is the lack of protection for Puerto Rico's food consumption if any disruption occurs in the supply chain. Even if the supply chain is functioning normally, it still has day to day effects on citizens. A lack of local production greatly reduces the leverage for Puerto Rico to control the price of its imports. As soon as local production is eliminated, food prices skyrocket. This has

been experienced firsthand on a small scale in previous years when hurricanes wiped out entire plantain crops on the island, causing the price to greatly increase (Carro-Figueroa, 2002).

Continuing the downward trend experienced due to rapid industrialization, Puerto Rico's agricultural production reduced by roughly 20% between 2003 and 2008 ("Puerto Rico Imports 85 Percent of Its Food", 2013). However, experts found that the island currently has the capability of producing nearly 45-50% of its food consumption. They also projected that in the future, the island has the potential to grow and produce 90% of the food it requires if it uses all of the resources available. Unfortunately, as of current day, Puerto Rico only produces 15% of the food it consumes; its low food production is shown below in Figure 2 (Ryan, 2011). The island's main trader is the continental United States, from which it receives 55% of its imports including chemicals, machinery, clothing, food, and petroleum (EconomyWatch Content, 2010).

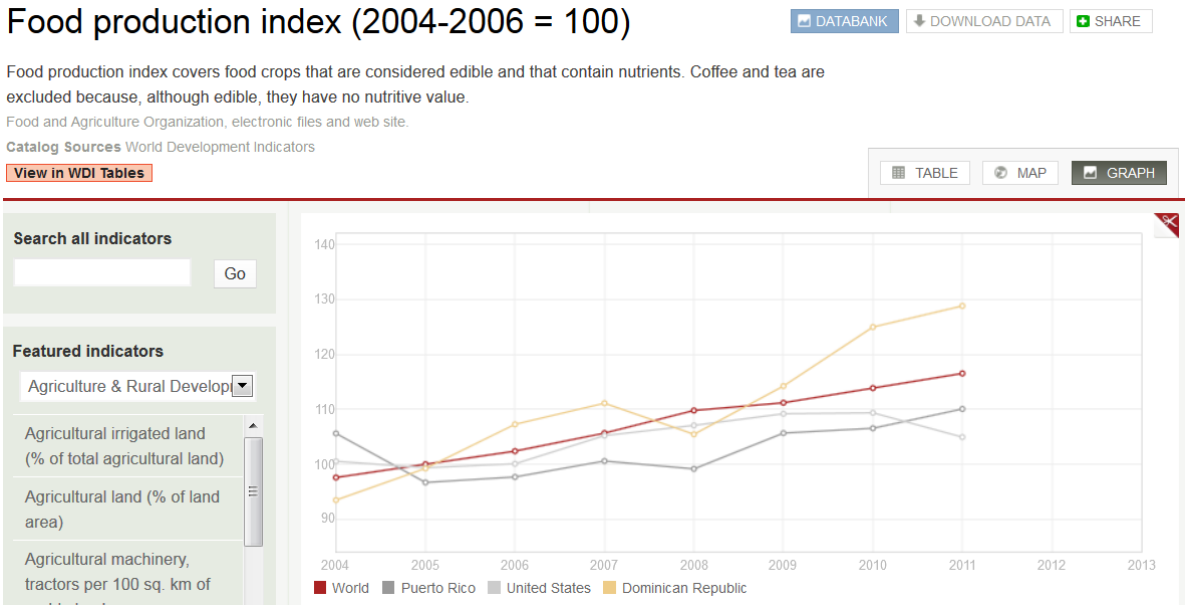

Figure 2: Comparison of Puerto Rico's Food Production Index

Over $2 billion worth of these imports were medicines that focused on aiding the digestive, nervous, and cardiovascular systems (Carmona, 2012). In addition, 85% of rice is imported, and most of the corn Puerto Ricans consume is imported; corn is grown on the island but is exported for sale in other parts of the world. On the other hand, an island-wide survey conducted by Gaither International, a marketing research company, showed that 95% of Puerto Ricans regularly purchased local products. When specifically asked what local products they purchase most often, most people replied with root vegetables, other vegetables, fruits, milk, and local coffee. Another study dissected this information and found that 27% of local food consumption comes from meat, followed by 24.7% from fruits and vegetables and 11% from dairy and related products (Ryan, 2011).

Although many Puerto Ricans are very interested in buying and supporting locally grown food, the market is not as large as it could be. The market demand is real and quite large, but there has been limited work done to improve the agricultural industry (Ryan, 2011). The responsibility of the social awareness and economic planning related to food security falls to the Marketing, Industry, and Food Distribution Chamber, also known as MIDA (Kantrow, 2011). In addition to other aspects of the commonwealth government, MIDA has been trying to improve local agriculture in any way possible. For example, there are fewer than 2,000 farmers on the island, most of whom are dependent on government subsidies to stay in business. There is also a training program available to farmers to teach them about modern technology and how they can incorporate it into their everyday work. The government hopes that expanding the agriculture industry will help to combat the high unemployment rates on the island

("Puerto Rico Imports 85 Percent of Its Food", 2013). However, in order for this to occur, the food industry can no longer be seen as an isolated economic entity.

The agriculture industry is no longer the same as it was years ago, and many of the people interested in getting into farming are young agro-entrepreneurs. Also, agriculture must diversify and move beyond producing only a few products for local consumption (Ryan, 2011). There are two types of farms typically seen across the island: small, low-productivity farms and highly subsidized industrial farms. However, these large, industrial farms contribute little to the island's food security, instead growing crops for export. This has further led to a decline in sustainability of the agricultural industry (Setrini, 2012). If these large industrial farms can be reworked so they contribute to food security, they may also lend their hand in decreasing the island's unemployment by creating more jobs.

In addition to the lack of farms growing agricultural products, another major issue with the island's food supply is that it is very dependent on the shipping and trade industry. If something were to happen to the supply chain, Puerto Rico's reserve of fresh food would be exhausted in 10 days, and the supply of canned food would be exhausted in 4 weeks. In addition, the prices of imported foods are directly related to gasoline prices, so as prices of gasoline increase so do those of imported food (Govardhan, 2007). These costs are also increased due to the geographic remoteness of the island (Setrini, 2012).

Due to the amount of trade between the United States and Puerto Rico, many believe that using international shippers would greatly reduce the cost to ship goods and thus increase the profitability of the agricultural industry. However, international food suppliers can have a large impact on food quality, safety, and homeland security. Consumers need to be aware of what

they are eating, and look for food with better taste and safer handling. This can easily be taken care of by consuming and supporting locally grown food, which would improve the economy as well as the consumer's overall quality of life (Ryan, 2011).

Current Agricultural Industries

While agriculture has experienced a dramatic downturn in recent years, there is still an economic niche for an agricultural industry in Puerto Rico. Currently, most of the limited agricultural production consists of fruits, coffee, and herbs ("Agriculture in Puerto Rico", 2013). Farmers markets bring a unique aspect to the agricultural industry by providing an opportunity for people to buy fresh, locally grown food. Puerto Rico has very few farmers markets, but there is the possibility for expansion across Puerto Rico if a proper business plan were to be implemented. Due to the lack of farmers markets in Puerto Rico, the team researched similar markets in other parts of the world to help determine the best methods and practices to recommend.

In the past, the main markets other than grocery stores were open air markets known as Plazas del Mercados. This type of market is common to many different cultures, each referred to by a different name. They were referred to as agoras in ancient Greece, forums in ancient Rome, and bazaars in the Muslim culture. These markets were generally open air markets that took place in a public, open area of land that served not only as a marketplace but also as a center of culture, politics, and social life. In the nineteenth century, hygienists raised many health concerns regarding these outdoor, open air markets. This led to the creation of iron architecture structures to serve as a roof covering, and now most current day markets have

some type of roof covering. In ancient times, these markets were very successful and served as a center for many community activities and gatherings.

Today, these markets are becoming less successful with each passing year. Due to increased industrialization, public land has become scarce and these “Plaza del Mercado” marketplaces are no longer held in public spaces. Instead, the operators of these markets are forced to rent private space, and this additional cost has become problematic. In some cases, vendors no longer sell at the market because the cost of renting the space limits their profits. This makes the market smaller and less enticing to people; customers prefer to attend bigger markets that have more options. Vendors that still sell at the market have been forced to increase the price of their goods in order to offset the cost of rent. This makes the cost of products at the market much higher than equivalent products that could be bought in commercial stores, which further deters many customers. Most people no longer see the benefits of these markets over a less expensive and more convenient supermarket, which may ultimately lead to their demise.

While these traditional Plazas del Mercados are failing in Puerto Rico, there is a new push to shift and create farmers markets in the style that is used on the mainland U.S. However, since there are still not many farmers markets in Puerto Rico, the team researched farmers markets in other parts of the world to allow for a more comprehensive review. The first market researched, Monteverde Farmers Market, is located in Costa Rica and was focused on for the aspects that make it successful.

This market is one of the more popular farmers markets in Costa Rica. However, it is only open one day of the week, with approximately 20 vendors in attendance. It offers a variety

of fruits and vegetables as well as baked goods, artwork, and live music. In addition, traditional foods as well as other ethnic foods, including some from China, are readily available. This variety of available goods is important to bring in repeat business because customers have the option to purchase something new each time they return. While there is a large variety of food at the market, it is important to notice that the market is similar to a festival. The live music and artwork entice members of the community to visit the market. Since it is similar to a festival, people of all ages are interested in going. This makes a very successful market, and other markets should strive to be modeled after this one to target a larger population of customers (Monteverde Info, 2013).

The second market is the Jamaica Farmers Market located in Queens, NY. The market thrives on its large variety of non-traditional options with foods native to Jamaican culture including fruits, vegetables, sauces, and salsas. In an effort to attract more customers, the market hosts multiple festivals and other events throughout the season where people can partake in raffles, games, and other enticing activities. These additional features help to attract larger crowds and are very important in making the market as profitable as possible (Community Markets, 2013).

Agroforestry, the Effects, and the Relation to Puerto Rico

Agroforestry combines forests with an agricultural industry, resulting in a synergistic relationship between the crops and trees. The trees can be in natural forests or on working tree farms, with crops, shrubs, or livestock tended to below the canopy of the trees. This combination of plants, if done properly, can result in increased biodiversity for a region. Environmental aspects that are often negatively affected by agriculture include: water quality,

wildlife habitats, erosion, soil fertility, and total biological production. In contrast, these aspects can all be positively affected by an agroforestry industry (Beetz, 2011).

Important Agroforestry Methods

Within agroforestry, multiple systems and methods can be used including: alley cropping, silvopasture, windbreaks, forest farming, and riparian forest buffers (Ramachandran, et al., 2009). Alley cropping is a system in which crops are grown in rows between newly planted trees. In the early stages, crops that require more sun can be grown among the immature trees. The small stature of immature trees allows plenty of sunlight to reach the ground and the crops. As the trees mature, more sunlight is blocked which requires the shift to crops that can thrive with less sunlight.

Figure 3: Example of alley cropping

Silvopasture is similar to alley cropping but incorporates the grazing of livestock into the system. This use of livestock reduces the need for and the cost of herbicides, mowing, and supplemental fertilization. Silvopasture also creates a dual use for the land, making it more profitable and reducing the negative environmental effects. Windbreaks, also referred to as shelterbelts, help to reduce the effects of wind on crops. Trees are planted in rows along the

edges of the fields, blocking high winds and greatly benefitting the soil by reducing erosion and drying caused by these winds.

Figure 4: Example of silvopasture

Forest farming uses naturally managed forests and crops capable of living below the canopy. Unlike alley cropping, this method involves planting crops beneath trees in an existing forest. This results in multiple sources of income from the same area of land, including the sale of lumber from the trees, any crops that grow on the trees, and any crops that grow on the forest floor.

Figure 5: Example of forest farming

Lastly, riparian forest buffers are trees and shrubs set up along streams or rivers, helping to protect the water quality. They help to slow down and break the flow of runoff into the river reducing the amount of sediment and chemicals that enter the water. In addition, the slowed runoff allows for more absorption into the soil, helping to reduce the threat of rivers overflowing their banks.

Figure 6: Example of riparian buffers

One of the biggest reasons for biodiversity loss and land use change in tropical areas was the cutting down of forests to use the land for agriculture. As deforestation increased, a movement for conservation of the forests began. The conservationists focused on the formation of natural reserves but neglected the protection of the landscape directly abutting the reserves. Agroforestry helps to combat the negative issues of deforestation by giving the land multiple uses and making it profitable without the need to cut down all of the trees (Bhagwat, et al., 2008).

The Positive and Negative Effects of Agroforestry

Agroforestry has benefits for both the farmer as well as society (Schroth, 2004). One benefit is the opportunity for multiple vertical levels of crop production that allow farmers to take advantage of the available space. While the addition of other plants creates more management for the farmer, it can pay dividends well beyond the cost of planting and maintaining these extra crops (Beetz, 2011). A major societal benefit of agroforestry is an increase in carbon sequestration, the absorption of carbon dioxide by trees (Jose, 2009).This increases the number of ways the land can be used, making the area a functional agricultural section while helping to maintain a healthy environment (Schoeneberger, 2009).

While agroforestry has multiple benefits, it is not always feasible. The cultivation and interaction of multiple plants requires a greater deal of maintenance, resulting in additional work for the farmer. There is also a substantially higher startup cost to an agroforestry design if the canopy trees must be planted by the farmer. This results in years of work before any fruits of their labors are seen. For farmers to consider the use of agroforestry as a method of land development, it must be an economically favorable option to all parties involved. Agroforestry is constantly in competition with methods of land development including livestock grazing, slash-and-burn, logging, and outright preservation. If any one of these uses is more favorable, agroforestry will not be chosen (Schroth, 2004). Economically, the success of agroforestry can be very hard to measure due to its significant societal benefits that are difficult to appraise.

Agroforestry around the World

The concept of agroforestry, while not well known, has been around for thousands of years. Based on current research, a variety of crops was grown in prehistoric times using the

principles of agroforestry. Specific evidence includes Brazil nut trees in the Amazon prior to the colonial times of the Americas, bananas in the rainforests of Africa roughly 3,000 years ago, and bananas in Papua New Guinea approximately 6,500 years ago (Bhagwat, et al., 2008).

In recent years, agroforestry studies were conducted in multiple countries around the globe. In 2005, a small-scale agroforestry adoption study was done in Calakmul Biosphere Reserve located in Campeche, Mexico. The study involved nine farmers who agreed to establish a test agroforestry system to determine the effectiveness of agroforestry in the area. They used three different management methods among the nine farms. For these farmers, the ability to diversify their crops and harvest products year round was their largest motivation for establishing an agroforestry system. Only two of the farmers in this study said that the selling of crops as their priority, which reduces its relevance to this project because the farmers were a specific population with their own goals. Nevertheless, this study is still important because it provides insight to the potential effectiveness of agroforestry and its corresponding testing methods (Mercer, et al., 2005).

Another study was performed in the northern grazing systems of Australia to research the potential of agroforestry to help reduce greenhouse gas emissions. This study used a silvopasture method of agroforestry in areas previously used for the grazing of livestock. It analyzed the costs of implementation versus the benefits to the land as well as any financial compensation that would result from growing the trees (Donaghy, et al., 2010). While this is a case study on agroforestry, it was conducted on a region much drier than El Yunque. However, both this case study and the study in Mexico show that agroforestry is a technique being pursued in other countries worldwide.

Agroforestry in Puerto Rico

There are some examples of potential agroforestry crops, such as shade-grown coffee, already being grown in Puerto Rico. The study "Shade-Grown Coffee in Puerto Rico" investigates the difference between sun and shade-grown coffee. Shade-grown coffee has allowed the farmers to produce multiple crops, mixing things such as plantains and bananas in with their coffee trees. Shade-grown coffee has also been shown to increase the biodiversity of an area, creating a more environmentally friendly farm (Borkhataria, et al., 2012).

While shade-grown coffee can be incorporated into an agroforestry system, an extensive agroforestry assessment has yet to be completed in Puerto Rico. Sr. Pedro Ríos, Ecosystem Management and Planning Team Leader of the U.S. Forest Service, has described (P. Ríos, personal communication, September 20, 2013) the limited agroforestry assessment done previously in Puerto Rico, citing its shortcomings and the need for a more extensive study. The previous study had focused more on the community's opinion of new agroforestry projects, lacking actual onsite investigation, data collection, and market evaluations.

The Puerto Rico division of the U.S. Forest Service has conducted preliminary meetings and tests to start determining the feasibility of agroforestry in El Yunque. The U.S. Forest Service is currently targeting undeveloped slopes of El Yunque where there is less chance for tourist or outside sources to interfere with the industry. These areas are mostly along the southern and eastern sides of El Yunque. The U.S. Forest Service Staff held multiple meetings and visits with community representatives from the Rio Blanco, Fajardo, and Rio Gurabo watersheds occurred to discuss and prioritize conservation and agroforestry projects. The report from these preliminary meetings, the production of vegetables in an agroforestry system

was ranked the highest. The production of fruit trees was ranked second and the production of natural products, including medicinal plants was ranked third. These reports were further reviewed with the U.S. Forest Service with an emphasis on sample selection and the community representative's underlying motivations.

The Importance of El Yunque and its Corresponding Environmental Restrictions

El Yunque is a rainforest located in the northeastern part of the island of Puerto Rico. It lies among the Luquillo Mountains, 25 miles from the metropolitan San Juan area. Elevation of the rainforest varies from 330 feet above sea level at the base to 3,530 feet above sea level at the summit. Due to these different regions of elevation, the climate also varies through the rainforest. Rain is a daily occurrence; on average, the area receives about 200 inches of precipitation per year. The average temperature is around 77 degrees Fahrenheit, or 65 degrees Fahrenheit in the areas of higher elevation. These different elevations and regions make El Yunque the perfect climate for tropical biodiversity (United States Department of Agriculture, 2013).

Although El Yunque rainforest only occupies a small area, about 28,000 acres, it has amazing diversity for its size (LexisNexis Academic, 2011). It has many distinct ecological zones and niches. Its grand eco-diversity sets it apart from other rainforests in the world, and for this reason, El Yunque has over 600,000 visitors per year (United States Department of Agriculture, 2013). A view into the eco-diversity includes: 150 fern species, 50 species of native orchids, 127 species of terrestrial vertebrates, 10 species of aquatic invertebrates, 5 endangered species, 1 threatened species, and 240 tree species (88 of which are only found in Puerto Rico, and 23 of

which are only found in El Yunque). This biodiversity is one of the reasons El Yunque was considered in the campaign for the "New 7 Wonders of the World".

El Yunque, its land, resources, and wildlife, are important assets to Puerto Rico. The rainforest was designated as a forest reserve in 1876 by King Alfonso VII of Spain and is the oldest natural reserve in the Americas and the New World (LexisNexis Academic, 2011). Today it is the largest protected area in Puerto Rico (Baver, 2012). El Yunque has been used as a worldwide model of tropical land management. The division of the U.S. Forest Service in Puerto Rico offers tours, hiking trails, and environmental education to visitors. El Yunque is part of the United Nations Man and Biosphere Program, which is a collection of reserves around the world that innovates and demonstrates its approach of conservation and sustainable development (Quinn, 2010). The parties involved share their ideas and experiences regionally, nationally, and internationally within the World Network of Biosphere Reserves. According to Quinn (2010), the U.S. Forest Service cares deeply about the conservation of El Yunque and partakes in this organization because they want to be an example of responsible land management and conservation to visitors and other parks.

Environmental Regulations

Despite efforts made towards conservation of the area, El Yunque has still struggled with environmental matters. Puerto Rico is plagued by urban sprawl and is faced with polluted reservoirs, a poor recycling rate, dying coral reefs, a decline in fisheries, and many other issues. Over 85% of urban areas built near El Yunque between 1985 and 2001 did not meet zoning requirements (Baver, 2012). Puerto Rico in general has also struggled with environmental issues; due to its limited size, tropical cyclones, and a high population density of 1,127 people

per square kilometer, the island has become more vulnerable to these issues (Yi, et al., 2008). Puerto Rico is also home to fourteen Superfund sites. According to the U.S. Environmental Protection Agency, Superfund is an environmental program established to address hazardous waste sites. The main goal of a Superfund site is to put into effect a cleanup process and ensure long-term protection of the areas.

In recent years, many efforts have been made to help protect and preserve the environment and the rainforest. El Yunque is managed by a team that includes a Forest Supervisor, an Ecosystems Management Team, a Property Manager, a Law Enforcement Patrol Captain, and other positions whose mission is to help guard and conserve the rainforest. In 1997, the Land and Resources Management Team adopted the El Yunque National Forest Management Plan (United States Department of Agriculture, 2013). The purpose of this plan is to develop the best way to manage the challenges faced in the rainforest. The U.S. National Forest Service improves this plan every 10-15 years with revisions, such as the 2012 Planning Rule that was implemented in April of 2012 to detail the process by which all developments, amendments, and revisions to land management plans will be conducted (United States Department of Agriculture, 2013). Other smaller efforts have been made such as mapping biological vulnerability to climate change and invasive species management (Yi, et al., 2008).

Chapter 3: Methodology

The goal of this project was to investigate and recommend applicable methods to establish a sustainable agroforestry industry in El Yunque National Forest based on an analysis of the proposed location and the investigation of local markets. The project team, consisting of five students from Worcester Polytechnic Institute, developed the following objectives in an attempt to achieve this goal:

1. Create and complete an agroforestry assessment based upon onsite investigations of the target area.
2. Determine market feasibility and what factors make a market successful.
3. Design a business model for the new industry.
4. Provide a source of education for farmers, consumers, and vendors.

The following sections will explain how the necessary information was collected and analyzed in order to address these objectives.

Objective One: Complete an Agroforestry Assessment

To complete an agroforestry assessment, the group drafted a set of criteria to determine the plausibility of agroforestry on the undeveloped slopes of El Yunque. While on site, the team had the opportunity to work with an expert in agroforestry, Luis Rivera, a forest botanist at the U.S. Forest Service with over thirty years of experience in this field. Sr. Rivera has his master's degree in agroforestry from Yale University. We worked closely with Sr. Rivera when drafting the criteria in order to increase our confidence in the proposed recommendations. An outline of the meeting with Sr. Rivera can be found in Appendix A:

Meeting with Luis Rivera, Forest Botanist at the U.S. Forest Service. The team used these criteria to rate the existing conditions in order to determine the type of agroforestry as well as the types of plants that would thrive in the area. The criteria take into account existing conditions, possible types of agroforestry, environmental effects, and a sampling of local farmers opinion. A broad list of criteria is provided in Appendix B: Agroforestry Assessment Criteria.

Investigation of El Yunque

The U.S. Forest Service provided the team with a Land Management Policy map of El Yunque National Forest, showing which areas were suitable for different types of activities. The map showed many areas of the forest marked as "Integrated Areas," which are areas where recreation and research are emphasized. These areas are the focus of the team's proposed agroforestry industry. The map is shown in Appendix C: Map of El Yunque. These integrated areas will be used for multiple smaller agroforestry sites, as opposed to one large area for the entire industry. Each site has its own specific conditions that need to be assessed.

The group visited two of the integrated areas on the eastern side of El Yunque in order to assess these locations for a possible agroforestry trial site. The group inspected the areas, noting current conditions including:

- Soil conditions
- Light conditions
- Temperature conditions
- Rainfall conditions
- Elevation and slope

- Accessibility

A comprehensive list of the existing conditions assessment is located in Appendix D: Existing Conditions Assessment. The division of the U.S. Forest Service located in Puerto Rico had already completed a watershed analysis on the area, while the Natural Resources Conservation Service (NRCS) had previously conducted research on existing soil conditions. Precipitation and temperature data were analyzed from the National Oceanic and Atmospheric Administration (NOAA), a federal agency focused on the conditions of the oceans and the atmosphere. The team planned to use light meters to measure the amount of light breaking through the canopy to the forest floor. However, the team was unable to secure these light meters and could not conduct these tests. The type of agroforestry for each location was assessed on a case-by-case basis, relying heavily on the farmer's opinion and the current conditions.

Determine Local Farmer Opinion

To help with the team's recommendations of the type of agroforestry to use and which plants to grow, the team met with Felipe Cano, a biologist at the U.S. Forest Service, who provided valuable insight regarding the new industry. A full summary of the meeting with Sr. Cano can be found in Appendix E: Meeting with Felipe Cano, biologist at the U.S. Forest Service. Sr. Cano also provided a report documenting community meetings and workshops that the U.S. Forest Service had conducted prior to our arrival. These meetings discussed the hopes that the U.S. Forest Service had for the community and listed multiple possible projects. The list of possible projects found in these reports is located in Appendix F: List of Possible Projects. The

report included discussions that occurred as well as voting results concerning projects that the communities were most enthusiastic about.

Each meeting had about 30 attendees consisting mostly of farmers over the age of 55. The team used the information in this report to tailor the agroforestry assessment to the more popular projects, giving the new industry a better chance to gain local support. This report did not take into account every farmer's opinion; not every farmer who is approached may support the new industry. However, based on the time and resources that the team had, the report was comprehensive enough to draw conclusions and guide the agroforestry assessment. A third, even more comprehensive community workshop was completed by the U.S. Forest Service in May 2012, but the team was unable to secure a copy to analyze this report. An analysis of this report would further strengthen determinations of local opinion drawn from these workshops.

Produce a List of Potential Plants

Before dedicating any land in or around El Yunque for the use of agroforestry, it was important to have a broad list of possible plants. A comprehensive list of plants that satisfies the previously mentioned agroforestry criteria can be found in Appendix G: List of Possible Plants and includes vegetables, fruits, root and tuber crops, and mushrooms. Dr. Frank Martin, a well-known researcher and author of several books about tropical plants, published a list of plants that would thrive in tropical climates worldwide; this list was used as a starting point for the team's research (Martin & Fennema, 1996). The team cross-referenced the needs of each plant with the conditions in El Yunque to determine what plants were viable options. We expanded the list further by using resources obtained from the U.S. Forest Service as well as interviews with local experts.

After establishing a preliminary list of plants, the team observed on site conditions and used them as constraints to narrow down the list and eliminate any plants that would not be successful in the area. Reasons for eliminating any plants were recorded, providing a baseline for future work to avoid repetition. The list of eliminations and reasons for these eliminations is located in Appendix H: Chart of Plants Eliminated with Reasons. The U.S. Forest Service and the NRCS were consulted to ensure the applicability of the list.

Interviews with Local Experts

To further advance the agroforestry assessment, the team met with several experts in the San Juan area. To gain a better understanding of soil conditions in El Yunque, the team interviewed Carmen Santiago, a soil scientist for the NRCS. A meeting with a plant material specialist from the NRCS, Edwin Más, also gave insight into possible plants and conservation techniques to be used in the new industry. The Agricultural Extension Service (AES), an organization located in Puerto Rico that focuses on agriculture education and provides support to small, local farmers, was also contacted and an interview was conducted with Hilda Bonilla. She was able to provide insight into the local Puerto Rican opinion and the issues the farming industry experiences. Lastly, Magaly Figueroa, a natural resource specialist for the International Institute of Tropical Forestry (IITF), was interviewed. She was able to provide important references to contact about the new industry and information on conservation threats to be aware of. The agendas and minutes from these meetings can be found in Appendix I: Meeting with Carmen Santiago, Soil Specialist at the Natural Resources Conservation Service (NRCS), Appendix J: Meeting with Edwin Más, Plant Specialist at the Natural Resources Conservation Service (NRCS), Appendix K: Meeting with Hilda Bonilla, Agricultural Extension Services (AES),

and Appendix L: Meeting with Magaly Figueroa, Natural Resources Specialist at the International Institute of Tropical Forestry respectively.

Objective Two: Determine Market Feasibility and What Factors Make a Market Successful

The second objective was to determine whether a market is feasible for the new agroforestry industry and assess what factors make a market successful. The two major aspects of this objective were to determine local opinion and to visit and observe local markets. The team used the information gathered to assess the market, determine what factors are important in making a market successful, and develop a final list of plants to recommend to the U.S. Forest Service for the potential new agroforestry industry.

Interviews to Assess Market Feasibility

Interviews were conducted with farmers market operators, farmers market vendors, and supermarket managers to understand local opinion regarding the new agroforestry industry and the development of a market for this industry. There is an obvious difference between markets located on different parts of the island, so this bias was taken into account when considering which markets to visit and observe. However, due to the limited time and transportation resources available, the team was only able to visit markets in the San Juan area.

At these markets, the team interviewed vendors and operators in order to gain a better understanding of the different aspects of a farmers market. We interviewed the operators of the markets to see what kind of work goes into running a successful farmers market and to discover the most important startup attributes. We interviewed farmers and other vendors to get their opinion on the pros and cons of the market and what they would change given the

opportunity. The sample population for these interviews was based on the principles of convenience sampling, which is a type of nonprobability sampling where the population is chosen based on convenience to the interviewer. This form of sampling, like all types of sampling, has a bias from the interviewer's individual selection of interviewees. However, based on the team's time and resources available for selecting a sample at the markets, convenience sampling proved to be the team's best option to gain the opinions of people at the markets. The full summaries for all of these interviews can be found in Appendix M: Farmers Market Operator Interview Questions and Minutes and Appendix N: Farmers Market Vendor Interview Questions and Minutes.

Interviews with supermarket managers were conducted to provide information on the current market for produce and possible new crops that have the potential to be profitable. We identified the possible bias between metropolitan markets versus markets in more rural areas; to compensate for this bias, the team had planned to interview supermarket managers located in different geographic areas. However, based on time and transportation resources available, not all of these interviews were completed, limiting our overall conclusiveness. A complete set of interview questions can be found in Appendix O: Supermarket Manager Interview Questions and Minutes.

The last interview that the team wanted to conduct was with an employee at the United States Department of Agriculture (USDA) in charge of the markets in the San Juan area. The team planned to gain information on the process for setting up markets in San Juan, which markets were successful and why, and possible general markups at farmers markets. In addition, the team wanted to learn where current markets are held in order to minimize

competition and determine where there is a need for a new market. A complete set of interview questions can be found in Appendix P: Meeting with Head of Markets for the Department of Agriculture. Unfortunately, due to the employee's schedule, we were not able to meet and conduct the interview.

Visit and Observe Local Markets

A major part of this project involved the development of criteria needed to create and maintain a successful farmers market for the products of the proposed agroforestry industry. In addition to gaining local opinion through interviews, another important aspect of this objective was to make observations of the markets during our visits. The team travelled to farmers markets and supermarkets in Puerto Rico to see first-hand how they operate. At each market, the team observed which products were sold in the produce department. This provided information on what products there is already a market for. The team took notes on each store and compiled a list of all produce that is currently sold in markets around Puerto Rico, which can be found in Appendix Q: Produce Currently Sold in Markets in Puerto Rico.

Finalize List of Plants

Using the information gathered through these interviews and markets visits, the team determined a final list of plants to recommend for the new agroforestry industry. In Chapter 3: Objective One, the team researched plants that thrive in a tropical climate and collaborated with local experts to create a preliminary list of plants. After interviews and visits to markets, the team created a list of plants sold there. This list was cross-referenced with the preliminary list of plants. The team attempted to find a third list of plants that are naturalized to the area of El Yunque to help assure cultivation, but were unsuccessful. We selected plants that met

criteria from the two lists, with a focus on if the plant was naturalized to the area because these plants would have the best chance of being successful in the industry. This final list of plants was then sent to the U.S. Forest Service as a recommendation of what plants should be used for the creation of a new agroforestry industry.

Objective Three: Design a Business Model

The creation and management of a successful market stems from the development of an in-depth business model. Designing a business model for a new market requires three steps: perform a stakeholder analysis, develop a marketing plan, and establish a farmers cooperative.

Perform a Stakeholder Analysis

To create an economically successful agroforestry sector, it was important to analyze the stakeholders through a SWOT analysis. SWOT stands for Strengths, Weaknesses, Opportunities, and Threats. To perform the SWOT analysis, the team discussed a preliminary list of potential stakeholders identified to be the following: local landowners, the U.S. Forest Service, food distributors, consumers, commercial markets, and specialty markets. The team then conducted interviews with these stakeholders and performed an analysis at the completion of the project. This analysis allowed the team to determine how this agroforestry industry would affect the stakeholders. While interviews with these stakeholders were previously discussed in Chapter 3: Objectives One and Two, the team added more questions to each of the interviews in order to accomplish the SWOT analysis. The interview questionnaire for supermarket managers can be found in Appendix O: Supermarket Manager Interview Questions and Minutes.

Marketing Plan

A major aspect of a business model is a strong marketing plan. A marketing plan is an important building block in the development of a new industry and consists of the four P's of marketing: Promotion, People, Place, and Price.

The first P of the marketing plan stands for promotion. One major part of promotion is the creation of a brand. The team researched creating a preliminary design of a logo to be associated with the brand that represents the new agroforestry industry. There are many important benefits that are a direct result of the development of a brand. A unique brand with a signature name and logo allows people to distinguish this brand among others. Customer recognition of a brand with a distinct background fosters repeat customers through brand loyalty.

The next step was to create promotional events to market the brand and inform the community. Through visits to various markets, the team researched events that currently promote markets and discussed the pros and cons of each event. Due to the increasing use of technology, the team also researched methods of online promotion. A recent study found that the majority of Puerto Ricans use Facebook (Socialbakers, 2013), so the team also researched the possibility of a social media campaign as a means of a free and effective promotional opportunity.

The second P of marketing stands for people. The main goal of this was to determine the customer profile of a farmers market. This was accomplished by attending farmers markets and visually surveying the area for the overall demographic. Each team member made observations concerning age and socio-economic status, and then the team discussed their

findings to come to an overall conclusion. Determining local demographics allowed for the identification of the target population, which is crucial to create the most efficient method for promotion and to identify the prime location for advertising. Identifying the target population is also necessary to understand which products are popular in each specific socio-economic area.

The third P of marketing stands for place. The main goal of this marketing aspect was to create a set of criteria to determine the most effective places and times to hold a farmers market. The team asked farmers market operators their opinions on what factors are important to consider when determining a place and time of a market. After analysis of the various interviews and discussions, the group was able to suggest several different times and places for the farmers market.

The fourth P of the marketing plan stands for price. The main goal of this aspect was to determine markup prices for the products sold under the brand that was created to represent the new agroforestry industry. One major benefit of branding is that it creates the opportunity to sell a product for a higher price through a markup on products being sold. In order to help determine a markup for specialty food products, the team researched several different products and their prices at regular markets and specialty markets. The cost of growing for the different crops was also researched and taken into account to recommend the prices to sell the products at.

Establishing a Farmers Cooperative

A farmers cooperative would be an ideal way to support the farmers that are a part of this new industry. By definition, a farmers cooperative is an organization owned and operated by the farmers who are members where they can receive support and share resources among

one another. In order to learn about establishing a new cooperative, we talked with the Puerto Rico Department of State to determine current regulations for cooperatives in Puerto Rico. Additionally, the team talked with current Puerto Rican cooperatives to discuss how they were established and what challenges they face. A full agenda of the cooperative board member interviews can be found in Appendix R: Interviews with Farmers Cooperative Board Members. The team also talked with farmers to determine their opinion on cooperatives and whether they were part of one or interested in joining one. With the information that was collected, the team was able to develop a plan to establish a farmers cooperative.

Objective Four: Provide a Source of Education for Farmers, Vendors, and the Consumer

An important aspect of this project involved providing a source of education to local farmers, vendors, and consumers. This entailed interviewing local experts in order to gather information to share with the public and using this information to create an outline for an educational medium. This educational medium is an important aspect of the project because it gives local residents the chance to understand what is going on and why, and provides them with an opportunity to get involved.

In order to gather all of the information necessary for the creation of the outline, the team met with many experts and local agencies, including AES, NRCS, the Department of State, and the Department of Agriculture. From meetings with these experts, the team gathered information to share with local farmers, vendors, and consumers. Once all of this information was collected, the team organized it into a template that was sent to the U.S. Forest Service for use in a technological medium.

The main reason for creating an educational medium was so that all of the information that has been gathered and analyzed by our team as well as teams before us would be available in one place. The team researched several technological mediums that could be used to present this information, and discussed the pros and cons of each to decide which medium would be the best option.

Chapter 4: Results and Analysis

Through the analysis of the information gathered during onsite investigations, interviews, and surveys, we were able to develop the following findings and results. These results addressed multiple questions, including whether or not agroforestry was possible on the proposed test sites, which plants the market supported and could be grown in the forest, and the most appropriate method for educating the public.

Objective One: Complete an Agroforestry Assessment

Onsite investigation played a main role in the results for the agroforestry assessment. The team was taken to two potential sites: one a cleared site that was a failed recreation area project, from here on referred to as Site A, and the other a more typical, undeveloped section of El Yunque, from here on referred to as Site B. The locations of each of these sites are shown

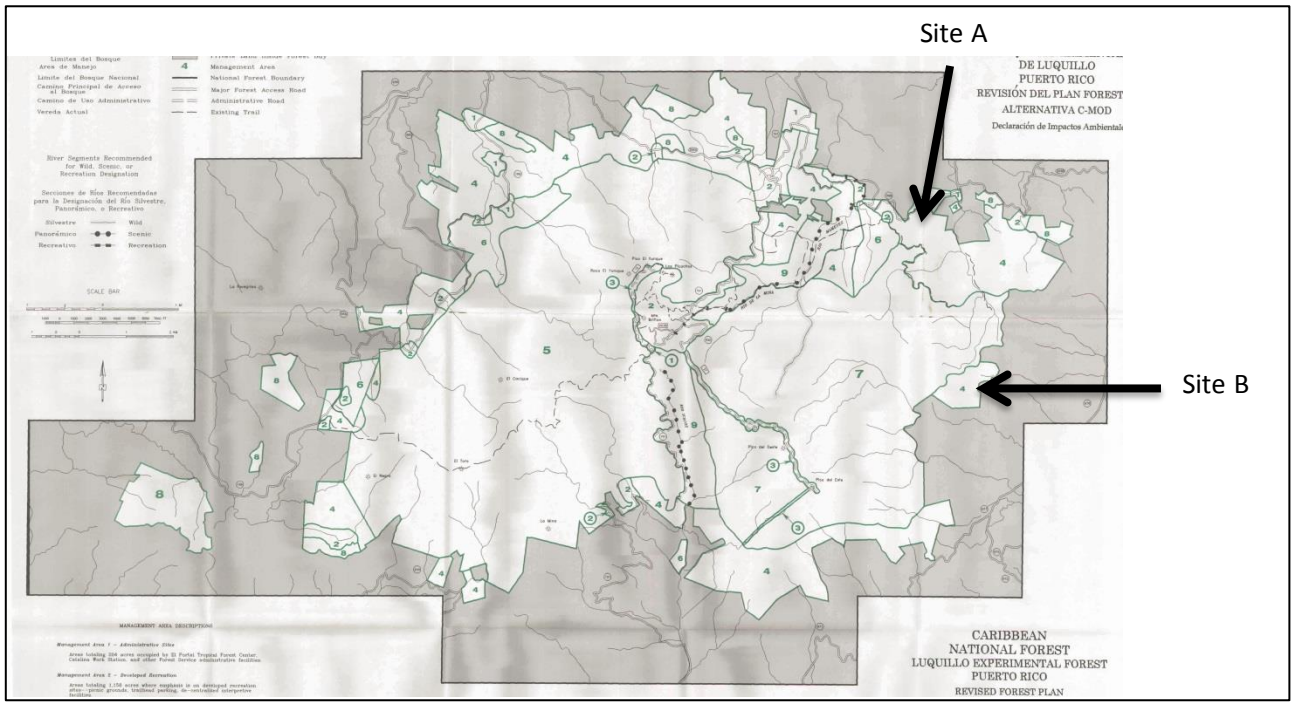

Figure 7: Map of El Yunque broken down by land management policy sector

in Figure 7. Site A will soon be the location of three bee hives for the cultivation of honey but may be used for the cultivation of plants in the future.

Site Characteristics

The team assessed the existing conditions for Site A. The area was flat and just off a main road through the forest, making the site easy to access. The lack of a canopy allowed for the sun to fully penetrate to the floor. It is not close to any major trails or tourist attractions, keeping the interference of outsiders to a minimum. The site was located at roughly 300 feet above sea level.

The temperature average for all of El Yunque is 73° Fahrenheit, but the temperature varies between elevations (United States Forest Service, 2013). The average temperature at the top of El Yunque is 62° F, while the average temperature along the mid-slope ranges from 78° F to 82° F with the temperature fluctuating little from season to season (FOSSweb, 2013).

Information on rainfall for the specific proposed sites was not available, so in order to obtain accurate information, data concerning the entirety of El Yunque and the surrounding towns was collected, analyzed, and compared. In the lower elevations of El Yunque, the average rainfall per year is around 55 to 60 inches. This was consistent with the amount the surrounding towns receive, around 5.6 inches per month. Using available weather statistics, the team found that the southern side receives the least amount of rain, on average about 4 inches per month. As the elevation increases, so does the amount of rainfall. At the higher elevations, annual precipitation averages around 200 inches per year. With this information, we analyzed each crop's water needs to further edit our plant list.

The entire rainforest contains predominantly clay soil, which is acidic with a pH around 5. For Site A, on the north side of El Yunque, the soil contains 67% crital-zarzil, a well-draining clay mix. The rest of the soil is not as well-draining. While these soil tests were conducted by the NRCS and are specific to the northern area, they are not one-hundred percent accurate to a specific area. Carmen Santiago, a soil scientist for the NRCS, discussed how certain alterations to the soil due to human interference can affect the conditions, and that a specific site test is best to determine the conditions. However, she said the online soil survey is accurate enough to determine if an area will support the growth of certain plants.

Unlike Site A, Site B was entirely unmanaged and located on the undeveloped east side of El Yunque. There was not a large pitch, less than 10% in the outskirts of the forest. Several hundred feet in, the slope begins to increase and rise with the mountain. This site was not nearly as accessible as Site A; this part of the forest can only be accessed across private lands. This will be fine if the landowner adjacent to the forest is the individual working on this new forest farm. However, an outside farmer would require agreements with private landowners in order to farm this area. The elevation in this area is up to 600 feet above sea-level. The average temperature and rainfall are the same in Site B as in Site A. The soil was a combination of crital-zarzil and humatas-zarzil, both well-draining clays.

The analysis of the existing conditions showed that agroforestry is possible from a purely technical sense. Because the areas are not high up in the mountains, they are more likely to succeed; higher elevations make accessibility and crop growth difficult. The sites are relatively flat, reducing the fears of erosion of soil and plants. The majority of future sites will be accessible to the farmer living adjacent to the forest's border. If this landowner is not willing

to be involved, however, it most likely will not be feasible to have another outside farmer try to come in and farm in the forest. As long as plants are selected that are accustomed to and thrive in these kinds of conditions, the weather should not be factor. A summary of the onsite conditions for each site is given in Table 1 below.

Table 1: Characteristics of Site A and Site B

Characteristic	Site A – Failed Recreation Site	Site B – Backyard of Farmer
Land Policy Number (Map)	4	4
Pitch of Slope	0-5% Flat	0-15% Foot of the mountain
Accessibility (0-10, easy-hard)	1 (with U.S. Forest Service key to gate)	8 (private land)
Elevation (above sea level)	300 feet	600 feet
Temperature (Average Annually)	78-82° F	78-82° F
Rainfall (Average Annually)	55-60 inches	55-60 inches
Soil Conditions	67% crital-zarzil	crital-zarzil/humatas-zarzil
Forest Management	Cleared	Unmanaged
	 **Figure 8: Site A**	 **Figure 9: Site B (Starting at the forest boundary behind the cleared, private land)**

Soil Analysis

The analysis of the soil showed that it is not the most desired soil for crop production due to its acidity and its lack of loam mixed in with the clay. From an agricultural standpoint, a loam-clay mix is much more desirable but this only appears in the southwest corner of the forest, an area not currently contemplated for the development of this new industry. Despite this, there is an abundance of vegetation in the forest, clearly showing that the soil will support the growth of trees and plants. As long as the plant being grown is carefully selected, the soil should not be an issue. A full soil analysis can be found in Appendix S: Soil Analysis Test.

Following discussions with Sr. Cano, the biologist at the U.S. Forest Service, the team decided to focus on plants that are already indigenous or naturalized to El Yunque. Knowing that the plant already grows in the wild will help to ensure a better chance at success. Sra. Santiago, the soil specialist at the NRCS, also warned about trying to grow root crops in the clay soil. The clay is very dense, restricting the growth of large root crops and ultimately giving the farmer a much smaller yield.

The farmer may be able to help plant growth through some simple soil management techniques, discussed with Sra. Santiago and Sr. Rivera. Any soil management would need to use organic materials to avoid damage to the forest ecosystem. One method used by the Taínos, the native people of Puerto Rico, involved a three foot wide mound consisting of composted and organic material. Vegetation would be planted in these mounds, providing nutrients for the plants as well as a larger growing surface area. The other technique is the use of terraces if the site is on a slope. Top soil is removed and saved while a flat platform is cut into

the hill. The top soil, along with other organic material, is placed back to give the seed the required nutrients.

Site Management

The team also considered the amount of work involved in the management of each area. The forest as a whole is unmanaged, meaning that there has been no human interference with the forest growth, due to the immense amount of work that it would entail. Site A was cleared because it was developed to be a recreation area project that ultimately failed. This allows a farmer to start anew, selecting plants for each vertical level of growth; however, there are currently no plans to use the area for this. The U.S Forest Service is focusing more on having landowners that border the forest farm on the public land behind their properties. These areas are all unmanaged. As both Sr. Rivera and Sr. Cano described in their conversations with the team, there is an immense amount of competition in the rainforest. Plants fight for nutrients, light, and space. To assure the plants the best possible chance of growing, some management of low plants such as ferns and small shrubs may be needed to help reduce this competition. Any management that is to occur must be done properly and comply with the Forest Management Plan set by the U.S. Forest Service.

In addition to proper management techniques, it is imperative that farmers complete the paperwork necessary for certain agricultural activities. Magaly Figueroa, a natural resource specialist from the IITF, provided information regarding two main permits required for farmers. The first was a tree removal permit, which can be found in Appendix T: Tree Removal Permit. This permit is required if anyone moves, removes, damages, or harms trees. Important aspects of this permit include talking to the appropriate environmental departments, gaining

authorization from the property owner, and providing contact information of the licensed professionals involved in the action. The second permit is a soil permit, which is required if any soil is moved in mining activities, excavation, removal, or dredging. The full permit can be found in Appendix U: Soil Removal Permit.

Type of Agroforestry

After onsite investigation, the team continued with the agroforestry assessment, a completed version of which can be found in Appendix V: Completed Agroforestry Assessment. It was clear to the team that the method of agroforestry to use must be selected on a case-by-case basis. If a site is managed like Site A, a farmer can have multiple options, ranging from a small alley cropping operation to forest farming. If there is water running through a farmer's property, a riparian buffer could be created from trees and plants that could also yield a profit for the farmer. In the majority of areas where the forest is unmanaged, there will be no choice but to use forest farming, leaving the canopy untouched. Any other method would require the clearing of existing trees and species, a strategy that is not being considered.

Size of the Proposed Location

The size of the location for agroforestry was the next item for assessment. In the U.S. Forest Service's new land management policy for the forest, 6,216 acres have been designated for integrated use where research and recreation is encouraged. In the undeveloped areas, this land is being used for research in agroforestry. While there is a large area with an agroforestry potential, most farmers along the border of El Yunque are small farmers who own only a few acres. Onsite investigation and discussions with Sr. Rivera suggest that the industry will be more likely to succeed if started as a small side project that farmers can check on only once in a

while, allowing them to continue with their current farming with minimal interruption. Thus, the projects will be small to start, with only an acre or two of space being used in the forest.

Local Support

Through the workshops and meetings that the U.S. Forest Service had with community representatives, there is strong local support for this new industry. The most popular project was the cultivation of vegetables in an agroforestry setting. The attendees of these meetings were local landowners from different regions. The team discussed these meetings with Sr. Cano, who was present at the meetings and helped to coordinate them. They developed the list of attendees with the help of a contract facilitator who has a long history of working on forest projects. The NRCS was also contacted for their list of farmers they had been working with who were already interested in the industry. It is noted that these meetings have an element of bias due to the selection of farmers by the contract facilitator and the NRCS. They also did not encompass and cover every single farmer on the eastern and southern border of El Yunque. However, based on Sr. Cano's account of the meetings and the team's limited time in Puerto Rico, the reports were used for analysis of local opinion. There may be more farmers against the implementation of the new industry but, based on the reports, it is believed that roughly 60% of farmers are in support of the agroforestry project.

Possible Plants

The last part of the agroforestry assessment was a list of possible plants. The team had arrived with a list of plants that grew in tropical settings, unaware of actual onsite conditions. Following meetings with local experts and members of the U.S. Forest Service Team, the list was edited. The characteristics of clay soil hinder the growth and expansion of roots, therefore

most root crops were removed. Products with large processing requirements, such as coffee and cacao, were also removed because these agroforestry projects are intended to be small side projects that do not require a lot of maintenance or post-harvest processing by the farmer. Analysis of the report from the workshops also yielded additions to the list as farmers stated crops they would like to see grown. These crops included ornamental plants, vegetables, medicinal plants, and mushrooms. Farmers also indicated that they would be interested in growing non-traditional fruits due to their increase in popularity as consumers are willing to pay extra money for them.

From the established set of criteria, provided in Appendix H: Chart of Plants Eliminated with Reasons, the team was able to determine four species of plants that would thrive under an agroforestry setting:

- Bell Peppers
- Parsley
- Chanterelle mushrooms
- Oyster mushrooms

All four of these plants were determined to be able to thrive in the climate, the type of soil available, and a large amount of shade. These products were also determined to potentially be very profitable for the farmers who will sell them. Mushrooms are a desirable crop for the area because of their tendency to prefer shady, wet, and humid areas. The team understands that growing mushrooms may not be the most favorable option, however the workshop report detailed that some community representatives, mostly farmers, expressed interest in it. Also,

the possible profit that could be gained from selling mushrooms makes them a very viable option.

In addition to these four plants, the team also determined a list of several other plants that may work in an agroforestry setting, found in Appendix W: Revised List of Plants. These plants met some of the aforementioned criteria; however they were determined to not be the most successful options for this system and climate. There were many plants that were on the original list of possible plants that were eventually eliminated. This was due to the conditions of the target sites, such as soil contents and sensitivity to lack of sunlight. The specific plants eliminated and the reasoning behind these eliminations can be found in Appendix H: Chart of Plants Eliminated with Reasons.

Objective Two: Determine Market Feasibility and What Factors Make a Market Successful

For the second objective, the team determined whether a market was feasible for the new agroforestry industry and assessed what factors make a market successful. In order to complete this objective, the team conducted interviews to determine local opinion and visited local markets for observation. The final step to this objective was to use all of the information collected to finalize a list of plants to recommend to the U.S. Forest Service for this new agroforestry industry.

Farmers Market Operator Interviews

Interviews were conducted with two farmers market operators to provide insight into the organization of a farmers market. Through these interviews, we found that these farmers markets provide a place for farmers to sell their products to customers who want to know

where their food comes from. Another important purpose of these markets is to increase the self-sufficiency of Puerto Rico and to further develop the agricultural industry on the island. The two operators agreed that the opportunity to produce more diverse products exists, but no one has taken advantage of it yet on a large scale. All products sold at these markets are locally grown, unlike most products sold in supermarkets. These operators do not necessarily measure their "success" based on profit, but rather if they are able to provide a market for these locally grown products and educate people about their agricultural products. These interviews also provided insight into factors that attract people to their markets and the benefits of a farmers market versus a supermarket. Location is a crucial factor regarding the popularity of a market. A market that is conveniently located attracts more customers due to its easy accessibility. None of the operators knew what their most popular products were, but believed that organic products are popular because they are not offered as extensively in supermarkets.

The operators also talked specifically about the duties and challenges they have faced while operating these markets. The duties of the operator varied between markets, but most supervise and coordinate all the vendors selling at the market. Information was ascertained regarding start-up methods, challenges faced during the start-up process, and daily challenges. For the creation of a farmers market, it is essential to determine the frequency, time, location, and structure of the market (cooperative market, group market, run freely, incorporated, etc.). It is also important to obtain the necessary permits and find vendors who are interested in selling at the market; it is these vendors who will decide what products will be sold. Finding a group of vendors who live in the area and have products ready for market is a big challenge due to the already scarce amount of agriculture on the island. Maintaining and running the market

was said to be the major daily challenge. Most markets were run entirely by volunteers or part-time workers, and no one listed this as a full-time, paid position. The team was only able to interview two operators due to several factors including the amount of time the team had, frequency of markets, and the busy schedules of individuals, limiting the ability to draw conclusions from the data.

Farmers Market Vendor Interviews

Eight interviews were also conducted with farmers market vendors, who provided information about their experiences selling at the market. Approximately 88% of vendors interviewed said that a farmers market was the main place they sell their products and most sell at several different farmers markets. The vendors from the larger more successful markets, Plaza Las Americas for example, only sold at that market because this market alone provided enough business. The team also found that most people find out about markets through word of mouth; therefore, the reputation of a market is vital. Substantial weight is placed on a market's reputation because not many means of advertising exist other than word of mouth. This lack of advertisement upsets many vendors because better advertisement could reach a larger audience. One thing all vendors agreed on is that customers shop at these markets because they know they are buying fresh, high quality local products.

Vendors were also asked whether or not they would consider selling their goods at a commercial supermarket, which garnered the largest variety of answers. The farmers that opposed this were very passionate about their reasoning because they did not support these commercial markets. They were firm believers in the movement to make agriculture more prominent in Puerto Rico so the island could depend less on imports. These farmers were

mostly the ones who listed farming as their main occupation. The other half of the farmers said they would consider selling to commercial markets as long as the money was there. These vendors were less passionate and did not say farming was their main occupation. They seemed more interested in the profit that could come from the industry rather than the purpose of the industry to increase Puerto Rico's food self-sufficiency.

The interviews also addressed the operation of the market and the vendor's opinion on its overall success. Vendors at Mercado Organico, located in Placita Roosevelt, enjoyed selling at this market because it is one of the oldest and most famous markets on the island, attracting many customers due to its popularity. Most farmers agreed that markets are more successful if held consistently in the same place at the same time every week. This allows the customers to make the market a part of their weekly routine, which increases their loyalty and creates more repeat customers. Overall, vendors seemed pleased with the markets they sold at, but they also had suggestions of things they would like to see implemented. Vanessa Rivera, an experienced vendor who sells her products at a number of markets, was able to provide valuable insight based on her experience at various markets. From her experience she found that important factors that attract people to a farmers market include: live music, a convenient parking area, public bathrooms, a safe area for children, and a strong community feeling.

Three farmers also talked about the government and its involvement with the agriculture industry. One vendor stated that food sovereignty needs to be the ultimate goal, and a good number of farmers agreed that emphasis needs to be put on eating food grown in Puerto Rico, rather than imported foods. The three farmers agreed that the government needs to decrease regulations because getting permits for these farmers markets as well as farming in

general is much too difficult. On the other hand, the Department of Agriculture of Puerto Rico (DoA) seemed to really support the farmers. For example, the farmers market in Plazas Las Americas is run by the DoA, and this market is set up free of charge to the vendors. Most vendors said they would not sell at a market that charged them to sell there, which has been an issue with some market locations because even though the land is public, the government is charging them to be there.

Supermarket Manager Interviews

The team also conducted interviews with four managers from four different supermarkets, including one specialty market, located in different areas of the island. These interviews provided information about the structure of commercial supermarkets, which was useful in the market evaluation. When asked about their most popular item, no manager could select one specific product. They did mention that some products are "trends" which become extremely popular for a short time until the customers lose interest. Different stores had different ways of learning about new products to sell in their stores. One company takes trips to stores in the continental United States (Wholefoods, Trader Joes, etc.) and uses this information to create their market, see what trends exists, and be the first ones in Puerto Rico with these new trending products. Other companies attend shows on the mainland that have meat and dairy suppliers displaying their products. Three of the four said that suppliers bring new food to them, and as long as the product gets the quality approval of management, they sell it in their store. Another method of determining new products is to observe current food trends and bring these foods in (ex. gluten free, organic, etc.). One store said they have

"request forms" at the customer service window for people to request items they would like to see, and they are willing to bring in anything people ask for as long as it is affordable.

When asked what attracts people to their supermarket, two managers mentioned their weekly specials, coupons, flyers, and advertisements (television, newspaper, and radio). All of the managers believed that people shop at their supermarkets rather than farmers markets because they are cheaper and more convenient. According to supermarket managers, for customers who do not care to buy directly from their farmer these supermarkets provide relatively fresh food at cheaper prices than a farmers market, and these supermarkets are more conveniently located. When managers were asked about cooperatives, another interview topic, the team found that some supermarkets belong to a cooperative while others do not. However, the supermarkets that do not belong to a cooperative think it would be a successful business venture. Pueblo, one local supermarket chain, said they belong to a cooperative and it allows them to sell the highest quality products and also gives them price advantages.

Managers were also asked about specialty products to gauge whether or not there could be a market for these items. Pueblo has many different store locations on the island and stated that their specialty items sell well in specific stores, such as Isla Verde which is located in a higher socioeconomic area, while they do not sell as well in other stores located in lower socioeconomic areas. When asked about issues they encounter, one recurring issue was the need to ship everything from the mainland U.S. due to the lack of consistency with products grown in Puerto Rico. A specific example was provided by one manager who said that his suppliers from Puerto Rico are just too unreliable; one week he had good tomatoes but the next week he did not have any. Another main problem was with supply and demand.

Sometimes stores got to a point where they had to reduce their quantities because they threw out too much food; it all depends on the location of the store and meeting the wants of the customers in that area.

Market Evaluation

The team worked to determine whether a market for this industry is even feasible in Puerto Rico. An evaluation of the market has shown that the right products in the right area have sold and been very profitable. The team also found results on factors that make a market successful, which include: products that customers are interested in, vendors that are reliable, reasonable prices, popular location, good reputation, recurrence, community feel, publicity and advertisement, attractions at the market, live music, high quality food, and customer loyalty.

Another important part of evaluating the market was to visit the different stores and observe their produce departments. At each store, the team took notes on the agricultural products that were being sold. From these observations, the team determined which products there is a market for. A compiled list of produce currently sold in stores around Puerto Rico can be found in Appendix Q: Produce Currently Sold in Markets in Puerto Rico.

Using the preliminary plant list that was created in Chapter 3: Objective One, the team narrowed this list down to include only the plants that would have the best chance of success. The preliminary list was cross-referenced with the list of products found in supermarkets, keeping in mind the projects that were supported by the local farmers. The team also focused on whether the plants were naturalized to the area of El Yunque or not because the naturalized plants have a higher chance of cultivation. The revised list of plants can be found in Appendix W: Revised List of Plants.

Objective Three: Design a Business Model

Stakeholder Analysis

After investigation, the team identified the main stakeholders of the new agroforestry industry to be: local farmers, the U.S. Forest Service, food distributors, consumers, commercial markets, and specialty markets. We then conducted interviews with members of each of these stakeholders to establish a foundation for our SWOT analysis.

The first interviews we conducted were with several members of the U.S. Forest Service to gain an understanding of what they were looking to accomplish with the new industry. Through these discussions, we found that they are looking for a way to use the forest for multiple purposes. A new land management plan was created that designates certain areas of the forest for different purposes, one of which is a new agroforestry sector, because they realized that a change needs to be made in order for the forest to survive. They are focused on sustainability and food self-sufficiency, which are the main goals of this project.

The team conducted interviews with local farmers market operators, and this information is discussed in Chapter 4: Objective Two. After the completion of this analysis, the team concluded that many of these markets would benefit greatly from the development of a new agroforestry industry. It would expand the market of organic goods, thus bringing these markets more business. In addition, it would work towards the island's (and the markets') goal of becoming more food self-sufficient.

The team then interviewed specialty markets, which we defined as small scale, holistic based markets that offer products that are not as common. These markets only offer a specific type of item, but have greater variety in the items that they do offer. From these interviews,

the team found that these types of stores are focused on the quality of goods. Everything these markets sell must meet their taste and presentation standards, so they would welcome a new agroforestry industry to provide them with a more consistent supply of high quality produce.

In contrast, the team also interviewed commercial markets, including local supermarkets in the San Juan area as well as in the area surrounding El Yunque. The managers of these markets explained that they buy locally when they can, and that they are willing to bring in new products if it is cost feasible for the store and if the product has a decent shelf life. In addition, they acknowledge that their customers are interested in knowing where their food comes from, so the store tries to cater to that interest when they can. Therefore, these stores would benefit from a new agroforestry industry because of their interest in buying locally grown produce.

Unfortunately, our stakeholder analysis is incomplete because we were unable to contact food distributors, consumers, or local farmers. We still recognize the importance of these groups as stakeholders, but felt that an analysis would be inaccurate and biased without communicating directly with members of these groups.

SWOT Analysis

The following SWOT analysis was completed to further analyze the stakeholders:

U.S. Forest Service

Strengths	**Weaknesses**
• The U.S. Forest Service is an already established subsidiary of the United States government, and already has a strong presence in the area surrounding El Yunque.	• Some farmers do not trust the U.S. Government and its subsidiaries. • The U.S. Forest Service needs to follow laws and regulations in any implemented farming plans.

Opportunities • The U.S. Forest Service could provide jobs to help stimulate agricultural activity. • The U.S. Forest Service could also assist in improving food security and sovereignty.	**Threats** • The industry could damage the rainforest if farmers do not follow proper regulations. • The industry could accidently introduce invasive species to the rainforest and damage local flora and fauna populations.

Commercial Markets

Strengths • Commercial markets are already established and wide-spread. • The markets reach a large population of consumers.	**Weaknesses** • Commercial markets may not be able to reach consumers who are interested in specialty products.
Opportunities • Commercial markets are already looking to purchase locally grown items.	**Threats** • Farmers markets offer an alternative market and may lure away customers more interested in locally grown, specialty products.

Specialty Markets

Strengths • The markets focus on the quality of goods and specialty products that may not be available in commercial supermarkets, including agroforestry produced items.	**Weaknesses** • Specialty markets are much smaller than traditional supermarkets. • These markets have less variety and only cater to a specific market.
Opportunities • Agroforestry items could be successful at specialty stores because they already have customers who favor locally grown, organic products.	**Threats** • Specialty markets are less popular than traditional supermarkets and have a smaller target audience.

Marketing Plan

A major aspect of a good business model is the development of a strong marketing plan, which is broken up into the four P's of marketing: Promotion, People, Place, and Price.

Promotion

For the first P of marketing, promotion, the team looked into several marketing strategies including branding, online promotion, and other promotional events. After discussion with Sr. Cano, a biologist at the U.S. Forest Service, the team decided to create a brand for the products grown under an agroforestry setting within the boundary of El Yunque. Through research, we found that creating a brand has many benefits. A distinct logo, or seal, on the agroforestry products allows consumers to distinguish our brand among others, and has the possibility to foster repeat customers through brand loyalty. To develop this brand, the team created a preliminary seal for the new products that represents El Yunque and identifies the product as natural. The seal, pictured in Figure 13: Preliminary seal design, also identifies the product as locally grown, which would hopefully inspire consumers to buy this product rather than an imported product, helping to combat the island's food self-sufficiency problem.

These products are labeled as natural because in order to label a product as organic, it must be organically certified by the United States Department of Agriculture (USDA). Through our research, the team found that it costs between a few hundred and a few thousand dollars to become certified, but that farms can apply for cost sharing after they become certified and get up to 75% of the cost back after approval. When applying to become certified, farmers will be asked for a detailed description of their operation, a history of the substances applied to the land over the past three years, and a written organic system plan. This plan must describe the practices and substances to be used, the crops to be grown, the acreage of the farm, how they will manage pests, weeds, and diseases, and how they will market their product. Farmers must be recertified annually and follow all rules and regulations that are available and outlined in the

National Organic Program (NOP) handbook, which is available electronically on the USDA website.

In addition to organic certification, online marketing has the potential to be an effective promotional opportunity. A recent study found that 85% of Puerto Ricans between the ages of 18 and 34 are Facebook users and that 57% of people 35 to 45 have an active Facebook page (Socialbakers, 2013). Advertising the new industry on social media sites would be a very effective way to spread the word and start brand recognition throughout the public, which could eventually lead to brand loyalty. In addition, the team found that a website containing information about the industry, among other things, would develop interest and support for the industry. After thorough research, the team also found that many products these days have quick response codes (QR codes) somewhere on their labels. These codes can be easily made using a free online generator; an example is shown in Figure 10: Example of a Quick Response Code below. Putting a QR code on the industry's new product packaging would spark customers' curiosity, and when scanned, would lead the consumer directly to the website so they can read about the new industry and what makes that product special.

Figure 10: Example of a Quick Response Code

In addition to online promotion, the team also considered different opportunities for in-person promotional events. During a discussion with the operator of the Old San Juan farmers

market, Laura Daen, she offered the team the opportunity to put a table at her market so we could tell the community about what we are doing and why they should be interested. This could be a successful marketing tactic if the U.S. Forest Service is able to find representatives to spend time every week educating local citizens about what is going on and keeping them updated with the industry's progress. Vendors working in this industry could also promote the brand while selling their products at a farmers market.

This operator also told the team about local community events that occur in Old San Juan through which the public could be informed about the new agroforestry industry and how they can benefit from it or get involved if they are interested. Organizations such as Beta-Local, a non-profit organization that offers programs and workshops to promote thought and discussion, often hold community forums where people from the local community can gather and participate in an open discussion. The team thought this would be a great venue to educate the public about the new industry, as well as to gain an understanding of the people's opinion on the subject.

Finally, when looking into the feasibility of a farmers market, the team found that one way to bring in more business and spread awareness of the new industry would be to hold a supplier showcase at a local market. This would provide food distributors with the opportunity to visit the market and see what new, local goods are available for sale. This could lead to increased business for the farmers, which in turn, could lead to an expansion of the industry.

People

The second P of marketing stands for people. For this section, the team profiled local farmers markets to determine our target population. We found that roughly 30% of the

customers were between the ages of 18 and 35 while 70% were over 35. The split of men to women appeared to be even, many people shopping as couples. This information allowed us to accurately identify our target population so we could tailor our promotional and advertisement methods to this target audience.

Place

The third P of marketing stands for place. The team conducted interviews with local authorities and farmers market vendors to determine criteria for the optimal time and location for a farmers market. An operator of a local market strongly believed that in order for farmers markets to be successful, they must become part of people's routines. A market should be held at least weekly, if not more often, to have the repetition and stability that will repeatedly draw in local community members. In addition, the team also interviewed farmers market vendors for their opinions on successful locations and times for markets. From these interviews, a set of criteria was developed to help assess a market location. The criteria are comprised of the most important characteristics of a location that must be assessed, including amount of traffic and the ease of access for the consumer. The full set of criteria can be found in Appendix Y: Criteria for Determining Successful Market Location.

Price

The fourth and final P of marketing stands for price. To determine an appropriate price and markup for the products sold under the new agroforestry brand, the team researched growing costs and observed prices of products in local farmers markets or supermarkets.

Research was conducted on multiple plants on the list to determine the cost of growing and to help recommend a mark-up for the products at market. However, many of these

products are not traditionally grown in an agroforestry setting so there is limited research on costs for forest farming. The costs for traditional farming are generally measured in cost per acre. This does not apply to a forest setting since the spacing of the crops will not be regular due to existing vegetation. For the plants on the list that also appeared in markets in Puerto Rico, the price per pound was recorded to provide a baseline for the unit price of the product at market, shown in Table 2.

Table 2: Comparison of prices of bell peppers between supermarkets and specialty food stores

Product	Average Supermarket Prices (per pound)	Specialty Market Prices (per pound)
Orange Bell pepper	$2.99	$6.99
Red Bell pepper	$3.69	$5.99
Yellow Bell pepper	$3.69	$6.99
Green Bell pepper	$2.99	$3.49

Certain specialty products such as shiitake mushrooms have in-depth research into the costs for growing in a forest farming setting. The startup cost for a four year, 500 log shiitake mushroom farm is roughly $3,300.00. This production will yield approximately 1600 pounds of shiitake mushrooms. Prices vary widely based on the region and the current market but these mushrooms can bring in $8-$15 per pound (Hill, et al., 2003). The costs to grow other mushrooms are similar to the cost of shiitakes and bring similar prices at market.

Due to our inability to determine the growing costs for many of the plants, different types of pricing and markups were researched, and cost based markup was found to be the best option. Cost based markup records all costs incurred by the farmer during the growing

process, assuring that the price per pound recuperates these costs along with an additional profit margin determined by the farmer. Another option was competition based pricing which determines the cost of products based on what the competition is offering. While this may be used to help determine a markup for products in the Puerto Rican markets, it is not as effective for the other plants. Also, there is little competition in the form of other agroforestry brands. While the product will be competing with others, the farmer may incur more costs due to the agroforestry method, something people will most likely pay more for due to the specialty of the crop.

Establish a Farmers Cooperative

To create unity and support among the farmers of the new agroforestry industry, the team researched the development of a farmers cooperative. We conducted interviews with the Puerto Rico Department of State, current Puerto Rico cooperatives, and local farmers. After our interview with the Department of State, Luis Rodriguez, the director of the Comisión de Desarrollo Cooperativo de Puerto Rico, provided us with a PowerPoint presentation detailing the steps necessary to create a new cooperative. These include:

1. Request the services of the Commission's guidance of Cooperative Development
2. Selection of the Organizing Committee or Rudder
3. Complete a feasibility study (this step is optional)
4. Cooperative education and training, and the preparation of constituent documents
5. Constituent Assembly
6. Founding Documents
7. General Assembly of Partners

This contact also detailed which laws govern the development and maintenance of local cooperatives. The Internal Revenue Code of Puerto Rico of 1994 contains Sector Act No. 239, General Law of Cooperative Societies, which provides a legal framework for cooperatives and the cooperative sector detailing their organization, operation, and regulation. This law governs many types of cooperatives including pharmacies, supermarkets, and most importantly, agricultural. According to Mayra Rosa, the coordinator for the Cooperativa Orgánica Madre Tierra and the operator of the cooperative's market held at Placita Roosevelt, each cooperative needs to have a director group to govern the day to day activities of the cooperative.

From our interviews with Puerto Rican cooperatives, it was found that the cooperatives feel there is a severe lack of support from the government, and that all cooperatives have to complete a lot of paperwork in order to comply with the regulations of being a cooperative in Puerto Rico. Often, cooperatives hire someone to take care of the paperwork because of its extremely extensive nature. The cooperative that runs Mercado Orgánico in Placita Roosevelt described how this cooperative acts as a stepping stone for small farmers. Farmers start by selling their goods at this market while they work on growing their farm or their business so they can eventually start selling their goods at local supermarkets. In addition, the president of this cooperative told the team that there is a Puerto Rico specific organic certification, Boricuá, that serves as an intermediate step to USDA organic certification. It acts as a local seal for quality control, and prepares farmers to begin the process of becoming organically certified by USDA standards.

The manager at the Pueblo supermarket in San Juan Miramar described how Pueblo belongs to a cooperative that allows the store to get what he asserts to be the highest quality

of goods and price advantages. Although a supermarket cooperative is very different from a farmers cooperative, it still gives an idea of how a cooperative is run and the benefits thereof. The Pueblo manager believes that cooperatives are a great idea, which is the same sentiment we received from the manager of La Hacienda, a local specialty store in San Juan Miramar. However, on the other hand, the operator of the Old San Juan farmers market believed that a cooperative would be too laborious for her market, and that in her experience, starting a new cooperative is very slow work.

Objective Four: Provide a Source of Education for Farmers, Vendors, and the Consumer

Another important aspect of this project was the development of an educational medium. After conducting meetings with U.S. Forest Service personnel, the team was able to determine what information was important to share with local citizens. In a meeting with Sr. Felipe Cano, he suggested that we create an electronic medium to educate farmers. He also informed us of policies and information that would be of interest to explain to the farmers, including farming incentives and land use policies. By properly informing the farmers, it could allow them to earn more income while still obeying the laws. To accomplish the task of educating the public, Sr. Cano suggested the creation of a website or a smartphone application to make this information available to farmers, vendors, and consumers.

Information to accomplish this objective was also gained through the interviews conducted with farmers market operators. The promotional events discussed in the Chapter 4: Objective Three, an information table available at farmers markets and a presentation at Beta-Local, a local community organization, can also be used as educational opportunities.

The main focus of this objective was to educate the public through a technological medium. Two options for this medium were considered: an online website or a smartphone application. A technological medium seemed to be the most viable option to communicate all of the information collected through the team's interviews. These two options were researched and compared to determine which option would work best for the U.S. Forest Service.

The major benefit of a smartphone application is that it is designed for a portable device; this allows people to always have the information with them once the application has been downloaded. However, a smartphone application requires a smartphone, which not everyone owns. The U.S. Forest Service currently only has an application platform for Android devices. Since Android is only a portion of the smartphone market, this limits who is able to use this application. Additionally, smartphone applications can often be costly to create, as they require multiple platforms that need to be regularly maintained.

The major benefit of a website is that it is accessible to anyone with internet access through the use of a smartphone or a computer. Unfortunately, because internet access is required, the information cannot be accessed if the user is in an area without internet or cellular data. Unlike an app, websites are easier to create and reach a larger audience of users. However, the U.S. Forest Service already has an established, credible website that can easily be modified to incorporate this information.

Chapter 5: Recommendations And Discussion

Following multiple onsite investigations, market visits, interviews, and discussions with local experts, the team has drawn the following conclusions and developed the following set of recommendations. These recommendations are broken down based on our four objectives as well as a fifth section titled Future WPI Projects and a sixth section titled Technology and Society.

Objective One: Complete an Agroforestry Assessment

Recommendations

1. **We recommend that the U.S. Forest Service provide simple, low level forest management at the target sites.**
2. **We recommend the use of soil management in the forest to help increase crop yield and growth.**
3. **We recommend that the agroforestry sites remain small, only a few acres at most, while the industry is developing.**
4. **We recommend that the farmers use the forest farming method of agroforestry.**
5. **We recommend that further research into fruits and vegetables, both naturalized and exotic to the area, be conducted by the U.S. Forest Service.**
6. **We recommend that target sites at the forest boundary only be used by farmers who own the land adjacent to the sites.**
7. **We recommend that the U.S. Forest Service take the time to analyze the third report from the community representative workshops, previously mentioned in Chapter 3: Objective One, to strengthen the determination of local opinion.**

Discussions

1. **We recommend that the U.S. Forest Service provide simple, low level forest management at the target sites.**

A main focus of this project was to investigate a new agricultural industry for farmers without causing any damage to the forest. Based on onsite investigation, the majority of the target areas for the sites are unmanaged and undeveloped. While no deforestation or large

amount of clearing is recommended, clearing of low brush and ferns will help a plant just starting out, partially reducing the large amount of competition present in the forest. The U.S. Forest Service should be in charge of this low level management in order to ensure that proper techniques are used and so the farmer knows that anything left in the forest after this low level management is meant to be there and should not be harmed.

2. **We recommend the use of soil management in the forest to help increase crop yield and growth.**

Almost all of the soil in the forest is acidic and clay based, with areas draining differently. The forest is lush with vegetation and plant growth, but is not necessarily good for agricultural operations. Loamy clay is preferred for cultivation of plants but is not found in any of the target areas. Therefore, the team investigated several soil management methods, including an old method used by the Taíno people, that can be used to appropriately modify the soil to ensure the success of future agricultural crops.

To account for soil conditions, the industry can either focus only on plants that grow in the exact conditions or introduce some soil management policies. Any changes to the soil must be completely natural and organic, using no chemicals or fertilizers that may hurt the ecosystem of the forest. The method of the Taínos consists of making small, three foot wide mounds of composted, loam material that provides nutrients to the plant. This helps avoid drowning the seed if the clay soil does not drain well. In addition, it provides extra nutrients to the seed by allowing the farmer more control over the soil conditions.

3. **We recommend that the agroforestry sites remain small, only a few acres at most, while the industry is developing.**

The focus of this project was to try to help small farmers who live along the border of the forest. These farmers currently only own small farms, a few acres along the edge of the forest, and on average do not have a lot of capital. The forest is also mostly unmanaged in these areas, making a large operation difficult.

We recommend keeping projects small for each farmer. These projects will most likely have more success if they are approached as side projects for the farmers, supplementing their current operations as opposed to replacing them. This approach will carry less risk since it is not trying to change their source of income but rather supplement it. The smaller projects will also reduce the startup costs that a farmer may experience, making it more appealing. Lastly, the unmanaged forest may reduce the ability for the farmers to create widespread operations, even if they had the means to set it up.

4. **We recommend that the farmers use the forest farming method of agroforestry.**

The onsite investigations showed that most sites would be located in unmanaged areas of the forest. Most sites will be located several hundred feet into the forest behind a private farmer's land. These sites require the use of the forest farming method of agroforestry, a method that involves planting beneath the forest canopy, to avoid clearing of the forest and damage to the ecosystem.

However, there were a few sites that are different, specifically the unfinished recreation site known as Site A. If a site is managed, there is a possibility to use other agroforestry methods. Site A was cleared, which would allow a farmer to alley crop and grow on multiple vertical levels. This would need to be assessed on a case-by-case basis, the main factor being the amount of previous management or clearing.

5. **We recommend that further research into fruits and vegetables, both naturalized and exotic to the area, be conducted by the U.S. Forest Service.**

The bulk of this industry should focus on the method of forest farming. This limits the effectiveness of planting trees in an area not cleared of existing trees and large vegetation prior to planting. The reports from the workshops held by the U.S. Forest Service showed local support for an agroforestry system that would grow fruits and vegetables. Carmen Santiago, a soil specialist from the NRCS, also discussed the local focus on specialty fruits and the high price that they can bring at market.

From onsite investigations and further talks with Sra. Santiago, the conditions of El Yunque are not ideal for crop production. Between the amount of rain, humidity, high temperatures, and acidic clay, it is a unique growing situation. The forest is lush with vegetation, but plants that are not common to El Yunque would have to be carefully selected and tested for cultivation. Choosing plants naturalized to El Yunque would avoid issues with the growing conditions and almost guarantee cultivation.

The team recommends the U.S. Forest Service conduct further research on the growth of fruits and vegetables in El Yunque. There is an established market for these and based on workshop reports, they were the most popular projects with local farmers. While fruits and vegetables are not the main plants recommended for the start of this industry due to the lack of time for cultivation tests and the inability to analyze a list of naturalized plants, they are still a viable option. A list of naturalized plants can be cross-referenced with the list of produce found in markets in Puerto Rico to attempt to find naturalized crops there is a market for. Exotic plants also have the possibility to be profitable but require extensive research to assure growth and that there are no negative effects on the forest. Specialty

crops such as coffee and ornamental flowers were also considered but do not address the issue of food self-sufficiency.

The research should focus on low lying plants, bushes, and vines that can be easily grown and have little to no competition with the surrounding trees and plants. Resources such as the Botanical Gardens may be used to help simulate the conditions of El Yunque.

6. **We recommend that target sites at the forest boundary only be used by farmers who own the land adjacent to the sites.**

Visits to the undeveloped east side of El Yunque, Site B, showed that access to the forest was often blocked by private landowners, most of whom use chain-link fences to mark property lines. This reduces the accessibility to the forest for everyone but the landowner. There are exceptions in certain parts of El Yunque where this is not true. At the site visited on the northern side, Site A, there was a main, paved road a few hundred feet from the site. This site is surrounded by forest, making it more accessible to an outside farmer. However, this is not the condition for the majority of sites. Based on analysis of the workshop reports, more than 30 farmers who live along the border of the forest are interested in an agroforestry opportunity.

Based on these findings, the team recommends that the U.S. Forest Service focus on these farmers along the border of the forest. They have immediate access to the sites, therefore avoiding the need to secure easements and reducing overall costs.

7. **We recommend an analysis of the third report from the U.S. Forest Service community representative workshops, previously mentioned in Chapter 3: Objective One, to strengthen the determination of local opinion.**

The team was unable to obtain a copy of the third report from the meetings with community leaders. It was said that this report was the most in depth of the three reports

from the meetings. By analyzing this report the U.S. Forest Service will be able to get a better understanding of community opinion, such as what crops they may want to grow, and any issues they may have with starting this project. This report will be vital in the success of this project and establishing community involvement.

Objective Two: Determine Market Feasibility and What Factors Make a Market Successful

Recommendations

8. **We recommend that chanterelles and oyster mushrooms be grown in the agroforestry industry.**
9. **We recommend that at this time, selling goods in an already established farmers market provides the best chance of success.**
10. **We recommend that if a new farmers market were to be established, the set of criteria developed for the place of a market should be used, including the specified time and length.**

Discussions

8. **We recommend that chanterelles and oyster mushrooms be grown in the agroforestry industry.**

From extensive research based on the onsite conditions, what is currently being sold in stores, and what is naturally growing in the area, it has been determined that two species of mushrooms, chanterelles and oyster mushrooms, would grow successfully in an agroforestry system. These species have met all the criteria we have established to flourish in an agroforestry system, especially in the humidity under the canopy of the forest. It was determined that after starting the growing processes, the mushrooms will grow successfully with little intervention from the farmer. This independence makes mushrooms a preferred crop to be grown as a side project for the farmers who do not want to spend much time focusing on the maintenance of the plant.

Based on research conducted in local supermarkets, it was found that there is a market for specialty mushrooms and that they are a very profitable crop. On average, in supermarkets around San Juan, mushrooms sell for about $7.00 per pound. Three other species of mushrooms that may not be naturally growing in El Yunque, Shiitake, Black Trumpet, and Head of the Woods, are also recommended as it seems the area has a good climate to grow them in and there is a large market for them. However, the decision to introduce non-native species of fungi into the forest is ultimately that of the farmers and the U.S. Forest Service.

In addition to these mushrooms, we also recommend several other crops that would grow under an agroforestry setting in El Yunque, which are listed in Appendix X: Final Recommended List of Plants and Chart of Additional Information, in addition to a chart that details requirements for each recommended plant. These crops were selected because under similar conditions in other places around the world, they have thrived. However, they were not found naturally growing in El Yunque so it is not certain they would flourish in the proposed areas. Therefore, we recommended that the U.S. Forest Service do further research into the possibility of growing these types of produce. These products will have a greater positive effect on the food self-sufficiency issue of Puerto Rico. While mushrooms will help a little, they are more of a specialty crop, serving as a good starting place for this industry.

9. **We recommend that at this time, selling goods in an already established farmers market provides the best chance of success.**

The interviews at local farmers markets showed that there is a definite market for the products that would be produced from this new agriculture industry. The major reason that farmers markets around Puerto Rico have not been successful is because operators of the markets cannot find enough reliable vendors to sell products at these markets. With operators already struggling to find enough vendors to fill their markets, finding enough vendors to fill another market would most likely be difficult. There are many vendors that are only part time farmers and have other daily occupations. The two operators we spoke with are also looking to expand their markets and gain new vendors.

Therefore, farmers trying to establish this new industry should try to sell their goods at existing markets. Establishing the foundation for a new industry is going to be time-consuming and laborious. Trying to establish a new market on top of that may be overwhelming and lower the chance for success. In addition, the harvest of this new industry will not be very large, thus reducing the effectiveness of a new market.

10. **We recommend that if a new farmers market were to be established, the set of criteria developed for the place of a market should be used, including the specified time and length.**

When the new agroforestry industry grows large enough to support its own agroforestry-specific market, a new farmers market should be developed in the area surrounding the forest. There is no set timeframe within which this new market should be developed, but rather when there is interest from at least 10 to 12 reliable vendors who have agroforestry-grown products to bring.

- **Frequency:** The market should occur on a weekly basis. This allows for the market to become a normal part of people's routines, thus creating regular customers.
- **Day of the week:** The day of the week for the market to be held depends on the type of geographic area. Cities should hold markets on Saturdays because this is a bigger day for tourists. Rural areas more based around churches should hold markets on Sundays because families will flock to the market following the day's services.
- **Time:** The recommended time to hold the market is 8am to 1pm. A 5 hour span of time is short enough that the food will not spoil but is long enough to accommodate most customers. This is the time span that two of the farmers markets the team visited used.
- **Location:** It is important to choose a location that is convenient in order to attract more customers. It is also important to be located in a public space that does not require the vendors to pay to rent space in which to sell their crops. Criteria for determining possible successful locations are located in the results section and Appendix Y: Criteria for Determining Successful Market Location.
- **Vendors:** The team recommends a market have at least 10 to 12 vendors who live in the area and have reliable, fresh, and high quality products that customers are interested in. The two larger farmers markets visited had 21 vendors and 30 vendors. The smaller market visited contained 12 vendors, and this operator stated that although the market was successful, she felt she needed more vendors.
- **Offerings at the market:** The team recommends the market has other offerings to attract customers including: live music, arts and crafts, local prepared food, seating

areas, parking areas, areas for children, public bathrooms, and anything else that could help promote a community feeling. Several successful markets, including ones in Rincón and Hato Rey, had offerings other than just crops, including live music, arts and crafts, and locally prepared food.

Objective Three: Design a Business Model

Current Recommendations

11. **We recommend the creation of a brand that represents El Yunque and identifies the agroforestry products as natural and locally grown. A preliminary seal design for this brand is provided in Appendix Z**: Preliminary Seal Design**.**
12. **We recommend that the farmers become organically certified by Boricuá standards. This should be a stepping stone to eventual USDA Organic certification.**
13. **We recommend that the U.S. Forest Service make use of social media (such as Facebook), tables at local farmers markets, and community forums for marketing and educational purposes. In addition, a QR code should be placed on the seal so consumers can scan it and be taken directly to an informative website.**
14. **We recommend that the U.S. Forest Service hold supplier showcases at local farmers markets so food distributors can visit and see what new, local goods are for sale.**
15. **We recommend that at the start of the industry, the farmers join an existing cooperative until the industry is established and other farmers have joined the industry.**
16. **We recommend the use of a cost based profit mark-up to determine the price to sell the goods, using the provided table to track costs of the growing.**

Future Recommendations

17. **We recommend that a cooperative is set up consisting of only farmers growing in El Yunque once enough have shown interest, perhaps when at least 10-15 farmers are in support of it.**

Discussions

11. **We recommend the creation of a brand that represents El Yunque and identifies the agroforestry products as natural and locally grown. A preliminary seal design for this brand is provided in Appendix Z**: Preliminary Seal Design**.**

The use of a brand with a signature name and logo will allow customers to distinguish our brand among others. In addition, a brand with a distinct and special background can foster brand loyalty by drawing in repeat customers. We recommend that this brand identify the product as natural and grown in El Yunque under an agroforestry setting. In addition, we recommend the seal also emphasize the fact that the product is grown locally and promotes food self-sufficiency for the island by enticing locals to buy locally grown food.

Figure 11: Preliminary seal design

12. We recommend that the farmers become organically certified by Boricuá standards. This should be a stepping stone to eventual USDA Organic certification.

Boricuá is a type of organic certification specific to Puerto Rico that can be used as an intermediate step to USDA certification. It is a form of local quality control, and prepares farmers for the process of becoming organically certified by USDA standards. This certification can help build a reputation for farmers and create more income. To become organically certified, the farmers will be asked for several documents that feature a detailed description of their operation, a history of the substances applied to their lands over the past three years, and a written organic system plan. The written organic system plan must describe everything involved in their growing process including, but not limited to, the practices and substances to be used, the crops to be grown, how they will manage pests and weeds, and how they will market their product. The only downfall to becoming organically certified by USDA standards is that it can cost between a few hundred to a few thousand dollars and is time consuming. However, farms can apply for cost sharing once they become certified and get up to almost 75% of the certification costs back from the government.

We recommend that the farmer becomes organically certified by Boricuá standards. However, if the farmer is ready and it is economically feasible, we recommend that the farmer become USDA certified at this time. Most consumers are aware of the USDA, so putting a USDA stamp of approval on the brand logo will help draw in a larger market of consumers and will hold more weight than simply putting “organic” or “natural” on the seal.

13. We recommend that the U.S. Forest Service make use of social media (such as Facebook), tables at local farmers markets, and community forums for marketing and educational

purposes. In addition, a QR code should be placed on the seal so consumers can scan it and be taken directly to an informative website.

For the purpose of marketing a brand there are several promotional opportunities.

- **Social Media Sites:** The first is online promotion, or more specifically, using social media sites to spread awareness of the new industry. The U.S. Forest Service should use social media sites such as Facebook and Twitter to advertise for this new brand and industry. A study showed that 85% of Puerto Ricans between the ages of 18 and 34 are Facebook users. Demographics of Facebook users also showed that 38% of Facebook users in Puerto Rico are between the ages of 35-64. The brand and the cooperative should each have their own Facebook page that provides a background about the goal of the industry and why it is important. Using social media as a method of advertising will reach the broadest audience possible and have the biggest opportunity to garner support for the industry while remaining inexpensive.
- **Farmers Market Table:** The second method of promotion is setting up tables at local farmers markets. We conducted interviews with two operators of farmers markets and found that both of them were very interested in and excited about this project; one even offered a table at her market for advertisement of the new agroforestry industry. We recommend that the U.S. Forest Service take advantage of these opportunities. Not only would this table be helpful in getting to know the community and gaining support for the industry, but it would also serve as a place to distribute pamphlets and other informational handouts so consumers can have something tangible to take home with them. In addition, interested farmers can

easily inquire about how to get involved with either the industry or the cooperative while they are at the market.

- **Community Forums:** The third method of promotion is community forums. While visiting a local farmers market in Old San Juan and interviewing its operator, the team was informed of several local community gatherings where local residents can go and voice their opinion or partake in community discussions. One organization in particular, Beta-Local, often holds community forums where local citizens can get together and hold open discussions. The team recommends that the U.S. Forest Service get in contact with these organizations and set up community discussions about the new industry. This will allow the community to feel as if it is a part of the industry, helping to reduce Puerto Rico's importation of food. It will foster support for the new industry as people begin to understand the how and why of the industry and ways they can help.

Finally, the team researched the possibility of putting a quick response code (QR code), pictured in Figure 10: Example of a Quick Response Code, on the seal for the new agroforestry brand. Many products on the current market have QR codes somewhere on their labels that lead to websites or apps. These provide the consumer with information, coupons for the product, or recipes in which the product can be used. Placing a QR code on the products may spark the curiosity of the consumer and, when scanned, would lead the customer to the informational website described in the results section for objective four.

14. We recommend that the U.S. Forest Service hold supplier showcases at local farmers markets so food distributors can visit and see what new, local goods are for sale.

After discussion with a member at the U.S. Forest Service, we found that a way to spread awareness of the new industry to larger supermarkets and to bring in new business would be to hold a supplier showcase at a local farmers market where farmers are selling their agroforestry products. A supplier showcase is a promotional event where food distributors are invited to local farmers markets to see what new, fresh, locally grown products are for sale. The team recommends that if the industry grows large enough that crops are consistent and farmers markets are not large enough to sell all of their products, a supplier showcase is held with local food distributors in attendance. This will help introduce the new products to local supermarkets, expanding the amount of consumers able to purchase the goods and growing the industry further. Unfortunately, the team was unable to get in contact with local food distributors, so we cannot definitively conclude that distributors are in support of this idea. However, we still recommend that the U.S. Forest Service contact local food distributors and look into setting up supplier showcases.

15. We recommend that at the start of the industry, the farmers join an existing cooperative until the industry is established and other farmers have joined the industry.

There are many benefits to being part of a cooperative. Farmers in the agroforestry industry could band together and form a cooperative to lend each other support and to gain negotiating power if they decide to sell to local supermarkets. In addition, it would allow for the offset of production to provide continuous income throughout the year, and would allow them to combine their resources. However, starting a cooperative is very labor intensive and requires multiple farmers working towards the same goal. If not many people are working in this new industry, starting a new cooperative may not be feasible. Therefore,

the team recommends that until there are enough farmers working in this industry to create an agroforestry cooperative, the farmers working in this industry join an existing cooperative.

16. We recommend the use of a cost based profit mark-up to determine the price to sell the goods, using the provided table to track costs of the growing.

To determine a price for products to be sold at, vendors should first take note of the prices the products are sold for in the supermarket. From there, they can get an estimate of the prices they should charge for their goods. To accurately calculate the price they should charge, their personal labor and expenses should be taken into account. This should be calculated by completing the following steps:

1. Determine the amount of time spent on working the crop
2. Divide one week's expenses of plants and work by the number of hours worked in one week
3. Set an hourly wage
4. Add the hourly wage to the number calculated in step two and divide by the weight of the crops

The number calculated in Step 4 will be the amount of money the farmer should charge per product. For example, if a farmer is selling twelve pounds of green bell peppers and works for ten hours a week tending to plants with $300 worth of expenses and a $10 per hour wage, the farmer should charge approximately $3.00 per pepper (Outrider, 2013).

To help farmers track their costs, it is recommended that they use a cost-based tracking chart to assure they are making a profit. Table 3 is an example of this chart for a tomato grower selling to both a farmers market and an institutional buyer.

Table 3: Example of chart to track costs based on the market sold at (Chase, 2008).

Table 1. Comparison of transaction costs by market				
	Farmers market: 20 weeks/40 markets		Institutional market: 20 weeks	
Transportation vehicle expenses	$.25/mi, 3,200 miles	$ 800	$.25/mi, 1,600 miles	$ 400
Labor charges	2 people @ 12hr/wk, 20wks, @$10/hr	$4,800	1 person @ 4hr/wk, 20wks, @$10/hr (includes selling)	$ 800
Supplies (bags, sacks, other supplies)	$20/wk	$ 400	$30/wk	$ 600
Total transaction costs for the season		$6,000		$1,800
Total transaction costs allocated to tomatoes (20% of total sales)		$1,200		$ 360
Total transaction costs/lb sold	(760 lbs sold)	$1.58	(800 lbs sold)	$ .45

17. **We recommend that a cooperative is set up consisting of only farmers growing in El Yunque once enough have shown interest, perhaps when at least 10-15 farmers are in support of it.**

Once the industry has been established, the team recommends that the farmers create their own cooperative consisting only of those farmers that are growing products under an agroforestry setting. This would allow the farmers to combine their resources and would provide them with support and the opportunity for negotiating power if or when they decide to sell to local supermarkets. The coordinator of Cooperativa Orgánica Madre Tierra, a local organic farmer cooperative that hosts a farmers market in San Juan Hato Rey, described the amount of work needed to both start and run a cooperative. They rely heavily on volunteer hours from the farmers. From this discussion, a recommendation of at least 10-15 farmers was determined.

Objective Four: Provide a Source of Education for Farmers, Vendors, and the Consumer

Recommendation

18. We recommend that the U.S. Forest Service create a website that includes various sections about the industry and the markets.

Discussion

The team held several interviews with U.S. Forest Service members and operators of farmers markets. There were several possible educational mediums. Based on ease of access, ease of upkeep, and cost of implementation, the team concluded that a website would be the best medium for education. The team also recommends a QR Code be put alongside the brand logo so people can link to the website from anywhere. On the website, we recommend the following sections be created: About the Project, Agroforestry, Agriculture in Puerto Rico, The Brand, Where Does your Food Come From?, Interested in Farming?, Land Management Policies, Agricultural Incentives, Organic Certification, Cooperatives, Farmers Markets, and Recipes. A full, detailed website outline can be found in Appendix AA: Website Outline.

Future WPI Projects

Recommendations

19. We recommend a project that focuses strictly on the markets in Puerto Rico and San Juan to help identify a larger amount of possible products to grow.
20. We recommend a project that focuses on transforming current private farms surrounding El Yunque into agroforestry farms.
21. We recommend a project that identifies the current plants that are growing in El Yunque and if these are being taken advantage of by the people in the area. In addition, we recommend that this data be used to create a database of plants currently growing in the rainforest.

Discussions

19. **We recommend a project that focuses strictly on the markets in Puerto Rico and San Juan to help identify a larger amount of possible products to grow.**

    Through discussion with market operators and a graduate student at the University of Puerto Rico, the team learned of the lack of studies on the markets in Puerto Rico. This turned out to be a major part of this project. There is very limited research on the markets in Puerto Rico which made it difficult to accurately determine products that will grow in El Yunque and that there will be a profitable market for. More in-depth research focusing strictly on the markets in Puerto Rico may be able determine products that are indigenous or naturalized to Puerto Rico and that there is a market for.

20. **We recommend a project that focuses on transforming current private farms surrounding El Yunque into agroforestry farms.**

    While our project focused on agroforestry within El Yunque, the team learned that it can also be used on private lands. Agroforestry provides an option to harvest while maintaining the natural forest appearance. In addition, if executed correctly, farmers could make more of a profit by taking advantage of different canopy levels of growth rather than just one level. Edwin Más, the plant material specialist from the NRCS, has experimented with agroforestry on the western side of Puerto Rico, but there is currently no agroforestry surrounding El Yunque. If agroforestry was to be established surrounding the forest, farmers could make a profit while seemingly expanding the borders of the rainforest.

21. **We recommend a project that identifies the current plants that are growing in El Yunque and if these are being taken advantage of by the people in the area. In addition, we recommend that this data be used to create a database of plants currently growing in the rainforest.**

When developing our final list of recommended plants to grow, there seemed to be a lack of information on what plants currently grow in the area. This was important in understanding what is readily thriving in the forest that would be a profitable crop. Having an organized list of many plants, besides trees, that grow in the area would have made it easier in determining what someone could and could not introduce to the area. To help gain better insight into the naturalized plants of El Yunque, a project could investigate and create a database of the plants, other than trees, growing in the forest. There could also be investigation into whether any of these naturalized plants are part of the local Puerto Rican market or diet for the residents around the forest. Determining what produce the people of Puerto Rico consume most regularly was also somewhat difficult, so it would be interesting to determine if people in the area are taking advantage of the natural resource, El Yunque, that is very close to them.

Technology and Society

Recommendations

21. A project's chance of success increases greatly when it focuses on not only finding a solution, but on finding a solution that is tailored to the needs of the people and inspires passion in everyone involved.

22. Due to the unpredictability that a social science project may experience, flexibility and creativity are a necessity to achieve success.

Discussions

21. A project's chance of success increases greatly when it focuses on not only finding a solution, but on finding a solution that is tailored to the needs of the people and inspires passion in everyone involved.

A major part of this project was the need for social data; interviews with local experts, vendors, farmers, and market operators. Three of the objectives were focused on this social

aspect of the project, with only one objective focused on the technical agroforestry side. When asking people to volunteer their time to help with a project, it is crucial to appeal to their desires. If the project does not focus on a topic that the local people are passionate about, then their responses will be less thought out and less conclusive. By explaining that this project was beneficial to the people of Puerto Rico and their society, this often triggered a sense of enthusiasm from the interviewee's. Furthermore, when the goals of the project were explained, many people become whole-heartedly interested in doing anything they could to help the project.

Another important part of this project was to ensure that all recommendations were tailored to the local farmers who will be impacted by the new industry. If the project does not gain the interest and attention of these farmers, they will be less likely to become involved in the project, reducing its overall chance of success. Regardless of how well planned the technical side of a project is, if it does not appeal to the passions of the local society, the project will almost surely fail because it will not be accepted or supported. When the project and its proposed solution addresses the needs of the people and gains their support, it greatly increases the chances of success.

22. Due to the unpredictability that a social science project may experience, flexibility and creativity are a necessity to achieve success.

After working on this project for almost nine weeks, the team learned the importance of flexibility and the unpredictability of a social science project when the central social problem that the project was focusing on suddenly changed. This required the team to eliminate and rewrite almost every major section of the report. Due to the strict deadlines

of the project, the team needed to be flexible and handle these changes efficiently. These types of changes can often require the elimination of work that the team spent hours creating and perfecting, but the more time spent dwelling on this loss will only create more lost time. Flexibility is vital when handling these changes in team meetings. Everyone may not always accept every change, but each team member cannot be prideful of their own work. Decisions must be made based on what is best for the team and the constantly changing scope of the project. Less flexible teams will only waste more time and consequently be less successful.

Creativity will also help greatly when unpredictable situations occur. Ingenuity and critical thinking will allow for the team to easily work around challenges and develop new methods and solutions. Multiple times throughout the course of this project, the team was dependent on an outside source for information. In some cases, these sources were not able to deliver the information, forcing the team to creatively shift their approaches to compensate for the lack of information. Being able to adapt to these circumstances allowed the team to work more efficiently and meet all deadlines and requirements.

References

"Agriculture in Puerto Rico". (2013). *Welcome to Puerto Rico.* Retrieved from: http://www.topuertorico.org/reference/agri.shtml

Augelli, J. L. (1953). *Sugar Cane and Tobacco: A Comparison of Agricultural Types in the Highlands of Eastern Puerto Rico*, 29(1).

Baver, S. (2012). Environmental Struggles in Paradise: Puerto Rican Cases, Caribbean Lessons. *Caribbean Studies, 40*(1), 15-35.

Beetz, A. E. (2011). Agroforestry: An Overview. *National Sustainable Agriculture Information Service.*

Bhagwat, S. A., Willis, K. J., Birks, H. J. B., & Whittaker, R. J. (2008). Agroforestry: a refuge for tropical biodiversity? *Trends in Ecology & Evolution, 23*(5), 261-267.

Borkhataria, R., Collazo, J. A., Groom, M. J., & Jordan-Garcia, A. (2012). Shade-grown coffee in Puerto Rico: Opportunities to preserve biodiversity while reinvigorating a struggling agricultural commodity. *Agriculture, Ecosystems and Environment, 149*, 164-170.

Carmona, J.L. (2012). Puerto Rico exported $41 billion, imported $24.5 billion in 2011. *Caribbean Business*. Retrieved from: http://www.caribbeanbusinesspr.com/prnt_ed/puerto-rico-exported-$41-billion-imported-$24.5-billion-in-2011-7690.html

Carrion, M. E. (2009). Operation Bootstrap (1947). *Puerto Rico Encyclopedia*. Retrieved from: http://www.enciclopediapr.org/ing/article.cfm?ref=06102003

Carro-Figueroa, V. (2002). Agricultural Decline and Food Import Dependency in Puerto Rico: A Historical Perspective on the Outcomes of Postwar Farm and Food Policies. *Institute of Caribbean Studies*, 30, 77-107.

Central Inteligence Agency. (2013). Central America and Caribbean: Puerto Rico. *The World Factbook.* Washington, DC: Government Office of Public Affairs

Chase, C. (2008). Pricing for Profit. *Agricultural Marketing Resource Center*. Retrieved from: http://www.agmrc.org/business_development/operating_a_business/direct_marketing/articles/pricing-for-profit

Chazdon, R. L. (2008). Beyond deforestation: restoring forests and ecosystem services on degraded lands. *science, 320* (5882), 1458-1460.

Community Markets. (2013). Jamaica Friday's Down to Earth Farmers Market. Retreived from: http://communitymarkets.biz/markets?region=Queens&market=Jamaica+Friday+Farmers+Market

Cramer, W., Fader, M., Gerten, D., Krause, M., & Lucht, W. (2012). Spatial Decoupling of Agricultural Production and Consumption: Quantifying Dependences of Countries on Food Imports due to Domestic Land and Water Constraints. *Environmental Research Letters, 8* (014046), 15.

Dietz, J. L. (1986). Economic history of Puerto Rico: institutional change and capitalist development. *Princeton University Press.*

Donaghy, P., Bray, S., Gowen, R., Rolfe, J., Stephens, M., Hoffmann, M., et al. (2010). The bioeconomic potential for agroforestry in Australia's northern grazing systems. *Small-scale Forestry, 9*(4), 463-484.

EconomyWatch Content. (2010). Puerto Rico Trade, Exports and Imports. *Economy Watch: Follow the Money*. Retrieved From: http://www.economywatch.com/world_economy/puerto-rico/export-import.html

Eden, L., & Kudrle, R. T. (2005). Tax Havens: Renegade States in the International Tax Regime? *Law & Policy, 27*(1), 100-127.

Febles, A. N. (1992). The Agroecology Movement in Puerto Rico. *Agro-Organics, Incorporated*. Cahovanas, Puerto Rico.

Ferré, J. (2011). Locavore movement looks to create food-related jobs. *Caribbean Business*. Retreived from: http://www.caribbeanbusinesspr.com/prnt_ed/news02.php?nw_id=5197&ct_id=49

FOSSweb. (2013). El Yunque Caribbean National Forest. *Populations and Ecosystems.* Retrieved from: http://www.fossweb.com/delegate/ssi-foss-ucm/contribution%20Folders/FOSS/multimedia_ms_1E/PopulationsandEcosystems/ecoscenario/elyunque/index.html

Govardhan, S. (2007). Food Security in Puerto Rico. *Agrotemas*. Retrieved from: http://organicfarm.net/Article_food_security_in_puerto_rico.htm

Grossman, J., & Guzda, H. (1978). Fair Labor Standards Act 1938: Maximum Struggle for Minimum Wage. Retrieved from: http://www.dol.gov/dol/aboutdol/history/flsa1938.htm.

Hart, J. M., Horneck, D.A., Owen, J.S., Sullivan, D.M. (2011). Soil Test Interpretation Guide. Retreived from: http://ir.library.oregonstate.edu/xmlui/bitstream/handle/1957/22023/ec1478.pdf

Hill, D., Szymanski, M., & Woods, T. (2003). Potential Profits from a Small-Scale Shiitake Enterprise. University of Kentucky-College of Agriculture. *Kentucky Shiitake Production Workbook.*

Jose, S. (2009). Agroforestry for ecosystem services and environmental benefits: an overview. *Agroforestry Systems, 76*(1), 1-10.

Kantrow, M. (2011). MIDA pursues sparking awareness on P.R.'s food future. *NIMB Online Business Journal.* Retrieved from: http://newsismybusiness.com/mida-pursues-sparking-awareness-on-p-r-%E2%80%99s-food-future/

LexisNexis Academic. (2011). Puerto Rican Department of Economic Development and Commerce; Puerto Rico's El Yunque National Forest in New Seven Wonders Campaign. *Ecology, Environment & Conservation*, 315.

Maldonado, A. W. (2002). The Loss of 936: Good or Bad for Puerto Rico? *Pharmaceutical Industry Association of Puerto Rico.*

Martin, F. W., & Fennema, M. P. (1996). Comparison Chart of Tropical Crops. In E. B. D. #6 (Ed.): ECHO Community.

Mercer, D. E., Haggar, J., Snook, A., & Sosa, M. (2005). Agroforestry adoption in the Calakmul biosphere reserve, Campeche, Mexico. *Small-scale Forest Economics, Management and Policy, 4*(2), 163-183.

Monteverde Info. (2013). Monteverde Local Farmers Market. Retrieved from: http://www.monteverdeinfo.com/local-farmers-market/

Natural Resources Conservation Service. (2013). Environmental Quality Incentives Program. Retrieved from: http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Outrider. (2009). Setting Prices for Products and Services. *Farmers Market Online*. Retreived from: http://www.farmersmarketonline.com/tips/SettingPrices.htm

Parés-Ramos, I. K., Gould, W. A., & Aide, T. M. (2008). Agricultural abandonment, suburban growth, and forest expansion in Puerto Rico between 1991 and 2000. *Ecology and Society, 13*(2), 1.

"Puerto Rico Imports 85 Percent of Its Food". (2013). *Latin American Herald Tribune*. Retrieved from: http://www.laht.com/article.asp?ArticleId=342325&CategoryId=14092

Quinn, A. T., Baldwin, S. C., & Arruda, K. J. (2010). *Sustainable Energy for El Yunque National Forest* (Undergraduate Interactive Qualifying Project No. E-project-050510-200150). Retrieved from Worcester Polytechnic Institute Electronic Projects Collection: http://www.wpi.edu/Pubs/E-project/Available/E-project-050510-200150/

Ramachandran Nair, P. K., Mohan Kumar, B., & Nair, V. D. (2009). Agroforestry as a strategy for carbon sequestration. *Journal of Plant Nutrition and Soil Science, 172*(1), 10-23.

Ryan, F. (2011). A new dawn for Puerto Rico's food industry. *Caribbean Business*. Retreived from: http://www.caribbeanbusinesspr.com/prnt_ed/news02.php?nw_id=5598&ct_id=0

Schoeneberger, M. M. (2009). Agroforestry: working trees for sequestering carbon on agricultural lands. *Agroforestry Systems, 75*(1), 27-37.

Schroth, G. (2004). Agroforestry and biodiversity conservation in tropical landscapes. *Island Press.*

Setrini, G. (2012). Cultivating New Development Paths: food and agriculture entrepreneurship in Puerto Rico.

Small Business Job Protection Act of 1996, 104th Congress. (1996).

Socialbakers. (2013). Puerto Rico Facebook Statistics. Retreived from: http://www.socialbakers.com/facebook-statistics/puerto-rico

Staff of Joint Committee on Taxation. (2006). *An Overview of the Special Tax Rules Related to Puerto Rico and an Analysis of the Tax and Economic Policy Implications of Recent Legislative Options*. Retrieved from: https://www.jct.gov/publications.html?func=startdown&id=1496.

United States Department of Agriculture. (2013). Welcome to El Yunque. *USDA Forest Service*. Retrieved from: http://www.fs.usda.gov/main/elyunque/home

United States Forest Service. (2013). About the Forest. *El Yunque National Forest.* Retrieved from: http://www.fs.usda.gov/main/elyunque/about-forest

University of Minnesota (2013). Our Soil Testing Methods. *Soil Testing Laboratory*. Retreived from: http://soiltest.cfans.umn.edu/our-methods/#NITRATENITROGEN

Yi, Y. J., Billmire, M., Wong, W., & Daimler, J. (2008). Future Management Strategies for El Yunque National Forest. *University of Michigan, Natural Resources and Environment at the University of Michigan*. Retrieved from: http://deepblue.lib.umich.edu/bitstream/handle/2027.42/58202/ElYunqueNationalForest-mastersproject2.pdf?sequence=1

Appendices

Appendix A: Meeting with Luis Rivera, Forest Botanist at the U.S. Forest Service

Items for Discussion:

1. Any tests completed on the area
2. Review of agroforestry criteria/methodology
3. What goes into an agroforestry assessment
4. Opinion of type of agroforestry to use
5. Review list of plants and their feasibility
6. Any plants in particular thinks would grow well
7. Technical challenges he foresees
8. Why hasn't this been attempted previously
9. Existing wildlife and the affects this could have

Meeting Minutes:

- Any tests done on the area?
    - Doesn't know what Pedro has already done
    - They just met with the community to determine what the interest of the community is.
    - A problem is that the community had trouble visualizing agricultural work.
    - If done correctly, Luis would support it.
- He hasn't had a chance to look at our report due to required work.
    - Soil conditions:
        - Tropical soils can contain nutrients but most nutrients are in the biomass that falls.
        - If you take out the forest, the nutrients will deplete very quickly, and you will need to add fertilizer soon.
    - Type of agroforestry:
        - Silvopasture
        - Plots must be designed east to west to maximize whatever sun is available
        - Agroforestry has a lot of potential but depends on the clients and what they are interested in growing.
        - Most of agriculture in this country is done in the forest and using the soil as a substrate (using fertilizer)

        - When there is a lot of rain, there is a lot of erosion.
    - Cultivar is the variety of a product;
        - For example, different corn varieties can grow in sun or shade, and others grow in a year or six months.
    - There has been a lot of deforestation on the island.
        - Plantain is a sun lover and needs no shade.
        - Shade-grown coffee is good, but most cultivated coffee is sun-grown to increase production and reuse spacing of the crop.
    - He believes accessibility will be difficult because the farmer may not always be there and workers will not have easy access to the forest through their farm.
    - Fruits need a lot of sun and open space so we should not look into them.
    - Expand forest by giving them trees to plant on their lands to expand the agroforestry sector.
    - Ask Pedro to give us the other land policies of the U.S. Forest Service.
    - Now policy is to work on lands immediately in boundary and lands that contain riparian environments existing or not all the way down to the coral reef
    - Water is public (nobody owns it and 5 m to either side – riparian zone) but the lands on the left and right are private.
    - Taino Indians created a small hill (1 m high) by collecting soil/leaves/organic matter and that was where they planted a root crop (yuka)
        - Small area, big surface, top is drier, bottom is more humid
    - Proposed locations cannot be big areas.
    - Find out what local people think about the project.
        - Go to organic market in Hato Rey, Saturday morning in Old San Juan also.
        - Focus on organic because people can be pleased with a smaller production, and they like a constant production (be pleased with a smaller production, they like a constant production so they can go to the market regularly with a product to sell)
    - Orchids are easy to manage and are another option.
    - Go and collect from farmers what it is they would like to grow.
    - Go to organic markets and see what the products they are selling that are self-sustainable.
    - Some farmers have PhD/Masters degrees (farm as a side activity or for the principle of organic agriculture).
    - Making a cooperative:
        - In Old San Juan market, there is a lady that works for the food market and works for a business that isn't a cooperative but goes looking for products to buy for the benefit of the idea and good food.

        - Rio Piedras public market to see a large market.
    - Labor availability shouldn't be difficult because there is high unemployment.
        - We will have to start with extended family of the farmer (nephews, grandchildren, etc).
        - We also need a capital to pay the salaries until a profit is made.
        - Call them assistants instead (that way no capital needs to be invested in salary).
    - Coffee has a big process (can sell as beans, but from then on is always a process).
        - Called the "poor family crop" because owner of the farm is the only one that gets any money.
        - Sugar also requires a lot of processing before it can go to market.
    - Huge market for coffee because a large amount is imported; recently a benefit was given to the coffee picker (paid 2 dollars more); however, they need a coffee producer near in order to sell it
    - Cacao is big and is being exported to the Dominican Republic.
    - Need to wash root crops which can easily be done by the farmers themselves.
    - Some root crops are taro, yam, tanir, and potato yam.
    - Vines are a smaller area and larger harvest.
    - U.S. Forest Service has a special webinar (KY2: Know Your Farmer, Know Your Food).
    - There is a tendency for exotic fruits but must avoid inviting a potential invasive species into the forest.
    - Dominica is a very small and green island but tallest canopy is coconut for example, next layer is oranges and grapefruits, then bottom layer is taro/tanir/manillo
- Why has agroforestry not been looked at?
    - Farmers do not have big farms so they need to think about what he needs to plant to bring in enough profit to pay the bills.
    - Agroforestry will be difficult to convince people to be a part of because the amount farmers can harvest.
    - We should sell the project as a supplement to their current work.
    - Luis does not believe we can get all the income from agroforestry.
- A lot of technical instruments and measurements that can be used to determine things.
- We need to get into the forest and see how it looks.
- The forest has 3 canopies.
- Most products we will look at are shrubs, herbs, and vines.

    - Some vines are yam, passion fruit, black pepper (may need more light than all of the others), chiote?? (white pear – boil it and mix it with other things; farmer can join several trees with rope/wire and it will grow on them), and ginger.
    - Bees is a good project however when parrots leave nests bees come in, management is to kill them.
- Another option for bees is to explain to farmers about the management of bee control in parrot nests, and we can offer the honey and bees to the farmers that assist with the management.
- Luis wants to go to the supermarket to show us what is there and what can be done in the forest.
- He says we are in the right direction.
- Will not usually have an open environment like the bee location we will see.
- Summer year round but the rain mildly varies (but not too much because it is the rainforest).
- The rain could be a problem if you have a product that needs good drainage, and it may not be feasible because the product may rot or drown.
- Change pitch to percentage of slope.

Appendix B: Agroforestry Assessment Criteria

1. Existing conditions
2. Type of agroforestry
3. Size of the proposed location
4. Local support
5. Plant possibilities
6. Labor availability
7. Crop processing requirements
8. Laws and regulations
9. Invasiveness of possible crops

Appendix C: Map of El Yunque

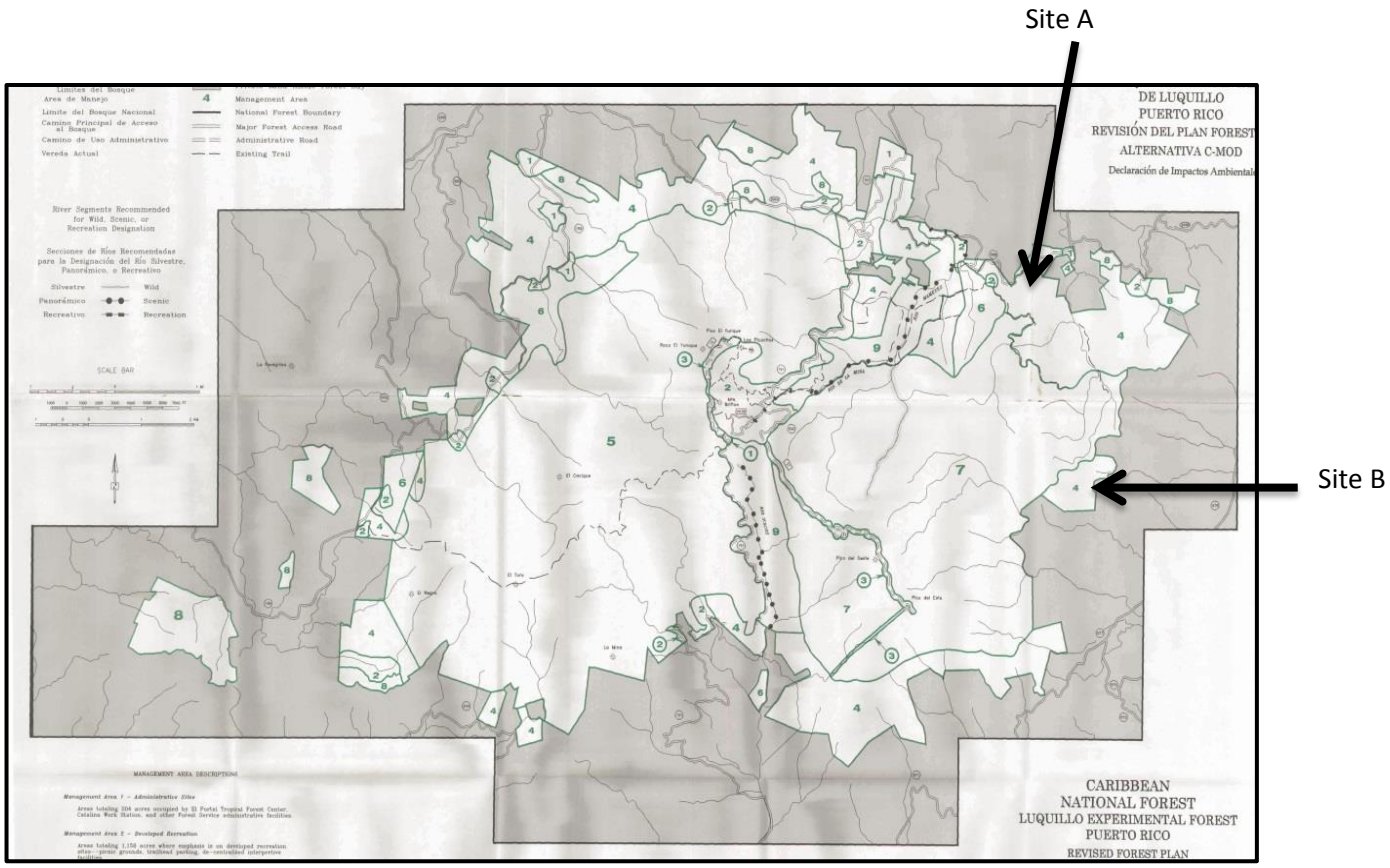

Figure 12: Map of El Yunque broken down by land management policy sector

The two locations shown above, Site A and Site B, are both located in areas labeled management area four. The 6,216 acres labeled with this number are areas where dispersed recreation and research are emphasized, and are considered "integrated" areas. Other management areas, in numerical order, include: administrative sites (1), developed recreation sites (2), communication sites (3), wilderness (5), research (6), research natural area (7), timber demonstration sites (8), and wild/scenic/recreation river corridors (9).

Appendix D: Existing Conditions Assessment

The completed Existing Conditions Assessment can be found in Appendix AB: Completed Existing Conditions Assessment.

1. Pitch of slope (average, percentage)
2. Accessibility (number and conditions of current roads)
3. Elevation (measured in feet above sea level)
4. Light conditions under the canopy (average, measured in foot-candle or lux)
5. Light conditions in the open (average, measured in foot-candle or lux)
6. Temperature conditions (average, measured in degrees Fahrenheit)
7. Rainfall conditions (average, measured in inches)
8. Soil Conditions (measured in a series of tests)
9. Management of the Area

Appendix E: Meeting with Felipe Cano, biologist at the U.S. Forest Service

Items for Discussion:

1. All of the past preliminary research and meetings
2. Ask about focus group feasibility/if needed
3. Present focus group questions
4. Talk about honey bee option
5. List of plants and their feasibility
6. Additional plants Felipe would like to see
7. Knows of any current wild life living in the proposed site
8. Farmers markets in the San Juan area

Meeting Minutes:

- There were two more meetings after the one with the report; report we got was the first two rounds of meeting.
    - The questions were what do you want to plant, how can the forest help you, would you consider doing small agroforestry products.
- A new paradigm needs to be added to the national forest in order for it to survive.
    - Sustainability is key.
- New agroforestry center.
    - Sent a video of the plight of the Puerto Rican people (80% of food imported)
    - Want to use El Yunque to grow sustainable compliant agroforestry products.
        - Also necessary in case of emergency since it is not sustainable.
- Felipe is trying to find the 3rd report, and he will try to get it from Pedro.
- Community representatives:
    - Contract facilitator has a long history of doing community forest projects with a focus on places that need to have awareness/synchronicity with the environment.
    - NRCS gave Felipe a list of people they are working with that are interested and took the people the contract facilitator recommended.
    - There were 37 landowners, and they could vote multiple times.
        - Nobody was under the age of 55 (everybody was senior citizen aged); younger people showed up at the third meeting.
- The west side of the island contains the majority of agriculture.
- Third report was very in depth; there were only 15 landowners at it.
    - Asked what they thought of the plaza mercados.
    - People aren't satisfied with the concept of plaza Mercado here.

        - Have to pay to go, do not see as much profit, invasion of public space that is typically free; some were into loans/grants, some not so much
    - Probably not feasible to complete this in 7 weeks (took Felipe a long time even with an experienced contractor).
- Department of Agriculture in PR is one of their biggest obstacles
- Grow mushrooms/ornamental plants in a unique way that doesn't destroy the environment.
- Locals are scared of the bees.
    - One guy from Boston that just moved here wants to do it; doing 3 hives (provides pollinators for the forest and honey for him to sell).
    - Just going to manage the bee problem (invading nests) as they arise; usually happens around March
- Any plants Felipe wants to see:
    - He said read the report (it covers a lot, comes from agricultural producers themselves)
    - Yuka, tubers, native plants (you can plant them and they flow with the native ecosystem)
    - Palo Colorado (serves no agricultural benefits) – provide cavities for parrots
    - Hydroponics, cattle raising
- Basically focused on forest farming, but also interest in turning private land into agroforestry settings.
    - Use fruit trees and the edges of the streams because there is supposed to be a buffer around streams.
- Felipe always focused on wildlife and how agriculture effects or can help wildlife.
- There is an actual area; they currently have a land management plan .
- Wildlife in area:
    - Broadwing hawk, sharp-shinned hawk
    - Broadwings hunt in canopy
    - If structure of forest changes, it would be an issue
    - Environmental changes can change behavior; might cause migration
    - Try and introduce diversity to change/open up midlevel
    - Waiting for hurricane so they can ask Congress for money for rehabilitation
- Farmers markets:
    - Old san juan; santurce?
    - Fajardo (daily but not too large)
    - Neguabo
    - New farmers market concept: public invasion of public space
- Some super markets are Freshmart, Selectos, and Supermax.

- Marketing aspects:
    - How to make them worthwhile?
    - Make products special

Appendix F: List of Possible Projects

The following list shows each project and the number of votes it received. This meeting had about 30 attendees, and everyone could vote multiple times.

1. Project for vegetable production — 19
2. Projects for soil restoration of the region — 17
3. Compost production at a commercial scale — 16
4. Production of trees and cultivation from fruit trees, ornamentals, alternatives for timber (small wood logs) —12
5. Production of natural products (medicinal plants, etc.) — 11
6. Commercial production of species mix or “sofrito” — 8
7. Meat production from sheep — 7
8. Hydroponic alternatives — 7
9. Aquaculture — 4
10. Commercial production of mushrooms in the forest — 3
11. Ornamental plants production — 1

Appendix G: List of Possible Plants

Miscellaneous

- Ginseng
- Honey
- Taro
- Parsley

Roots and Tubers

- Queensland arrowroot
- Leek
- Ginger

Fungi

- Shiitake (Florida 55)
- Hen of the Woods
- Golden Chanterelles
- Black trumpets
- Oyster

Grains

- Okra
- Wax gourd

Legumes

- Asparagus beans

Vegetables

- Tahitian taro
- Scallions
- Bell Pepper
- Pak Choy
- Tropical pumpkin
- Cauliflower
- Mesclun
- Squash
- Garlic
- Eggplant
- Leek

Orchids

- Ornamental Plants

Vines

- Vanilla
- Black Pepper
- Passion Fruit

Trees

- Cacao
- Coffee

- Mamey sapote
- Rambutan
- Bananas
- Mango
- Plantains
- Coconuts
- Guayusa
- Allspice

Appendix H: Chart of Plants Eliminated with Reasons

Plant	Reason Not Selected
Roots and Tubers	Soil conditions do not allow for much subterranean growth
Grains	Not enough sunlight available
Tahitian Taro	Soil conditions do not allow for much subterranean growth
Tropical Pumpkin	Not enough sunlight available
Ginseng	Requires a lot of maintenance
Cauliflower	Prefers colder temperatures
Mesclun	Prefers colder temperatures
Coffee	Labor intensive and would not help the food self-sufficiency issue
Cacao	Labor intensive and would not help the food self-sufficiency issue
Rambutan	Very large tree, years until a profit is seen, requires a lot of sun
Bananas	Being grown in abundance on the island already
Plantains	Being grown in abundance on the island already
Coconut	Being grown in abundance on the island already
Squash	Not enough sunlight available
Garlic	Not enough sunlight available
Allspice	Very large tree, too big to grow under the canopy
Eggplant	Not enough sunlight available

Criteria for Selecting Plants:

pH Requirement: around 5
Water Requirement: Well drained soil, around 55”-100” per year
Climate: 70-80 degrees F, Humidity
Sunlight Requirement: partial-complete shade
Labor intensity: Not very labor intensive

Appendix I: Meeting with Carmen Santiago, Soil Specialist at the Natural Resources Conservation Service (NRCS)

Items for Discussion:

1. Project overview
2. Soil information we gathered from the website
3. Which soils are better for the growth
4. Need for lime or organic fertilizer for cultivation?
5. Specific plants that would grow well in these conditions?
6. Weather conditions for the proposed areas
7. Weather effects on the soils (erosion etc)
8. Idea of Taínos planting on small mounds to help increase space and nutrients, possible?
9. Comments on our current plant list:
    - Plantain (already being grown)
    - Orchid (do not have to do much, easy to manage)
    - Root Crops (taro, yam (the one that is a vine, not sweet), tanir, potato yam)
    - Vines (smaller area, bigger harvest)
    - Shrubs, herbs, vines
    - Yam
    - Passion fruit
    - Black pepper
    - Ginger

Meeting Minutes:

- Edwin Mas has done agroforestry in Maricao forest.
    - El Yunque is the most humid forest so not everything might not be applicable.
- Conference call with Edwin
    - He has a presentation from farms in interior of island (crops could be similar to El Yunque).
    - He suggested Rambutan (tree) and Lychee (fruit).
- They need to know exact species to know if they will work with the acidic soil in El Yunque to give us accurate information.
- Non-traditional fruits have become popular lately.
    - There is a wide variety.
    - People will pay good money for them.
    - We already see them in supermarkets everywhere.
- There are a number of conservational practices to take into consideration to preserve soil.
    - Use this as a limitation.
    - If the practices are not viable, then we can't use them.

- If people are registered in FSA they can receive USDA incentive for applying certain practices (conservation).
- Try to correlate same soils in different areas, but not completely reliable because the soil could be managed differently, but it is an idea of natural conditions.
- Concentrate soil choice on the soil farmers have.
- Using lime or organic fertilizer depends on the crop and what conditions it needs to grow.
- Weather conditions?
    - Pedro will send us monthly report
    - Check NOAA for more information.
- Erosion issue? Not in El Yunque if you preserve and maintain rain cover, no erosion other than natural. Do not disturb and move the soil, because that causes issues.
- Taino built small mounds of dirt and planted on them.
    - Carmen has never heard, Edwin maybe, but she thinks it makes sense.
    - Steps in the slop method, need to be sloped to the inside to keep soil in, or level
    - Farming following contour of land, so they do not have to move soil.
    - Plant trees in a triangle, triangle grid, space the trees out instead of alleys, helps water filtrate.
    - Move earth enough to make a small terrace for one plant. In Peru they do a similar method.
        - Move top soil to the side, cut, then bring top soil back.
- Individual planting even might have incentive because it moves the soil minimally, incentive for farmers
    - A little round soil cut, and it is a little step for the individual plant
    - Gradient to the side so the water infiltrates
    - Used for coffee a lot, good for trees
    - Edwin will show us demos
- Additional comments on our crop list
    - Root crops like yam, prefer not clay soils (like the rainforest), because the root needs to grow.
    - Passionfruit is a vine we should consider.
    - Never heard of a black pepper, instead a seasoning pepper needs semi arid, flat, soil
    - Taro is a root crop but the root doesn't grow that much, needs a lot of water too.
    - Use Edwin's research because it has been proven.
- Labor is expensive and scarce, everyone prefers working indoors.
- Whole year is growing season, so it is easier to lose the crops to weather
- Banana trees are weak, not stable.

Appendix J: Meeting with Edwin Más, Plant Specialist at the Natural Resources Conservation Service (NRCS)

Items for Discussion:

1. Please review agroforestry assessment attached and let us know if its comprehensive enough
2. Opinion on using El Yunque for agriculture?
3. We are looking to focus on plants that are indigenous or naturalized to El Yunque to help assure cultivation and would thrive in a forest farming setting due to the projects current small size. To start, the focus is on small side projects for the landowners abutting the forest. Any specific plants or crops that come to mind that would thrive under such a setting? The area of forest is unmanaged; some small ground level management by the farmer may be possible.
4. Specific plant combinations that are symbiotic or parasitic?
5. Any specific plants to avoid due to invasiveness?
6. Do you have any experience establishing forest farming or other forms of agroforestry in other locations or knowledge of any that have been successful in other parts of the world?
7. Have you had farmers approach you about agroforestry anywhere in Puerto Rico?
8. Are you aware of any specific laws or regulations governing new agriculture or agroforestry in Puerto Rico?
9. Specific challenges that you may foresee in establishing such a forest farming system?

Meeting Minutes:

- A- frame or PVC level for layout in field, used to build hill side ditches/meet contour
- Big with erosion control, making sure where planting has right pitch
- Take PVC, put flag in one spot, then swing until level with bubble, put flag there, continue going every desired distance, in end have row of flags that show contour of hillside.
- Best Management Practices:
    - Based on field integration, some brought from U.S. but tested locally
    - Most of the practices are adopted by the farmers
    - Most of PR mountainous, so need to practice here especially
    - Most of profitable farm land in the interior of the island, 10-30% slope here, steep but prime land
    - Important recognize areas that previously plantations in the uplands and that it is still prime
    - Have land up to 40% slope and still planting here
    - Percent is rise over run, if 100%=100 feet long and 100 feet up.
    - 4 Conservation practices
        - Vegetative

    - Mechanical/structural (concrete, boulders, wood etc)
    - Management (rotating cattle/fields)
    - Tillage
- Natural Resources:
    - Air
    - Plant
- Erosion:
    - Geological which is natural process, never stops
    - Accelerated is caused by human activities, and can be reduced
    - GOCline??
- More vegetation and less disturbance reduces the potential of erosion
- Conservation practice=one conservation measure
- Conservation system=more than one measure
- Some invasive trees not always bad, can end up providing food and shelter for animals, solution to keep some and kill some
- Forage planting, rotational grazing, and watering facilities
- Conservation buffers with bodies of water, grass buffers etc.
- Need to be careful of planting grass that doesn't take over entire field
- Terraces
- Office located in Mya West, ARS, agricultural research stations
- By product management, infiltration ditch and pond
- Gabions, mulching, water runoff
- Critical area planting, very important human areas, soils usually poor and need to plant to keep soil in place
- Media Luna (half-moon), individual terraces for plants, from the Incans
- Bioengineering, using tires in the side of the hill to hold soil
- Gabions=mats of rocks, good when no plants grow in area or big drop
- Want funding from NRCS, must follow their specs in their standards, how to plant some
- Alternatives
- Rambutan, exotic fruit from South Asia, $5.00/lb, no risk of invasiveness
- Tree cost $20.00, start harvesting in 5 years
- Lichee
- Logan (grows in tree)
- Cacao or cocoa, U.S. government and PR promoting, all production sold right now
- Romero, rosemary, oregano, mejorana (ingredient of KFC)
- Eggplants, green peppers, sweet peppers (ajíes), okra. These are cash crops that grow quickly while the Rambutan is growing

Appendix K: Meeting with Hilda Bonilla, Agricultural Extension Services (AES)

Items for Discussion:

1. Project overview/present newsletter
2. Present focus group questions
3. Present farmer questions
4. Ask her opinion on challenges starting up new agriculture/reason hasn't been already done
5. Opinion on using the rainforest for agricultural purposes
6. Possible ideas for educating the public
7. Rules and regulations for starting up new agriculture
8. Rules and regulations for starting up farmers market
9. General process for farmers to get their food from field to market

Meeting Minutes:

- There are a lot of problems w/ market because prices fluctuate
- What do you think about the cooperative organization?
    - Farmers are very repellant about working w/ other farmers.
- There is an organization that rules all cooperatives and deals with rules and legal requirements.
- We should contact the Department of Agriculture.
- Cooperative question for farmers: if not, then why?
- Not all farmers know what agroforestry is; mostly young people would know.
- Most often start farmers by deforestation which is very expensive
- Dept of State is where cooperatives are registered.
    - Look for cost to register/maintain the organization
- The challenge they face is to produce what they eat.
    - Rice and beans are a huge staple in the diet, but they are currently all imported.
- Self-sustainability is difficult because it is an island
    - Boats go to U.S. first then to Puerto Rico.
- Ley de Cabotaje is important.
- Four companies control the shipping market currently.
- It would be important to teach families to grow community gardens.
- Hilda believes growing in the rainforest is a great idea as long as it doesn't harm the rainforest.
- Director of Institute of Tropical something; Arille good teacher/best ecologist
- USDA has a farm service (NRCS).

    - They give loans and incentives and have rules and regulations.
- Do you think unemployed people will want to work in the field?
    - She thinks it should be a requirement or an obligation to work in fields if you receive food stamps, because farms need workers.

Appendix L: Meeting with Magaly Figueroa, Natural Resources Specialist at the International Institute of Tropical Forestry

Items for Discussion:

1. Project overview and background
2. Does she have any information on proposed sites in El Yunque
3. What difficulties she might see the U.S. Forest Service have in establishing this program
4. Is there anything in the area we should take into account when working on this project? (she's a natural resources specialist)
5. Does she have any resources or information on the area that may be helpful to the project?
6. Does is she aware of any laws or regulations we need to understand when working in the area?
7. Any suggestions for us?

Meeting Minutes:

- The Secretary of Agriculture has a PhD in food security and is a friend of Magaly Figueroa.
- She suggested we ask Carmen Santiago about the NRCS community garden project.
- Agroforestry
    - There is currently shade-grown coffee, oranges, and cattle in the southern part of the island that follow agroforestry-style planting.
    - On the western side of the island in Maracao there are plantains, oranges, and shade trees.
    - Rambutan and other exotics are being sold to Pueblo and are making a lot of money.
- Georges Felix has a PhD in agroforestry and could be a good contact for us.
    - He is currently working with agroforestry in Africa.
    - He has a paper on agroforestry, and it should help our paper.
    - George is coming first week of December to IITF.
- What is currently growing in the area?
    - Coffee is good in shade.
    - Menonas Corazon can tolerate shade.
    - Incavara (scientific name) can grow in shade also.
    - Another idea to look into are species of flowers that can grow in shade and be sold.
- What do we need to make sure to ensure conservation in El Yunque?
    - Farmers need to stay in contact with U.S. Forest Service.
    - We need to check to see if any species are currently endangered.

    - Special management restrictions may exist in El Yunque, so we need to be aware of what they are.
- DNER contractor to find a management plan for eastern border sides
    - Recommend this to landowners.
    - Cospro is the entity for professional services.
        - Carlos is the executive director, and we should email him.
- She will send us Myrna Comas's contact.
- Matos is a program from NRCS.
- UPR in Maraguays is an agricultural college.
    - Sally Gonzalez focuses in agronomy is a partner of IITF.
    - Agroforestry
    - Food security
- The difficulties growing in El Yunque are:
    - Getting people involved.
    - People who trust the government.
    - Landowners priority is not farming, it's building houses on land.
    - Hardest part is definitely selling the idea to the farmers.
- We need to identify and target the leaders of the community, and other people will follow.
- Schools want to develop community gardens.
- Department of Natural Resources (DNER??)
    - Permits for removing trees will be sent.
    - Permits to move soil will also be sent.
        - There is a tax exemption if landowner is certified for keeping the land conserved.
- Betalocale idea is good because many people own land but work in San Juan.
    - It is a good event on a Saturday (40 people).
        - Had major government organizations there.
        - Composting facilities are a good idea.
        - Community center, good area, do not make people travel
            - Should be able to get it for free
- Farm Service Agency gives incentives to land owners.
- Rural Development
    - Funding is given to improve community roads.
- DNER could sponsor our projects and provide trees.
    - Enrique Santiago is a good contact at DNER.
- Taino mound idea is not a good idea for our goals.
    - People do it in small gardens, but not in the forest.

- USDA National Agroforestry Center website
    - Download information to be able to distribute to farmers.
    - Guide to a successful project are planning, marketing, and visualizations.
- She suggested we look into introducing more bees/honey to the area.

Appendix M: Farmers Market Operator Interview Questions and Minutes

1. How long have you operated this farmers market?
2. Would you say that this market is successful?
3. What does your job entail?
4. In your opinion, what would be the most important things to consider when trying to start up a new farmers market?
5. What challenges did you face when establishing this farmers market?
6. What continued challenges do you face?
7. What do your day-to-day activities include?
8. How important do you think location is to a market's success?
9. How do you maintain your farmers market?
10. Do people prefer locally grown food?
11. What is your most popular item?
12. Are most of your customers one time visitors or regulars?
13. What do you think attracts people to shop at your market?
14. In your opinion, what are the benefits of farmers markets as compared to regular supermarkets?

Operator 1: Laura, Old San Juan Farmers Market

- She thinks agroforestry is a good idea.
- Market has been around for 3 and ½ years and she believes its successful currently.
- How the market start:
    - She went out and found an organic farmer willing to bring his produce to her house.
    - Over the next year and a half, she had created a mini market in her house that included 19-20 people in her living room.
    - Thinks a cooperative is laborious, and all her market needed was space.
    - Chose the old city because it is unique due to the residents, local/state government, and national parks.
    - Took a while to get permission to hold the farmers market in their current location (because she had to talk to a lot of different people).
- Everybody is volunteer and they do not have to pay for the space because it was originally built to be the local community farmers market place.
- She has had people come and go; they are currently coming into the high season of the market.
    - Summer/fall is the slowest because it is hot and there is a lot of rain.
    - Winter has more diverse products and it is cooler.
- There is an opportunity to have a lot of diverse fruits and vegetables but they just do not see any.

- Her goal is to be totally self-sufficient.
- The majority of venders are young entrepreneurs want to farm.
- Roosevelt market are mostly repeat customers and locals but the Old San Juan Market has both tourists and locals, and more tourists during tourist season.
- People like the ambience, and there is usually music.
- Thinks that there is nothing more important than knowing your farmer and where your food comes from which you can't always get in the local supermarket.
- She tried to start a cooperative but it is very slow work.
- Passerby thinks there should be an agroforestry industry and thinks it's not understandable that most of Puerto Rico's food is imported.
- We could put an information table in the Old San Juan market if we wanted.
- Beta-Local
    - Beta-Local is a community dinner, which we could possibly present at.

Operator 2: Mayra Nieves, Placita Roosevelt Organic Farmers Market

- It has existed for 11 years but she has been there for 2.5 years.
- Market has been a success, goes up and down like any business.
- Their purpose is to offer a place for agricultural people to gather and offer products directly, in that sense its successful.
- They are not making a lot of money, they have a tight budget
- Do not have regular staff, most people are part time.
- Main goal isn't money but to offer a place for farmers to sell their produce as well as education.
    - Every Thursday and Sunday offer education, small seminars to community for free
- Organic products are important to the customer
- Goal is to have the market twice a month
- Her main job is a coordinator, coordinates all the efforts of the market.
- Important to decide the structure of market you are going to use: coop market, group market but run freely, or incorporated.
    - Every structure has certain rules to follow.
- Be aware of all necessary permits
- Consider: who is your market, what are all the permits, vary by town, community supports the farmers market ideals.
- Structure, place, and market are important
- Market decides the products.
- Determine the needs of people: producers to start the market
- Challenging to find people to sell at the market who were organic
- All of the paperwork/permits required is a challenge
    - Gather all info necessary for permits
- Volunteers to do work is a continued challenge

    - Most work other jobs and only have a few free hours
- Location of market is important
    - Placita Roosevelt is well known
- People come to look for specific products because not many organic products are offered in Puerto Rico yet
- The farmers market in Plaza Las Americas is government run
- Over 350 types of soil in Puerto Rico

Appendix N: Farmers Market Vendor Interview Questions and Minutes

1. How long have you been selling your merchandise at this farmers market?
2. Is farming your main occupation?
3. Is this the main place that you sell your goods?
4. If yes then: Would you consider having any of your items sold in a commercial supermarket?
5. On average, how many people stop by your booth per day? How many make purchases?
6. Does location of the booth within the market make a difference to your sales?
7. What do you like about your farmers market? What do you not like?
8. If given the opportunity, would you change anything about this market?

Vendor 1: Plaza Las Americas farmers market, fruit vendor

- He has been in the mall for two years.
- He finds the farmers market is pretty successful.
- The farmer grows in Sansiba.
    - The farmer only sells to this merchant.
- Farmer also sells to grocery store suppliers.
- A lot of people come to the mal specifically for the farmers market.
- He thinks the designated area is better than the first floor.
- The market has a good relationship with the mall owner.

Vendor 2: Plaza Las Americas farmers market, fruit vendor

- The vender has been selling for many years.
- The farmers market is successful.
- They see 500 or more customers a day.
- Mall is a good place to sell.
    - Prefers the first floor over the third floor because more people casually walk by and see the stands.
- This seller only sells in the mall.
- The farmers market is free for the venders to sell.
- He loves the setup of the farmers market.

Vendor 3: Plaza Las Americas farmers market, Lavender vendor

- He has been here for 2.5 years at the mall.
- He sells to many farmers market, but is mostly here.
- He sees about 100-200 people a day.
- He wishes there was more marketing of the farmers market.
- He grows in Calle.

- Government makes getting permits difficult.
    - He believes the government needs to be more pro-business.
- He gets a lot of repeat customers.
- Mercado Urbano was started 3 years ago, and is growing in popularity.
- Emphasis needs to be made on eating Puerto Rican food over other foods.

Vendor 4: Plaza Las Americas farmers market, Orange juice vendor

- She has been here for 3 years.
- Been growing in Larres
- The farmers market allows fresh products to be easily accessible.
- She thought the same people came to here and the third floor.
- The difficult part of starting up was selecting the product to sell and having enough of it.
    - Also it was a lot of hard work, because she did not have many people to work it.
- Markets location is very important.
- Also sells at the Condado market.
    - Very good because there are a lot of tourists.
- She sells fresh products which is enticing.
- She used to sell commercially, but now she doesn't need to.
    - There was a distribution center in Lares, sold mainly at schools
- Department of Agriculture really supports the farmers.

Vendor 5: Plaza Las Americas farmers market, fruit vendor

- Her father was a farmer and she inherited the farm, which is located in the middle of the island.
- She has been here for 3 years.
- It is successful because there's fresh product and people can talk to the farmer.
- Rambutan is the most popular product she sells.
- People purchase crops with healing principles and health benefits.
- The most difficult part of growing is being a women.
    - There are a lot of prejudices against her.
- The most important part is to have fresh and quality products.
- About 75% of her customers are repeat customers.
- Lunch time is the peak selling time because people are hungry.
- She also sells to the Virgin Islands.
    - The Farmers Market is a side thing.
- Sees about 200 people a day.
- She wants to see more marketing.

Vendor 6: Old San Juan farmers market, fruit vendor

- He has been selling at this market for 2 years.
    - Sells fruits, guineos, chayotes, etc
- Farming is his wife's main occupation, but for him it is only a side job.
- He also sells his stuff in a farmers market in Plaza Roosevelt.
- He would consider selling his goods in a commercial supermarket.
- His business is okay, but he would prefer to sell more.
- He likes the farmers market idea, but it depends on the customers.
- About 1/3 of the customers are tourists.
- It is hard to say whether customers are repeat customers or regulars because it depends on the day and the amount of ships docked.
    - He doesn't think people would come from far away to go to this market.
- His farm is in Jayuya, which is located in the center of the island, straight up from Ponce.

Vendor 7: Old San Juan farmers market, organic products vendor

- She has been selling at this market for 3 years or so and is part of a cooperative.
    - She sells breads and organic things.
- Farming is her main occupation.
- She also sells at CSA and to restaurants.
- She would not consider selling her goods at a supermarket because she doesn't want to compromise.
    - She has two college degrees, knows a lot, likes explaining things to people which is one of the reasons she prefers selling at a farmers market.
- She also sells avocado, chobata, oregano, tarragon.
- Need an open door policy because you have to build your reputation.
- She believes food sovereignty is the main goal
- Important things to consider are the reputation of people selling at market, word of mouth, and consistency (make it part of people's routine).
- Good ways to draw in people are places with parking, bathrooms, and a way to keep an eye on children.
    - For example, people at this market keep an eye on children so parents feel free to shop because they know the venders will be aware of their kids.
- Music always helps it become an attraction.
    - For Example, in Rincón it is by churches so they do not play music during services; people gather when there is music.

Vendor 8: Placita Roosevelt Farmers Market, fruit vendor

- He has been selling at this market for 10 years; and the market has been open for 12.
- He is a student and farmer, and doesn't farm full time.
- This market is the main place he sells his stuff.
- They're too small to smell commercially.
    - When he finishes his master's degree he wants to grow more.
- He sees roughly 100 people at his stand per day.
- This is the oldest farmers market on the island and most famous.
    - The market is popular and well known.
- If he could fix anything, he would make the market weekly.

Appendix O: Supermarket Manager Interview Questions and Minutes

1. What produce do you currently buy on a regular basis?
2. What crops would you like to see available for sale?
3. Are there any specific crops you have no interest in buying?
4. Are you familiar with the term cooperatives?
5. Do you know of any cooperatives in the community?
6. Why do people come to your supermarket as opposed to others or farmers markets?
7. How do you get people to come to your supermarket?
8. Do you think your clientele would buy specialty products produced in an agroforestry setting?
9. What challenges do you face when determining what your clientele wants to see in your supermarket?
10. How do you learn about new crops?

Manager 1: Pueblo, Miramar San Juan

- Spoke with a manager from the corporate office.
- This store is abnormal because it is very small and variety is limited.
    - The Isla Verde store is bigger and has a better selection.
- They import a lot (onions, yams), buy locally when they can (pineapples, bananas, papayas).
- Pueblo has tried specialty products and they do well is some areas, not well in others.
    - In other areas, people do not buy produce because they eat what they grow on their own land.
- Willing to bring in anything people ask for if it is cost feasible and if there is a shelf life.
- When the United States produce ends, they buy from Chile.
- Have cards in customer service to make requests, these then get sent to the central office.
- Produce is determined by what crops are available.
- Pueblo belongs to a cooperative and is very active in purchasing from them.
    - The cooperative makes sure Pueblo gets the highest quality and gives price advantages.
    - They highly believe in cooperatives.
- Pueblo is privately owned.
    - Pueblo markets via coupons, advertisements on tv, newspaper, radio, and flyers.
- Sometimes Pueblo purchases too much and needs to throw out some food which is undesired.

- This depends on the zone because they have to match the offerings with what the customers want.
- Isla Verde offers more organics, readymade salads, etc.
- They take trips to the states (Wholefoods, Trader Joes, etc) a few times a year to see what's evolving in the food industry.
- Keep an eye on the trends in the United States.
- They try to be first on the market with new products.
- They go to shows in the states, including meat and dairy shows.
- People are into gluten free foods and other foods without certain things, and Pueblo is trying to move in that direction

Manager 2: La Hacienda, Miramar San Juan

- Popular foods include:
    - Mangos, oranges, mandarins/tangerines, arugula, romaine, root vegetables (including sweet potatoes)
    - Cilantro, basil, parsley, other herbs
- They ship almost everything from the United States due to a lack of consistency with Puerto Rican products.
- Acai and medicinal plants are only a trend, and he doesn't think it will last.
- Doesn't know the word "cooperatives"
    - Has heard that they are starting: a group ships to one place and then distributes to stores from there
    - Thinks it's a good idea
- La Hacienda specializes in specialty foods (meats and produce) and there are 4 stores in Puerto Rico
- Micro herbs are really popular right now
- Everything in the store must meet their standards (taste and presentation must be good).
- Suppliers come and bring new stuff, the store managers and other people taste, approve, and sell to customers.
    - It has been a family business for 36 years, and started as a butcher truck and expanded after.
- Customers want homemade bread (only 2 suppliers in Puerto Rico; humidity makes it difficult to stay on shelf)

Manager 3: SuperMax, Old San Juan

- Papaya is the most popular produce.
- Customers haven't requested any produce that they do not have.
- Currently, they do not know of cooperatives.
- It is the only supermarket in Old San Juan, so customers have limited options when shopping (and therefor go to this store).
- There is a specific in-store-shopper with coupons to this store only.
- They had never heard of agroforestry.
- People are interested in knowing where their food comes from.
- There are specialty products, but in other sections and not produce.
- Suppliers bring the new food.

Appendix P: Meeting with Head of Markets for the Department of Agriculture

Items for Discussion:

1. Brief overview of our project thus far
2. How many farmers markets are currently operating in the San Juan area?
3. What is the process to starting a farmers market?
4. Are there any laws or regulations farmers markets must see to?
5. What are some common methods of promoting a farmers market?
6. Are these markets in general successful?
7. What are some of the most common obstacles someone goes through in establishing these markets?
8. Do you know of other farmers markets outside of San Juan? Approximately how many there are?
9. Any other information that may be helpful in this project?

Appendix Q: Produce Currently Sold in Markets in Puerto Rico

Commercial Markets:

Fruits:

- Berries
- Oranges
- Apples
- Grapes
- Mangos
- Pineapples
- Bananas
- Plantains
- Coconuts
- Avocados
- Kiwi

Vegetables:

- Ginger
- Onions
- Garlic
- Potatoes
- Squash
- Cabbage
- Tomatoes
- Perejil
- Esparagos
- White mushrooms
- Lettuce
- Arugula
- Carrots
- Celery
- Okra
- Recao
- Yellow, red, and green peppers
- Yellow squash
- Green squash
- Collie flour
- Egg plant
- Malanga lila
- Yautia lila

Farmer Markets:

Milks and Juices:

- Sesseme seed milk
- Coconut milk
- Fresh juices (mango, orange, lemonade etc)
- Horchata

Fruits:

- Bananas
- Mangos
- Sour orange
- Mandarins
- Oranges
- Jalapeño
- Malvasia
- Arandano

Vegetables:

- Malanga
- Yautia
- Squash
- Tomato

Herbs:

- Salvia
- Menthol
- Chaya
- Sabila
- Piña
- Jennibre
- Cilantro
- Perejil
- Albahaca
- Recao
- Juana la Blanca
- Calabaza taina
- Pacholi
- Collards

- Cebollin de ajo
- Llanten
- Limoncillo
- Albahaca limon

Miscellaneous:

- Candles
- Honey
- Yogurt
- Fresh bread
- Facial products
- Marigold

Specialty Supermarket

- Ginger
- Green onion
- Leaks
- Zucchini
- Yellow squash
- Tarragon
- Parsley
- Sage leaf Isabel
- Carrots
- Mint
- Cilantro
- Spinach
- Asparagus
- Tomato
- Egg plant
- Butter squash
- Apples
- Red pear
- Orange
- Lemmon
- Lime
- White whole mushrooms
- Broccoli
- Dill weed

Appendix R: Interviews with Farmers Cooperative Board Members

Carlos, President of Cooperativa Orgánica Madre Tierra

- Cooperative and market were set up 11 years ago.
- There was a conflict between producers and consumers.
- There is a lack of production and lack of farming on the island.
- People are interested in agricultural consciousness, and are looking for somewhere to sell.
- Farmers can start here, grow, and then sell to supermarkets.
- There are not a lot of big producers on the island.
- There is not a lot of support from the government.
    - The USDA regulates organics but Puerto Rico has their own name called Boricuá.
- There is a local seal for quality control.
- The department of agriculture holds lands.
- The government treats small farms differently.
- There is a meeting with the venders after every market.
- There is a need to comply with regulations of being a cooperation in Puerto Rico.
    - There is a lot of paperwork.
    - You need to hire someone to be in charge of papers.
- Cooperatives do not need to pay taxes but they can be fined.

Mayra, Member of Cooperativa Orgánica Madre Tierra

- Coop has an executive board with president, vice president, treasurer, secretary
- Ruled by law 939, in Puerto Rico coops are supervised by law.
- Based on bylaws, they need to have a director group, could go from 3 to 11 theirs has 7.
    - Every year at assembly can change number of people in director group.
    - Board governs day to day activities
- Steps for incorporation of cooperative requires a commitment
    - people live in different parts of island, issue of accessibility leads to reduced frequency of meetings
- Cooperative members must offer at least 3 hours of service per month.

Appendix S: Soil Analysis Test

Background

There are several major nutrients required in soil for the healthy growth of plants and high crop yield. The main nutrient that has a large influence on the health of the plant is nitrogen. Excessive amounts of nitrogen cause leeching into groundwater, resulting in polluted water. Management of this crucial nutrient is difficult and essential to crop growth. Nitrogen is added to soil through organic matter, such as manure and compost, or fertilizer. Nitrogen is often lost through leeching, volatilization, de-nitrification, immobilization, or use by the growing crops. The loss from crop use is often the largest source for removal of nitrogen (Agriculture, 2013).

Other major nutrients include phosphorus, potassium, calcium, and magnesium. Phosphorus is necessary for a healthy plant metabolism. It is immobile in the soil, requiring fertilization prior to planting if levels are low. Potassium is utilized by the plant for the transport of nitrates within itself as well as opening and closing stomata (Agriculture, 2013). High levels of potassium can have harmful effects on wildlife consuming the leaves of the plant. Low levels often result in stunted growth of the plant. Calcium is often at the correct level when the soil pH is at the proper level. Liming can correct deficiencies in calcium if the pH is also at an improper level. If the soil pH is adequate, calcium sulfate will help introduce calcium without affecting soil pH (Hart, et al., 2011). A plant relies on magnesium to metabolize nitrogen as well as produce chlorophyll ("Agriculture in Puerto Rico", 2013)

Another important aspect of plant growth is the pH of the soil. High acidic or alkaline soil will stunt the growth of plants. The majority of crops will thrive between a pH of 6.0 to 8.2 (Hart, et al., 2011).

Testing

These nutrients and pH levels can be tested for in soil labs using multiple methods. Labs utilize multiple chemicals that they add to a determined mass of soil, the reactions showing the amounts of each nutrient. One example is the nitrogen test, where 60 millimeters of 0.01 M $CaCl_2$ extracting solution is added to a two gram soil sample, shaken for 15 minutes, and the extract measured by a continuous flow analyzer (University of Minnesota, 2013). Another example is a calcium and magnesium test. The nutrients are extracted by “mixing 10 millimeters of 1 normal, neutral, ammonium acetate with a 10 gram scoop of soil and shaking for 5 minutes”, the extract being filtered and analyzed using “an inductively coupled plasma atomic emission spectrometer for calcium and magnesium (University of Minnesota, 2013).”

Appendix T: Tree Removal Permit

Formulario DRNA-MA-SPAIO-001-Rev 31-12-2004.doc

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES
PO BOX 906660 PUERTA DE TIERRA STATION - SAN JUAN, PR 00906-6600

HOJA DE COTEJO Y REQUISITOS PARA LA
SOLICITUD DE PERMISO PARA CORTE, PODA, TRANSPLANTE Y SIEMBRA DE ÁRBOLES
(ACCIONES INCIDENTALES A OBRAS)

Cuando la información solicitada no aplique escriba N/A en el espacio correspondiente. Escriba en letra de molde o maquinilla. Deberá llenar todos los incisos. Esta solicitud oficial no podrá ser alterada o modificada. A continuación se detallan los requisitos para la presentación de solicitudes para el manejo de árboles localizados en predios **para proyectos de desarrollo.**

I. ☐ **Solicitud** debidamente cumplimentada.

1. **Nombre del Proyecto**
2. **Actividad para la cual se solicita el permiso** – Marcar la que aplique: corte de árboles, transplante de árboles, siembra, poda de ramas, poda de raíces u otro. De no ser ninguna de las anteriores, especificar la actividad a realizarse en otro.
3. **Propósito** - Indique si es agrícola, desarrollo de terrenos: institucional, residencial, infraestructura de gobierno, recreacional, industrial o comercial, una reforestación u otro propósito, de no ser ninguna de las anteriores.
4. **Localización del (los) árbol(es) -** Indique si se encuentra en un área pública, área privada, urbana o rural.
5. ☐ **Información del Peticionario** – Nombre, dirección y teléfonos de la persona y corporación que solicita el permiso. En el caso de personas naturales, si el Peticionario no es el dueño de la propiedad, deberá presentar un **documento donde éste le autorice a solicitar el permiso. En casos de enmienda**, el Peticionario deberá incluir el **número del permiso vigente**.
6. ☐ **Persona autorizada -** Indicar si autoriza a otra persona para dar seguimiento a su solicitud. Escriba nombre de la persona e incluya carta de autorización
7. ☐ **Información el Propietario o el Representante si es una Corporación, Agencia o Institución** – Someta evidencia fehaciente de la tenencia de los terrenos. Si el Peticionario no es el dueño de los terrenos someta además, un documento notarizado del dueño donde le autorice a realizar la actividad propuesta en la solicitud. En caso de sucesiones y comunidades de bienes gananciales, deberá presentarse una autorización notarizada de todos los co-propietarios del inmueble.
8. **Dirección del terreno donde se llevará a cabo la actividad** - Especificar el municipio, sector o barrio, urbanización o finca, carretera o calle, kilómetro y hectómetro o número de la propiedad. Incluya los puntos geográficos de referencia.
9. **Profesional de siembra**: Número PFS, nombre, dirección y teléfonos del profesional de siembra.
10. ☐ **Memorial Explicativo para el permiso -** Incluir un documento aparte que contenga lo siguiente:
    - ✘ Tipo de Proyecto (residencial, industrial, institucional, infraestructura u otros)
    - ✘ Descripción general del proyecto
      - i. Ubicación y extensión (área total y área a ser impactada), Zonificación, Hidrografía, Climatología, Topografía
      - ii. Descripción y clasificación de suelos
    - ✘ Metodología
    - ✘ Biodiversidad de organismos asociados a la vegetación
    - ✘ Descripción detallada de la biodiversidad de organismos asociados a la vegetación existente en el lugar mediante la utilización de parcelas o transectos y otros métodos para la caracterización de especies en el área de interés
    - ✘ Recomendaciones de manejo y conservación
      - iii. Especificaciones de manejo, transplante, poda y mantenimiento
      - iv. Plan de Siembra (desglosar la mitigación del proyecto según aplique e indicar las especies de árboles a utilizarse para la mitigación del proyecto)
11. ☐ **Enmienda, Actualización o Reconsideración -** Incluir explicación y descripción en documento aparte.
12. ☐ **Apéndices**
    - ✘ ☐ Dos (2) fotos de cada árbol (si son menos de 10) y Foto aérea (si son 10 o más) La foto aérea puede ser adquirida en la Autoridad de Carreteras y Transportación.) Delimitar clara y exactamente sobre la misma el sitio propuesto
    - ✘ ☐ Inventario de árboles
      - i. Número de identificación, nombre común y científico, DBH – altura - condición, acción propuesta
      - ii. Especificar la metodología utilizada para realizar el inventario [por individuo o estimado (parcela, transecto)]
      - ii. Presentar el proceso numérico que se utilizó para determinar la cantidad de árboles en el proyecto
    - ✘ ☐ Plano de mensura con localización de los árboles (utilizar la misma identificación del inventario y especificar la escala del plano)
    - ✘ ☐ Plan de siembra
    - ✘ ☐ Plano de siembra certificado (identificar con símbolos cada especie a utilizar, la escala del plano de siembra deberá ser igual que la escala en el plano de localización, si hay siembras fuera del proyecto incluir planos del área y de localización)
    - ✘ ☐ Plan de mantenimiento de árboles (según aplique) [Método de siembra, anclaje, procedimiento de transplante, mantenimiento (riego, fertilización, poda), control de plagas, medidas de protección para árboles a conservar]
    - ✘ ☐ Mapa topográfico

II. ☐ **Certificación de No Deuda -** Incluir certificación de no deuda con el **DRNA** por concepto de pago de franquicia de agua, regalías, multas, concesiones y /o autorizaciones, entre otras.

III. ☐ **Cargos por Presentación** - Toda solicitud deberá estar acompañada de un giro postal o cheque certificado a favor del Secretario de Hacienda **por la cantidad de _____ dólares ($___.00).**

IV. **Información adicional** - El Departamento solicitará información adicional cuando sea necesario para completar la evaluación de esta solicitud. Toda solicitud presentada en ORIGINAL y una (1) COPIA será ante el Departamento de Recursos Naturales y Ambientales o enviada por correo a la dirección indicada en el membrete, atención a Oficina de Secretaría.

En caso de dudas sobre esta solicitud, puede escribir a la dirección anterior o llamar a la Oficina de Secretaría al teléfono 724-8774, ext. 235 ó al 722-5489 o a la **División para el Manejo de Arboles** al 787-983-7202, 983-7224 ó 724-8774, ext. 2116, 2117, ó 2121

☐ Certifico que la solicitud **está completa** y tiene anejos todos los documentos complementarios necesarios para la presentación.

☐ Certifico que la solicitud **no está completa** y/o no tiene anejos uno o más de los documentos complementarios necesarios para la presentación.

En el encasillado de Cotejo se le indica la información y/o documento(s) que le faltan a la solicitud para poder ser tramitada.

Firma del Funcionario que recibe la solicitud	Número de Presentación (NUPE)	Fecha (Día – Mes – Año)

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES
PO BOX 906660 PUERTA DE TIERRA STATION - SAN JUAN, PR 00906-6600

SOLICITUD DE PERMISO PARA CORTE, PODA, TRANSPLANTE Y SIEMBRA DE ÁRBOLES

(ACCIONES INCIDENTALES A OBRAS)

PARA USO DEL DEPARTAMENTO SOLAMENTE

NÚM. DE PRESENTACIÓN (NUPE):	NÚM. DE RECIBO DE PAGO: (INCLUYA FOTOCOPIA DEL RECIBO)

TIPO DE SOLICITUD:	( ) Original (Nueva)	( ) Enmienda	( ) Exención	( ) Reconsideración

NÚMERO DE PERMISO:	NÚMERO DE RADICACIÓN ANTERIOR:	Fecha **Expedido**:	Fecha que **Vence**:

RESOLUCIÓN DE ARPE:	RESOLUCIÓN DE LA JUNTA DE PLANIFICACIÓN

INFORMACIÓN DEL PROYECTO

1- NOMBRE DEL PROYECTO:

2- ACTIVIDAD PARA LA CUAL SE SOLICITA EL PERMISO:

( ) Corte de Árboles ( ) Poda de Ramas ( ) Transplante de Árboles ( ) Siembra de Árboles
( ) Poda de Raíces ( ) Recuperación / Conservación ( ) Evaluación de Árboles ( ) Plan de Mitigación
( ) Otro **(Especificar)**:

3- PROPÓSITO: ( ) Agrícola ( ) Reforestación ( ) Otro **(Especificar)**:

( ) Desarrollo de terrenos ( ) Comercial ( ) Industrial ( ) Infraestructura de Gobierno ( ) Institucional ( ) Recreacional

4- LOCALIZACIÓN: ( ) Área pública ( ) Área privada ( ) Urbana ( ) Rural

5- INFORMACIÓN DEL PETICIONARIO : (De no ser el dueño, acompañar autorización escrita por el dueño para solicitar dicha actividad)
Nombre Peticionario:

Dirección Física:

Dirección Postal:

Teléfono:	Celular:	Fax:	Email:

6- PERSONA AUTORIZADA A DAR SEGUIMIENTO A ESTA SOLICITUD:

7- INFORMACIÓN DEL DUEÑO o el Representante si es una Corporación, Agencia o Institución (De ser la misma persona que el Peticionario, indique IGUAL-PETICIONARIO)
Nombre:

Dirección Física:

Dirección Postal:

Teléfono:	Celular:	Fax:	Email:

8- DIRECCIÓN DEL TERRENO donde se llevará a cabo la actividad (De ser la misma dirección física del Peticionario o propietario, indique IGUAL-PETICIONARIO, IGUAL-PROPIETARIO) - (Incluya copia de la escritura de la propiedad)

Municipio	Sector/Bo.	Urb./Finca	Carretera/Calle	Km./Núm.	Hm.

9- INFORMACIÓN DEL PROFESIONAL DE SIEMBRA: **Número del PFS:**
Nombre:

Dirección Postal:

Teléfono:	Celular:	Fax:	Email:

10- MEMORIAL EXPLICATIVO *(Incluir en Documento Aparte)*

11- ENMIENDA, ACTUALIZACIÓN O RECONSIDERACIÓN *(Explicar y describir en Documento Aparte)*

AUTORIZACIÓN

Autorizo al personal del Departamento de Recursos Naturales y Ambientales, debidamente identificado, a entrar a inspeccionar la propiedad con el propósito de evaluar esta solicitud.

Certifico que la información aquí expuesta es correcta, según mi mejor saber y entender.

Nombre del Peticionario o Representante Autorizado (Título o posición que ocupa (si aplica))	Firma	Fecha (Día – Mes – Año)

Appendix U: Soil Removal Permit

Formulario_DRNA-CT-SPIA-003-Rev_27-04-2005.doc

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES
PO BOX 906660 PUERTA DE TIERRA STATION - SAN JUAN, PR 00906-6600

HOJA DE COTEJO Y REQUISITOS DE PRESENTACIÓN PARA LA SOLICITUD DE PERMISO DE ACTIVIDADES INCIDENTALES A UNA OBRA AUTORIZADA POR ARPE

Este tipo de permiso aplica a las actividades de extracción, excavación, remoción y dragado de los componentes de la corteza terrestre incidentales a obras autorizadas por la ARPE, siempre y cuando cumplan con lo siguiente:

1. Que el movimiento de la corteza terrestre sea incidental a una obra tramitándose ante la ARPE y que ésta haya obtenido al menos, la aprobación de Desarrollo Preliminar o tenga una Consulta de Ubicación aprobada por la Junta de Planificación y esté para la consideración de un permiso de obras (entiéndase: Permiso de Construcción, Permiso de Urbanización o Permiso de Movimiento de Tierras, o según disponga la ARPE).
2. Que la actividad propuesta se lleve a cabo en terrenos privados o en cauces privados de cuerpos de agua sitos en terrenos privados o en terrenos patrimoniales del Estado.
3. Que la actividad propuesta no sea en bienes de dominio público.

Del uso del material excedente destinarse a la venta comercial, la actividad deberá ser autorizada bajo un Permiso Formal.

Toda solicitud de Permiso de Actividad Incidental a una Obra Autorizada por la ARPE debe presentarse personalmente en la Oficina de Secretaría o en la Oficina Regional correspondiente del Departamento o en el Centro de Trámite. Cuando la información solicitada no aplique escriba N/A en el recuadro de cotejo. Escriba en letra de molde o maquinilla. La solicitud oficial no podrá ser alterada o modificada. Deberá llenar todos los incisos y deberá cumplir con lo siguiente:

Cotejo

1. ☐ Llenar en todas sus partes el formulario de solicitud para Permiso Incidental a una Obra Autorizada por la ARPE, debidamente firmado por el peticionario. Deberá acompañarse con un expediente que contenga los documentos presentados, debidamente identificados y con un índice de referencia.
2. ☐ Pago, por concepto de presentación de la solicitud, según el desglose de costo en la siguiente tabla, en cheque certificado o giro postal a favor del Secretario de Hacienda. Del peticionario ser un municipio o instrumentalidad pública, cuya acción solicitada sea de naturaleza de interés social y de bienestar público, este pago será el cincuenta por ciento (50%) de lo expresado en la tabla. Este pago reducido también aplicará a compañías privadas que proponen efectuar obras de dicha naturaleza a nombre de un municipio o de una instrumentalidad pública, siempre y cuando la solicitud venga acompañada de una carta del alcalde o jefe de agencia solicitando el mismo.

COSTO ESTIMADO DEL PROYECTO (SEGÚN CERTIFICADO ANTE LA ARPE)	PAGO POR CONCEPTO DE PRESENTACIÓN SOLICITUD
$1 A $250,000	**$75.00**
$250,000 A $1,000,000	**$375.00**
MAYOR DE $1,000,000	**$750.00**

3. ☐ Memorial explicativo donde se describa detalladamente el propósito de la actividad propuesta, indicando: la cantidad y tipo de material a ser extraído, excavado, removido y dragado; área a ser impactada; el equipo y la maquinaria a utilizarse; descripción del método operacional; descripción del área de almacenaje; indicar si habrá acarreo de material fuera del predio aprobado por la ARPE para realizar el proyecto y el uso y manera en la cual se dispondrá del mismo.
4. ☐ Copias de la sección correspondiente del cuadrángulo topográfico del USGS (1:20,000), debidamente identificado, resaltando clara y exactamente la localización del proyecto.
5. ☐ Copia, debidamente firmada y sellada, de la autorización expedida por la ARPE para la obra o la aprobación a la Consulta de Ubicación expedida por la Junta de Planificación vinculada al trámite ante la consideración de la ARPE.
6. ☐ Copia del endoso al proyecto otorgado por el Departamento a la obra, si aplica.
7. ☐ En caso de utilizar explosivos, deberá especificarlo y presentar la información de apoyo necesaria o cumplir con lo dispuesto en el Artículo 11 del Reglamento para Regir la Extracción, Excavación, Remoción y Dragado de los Componentes de la Corteza Terrestre.
8. ☐ Copia de la certificación de cumplimiento con la Ley Sobre Política Pública Ambiental, expedida para el proyecto por la JCA.
9. ☐ Documento debidamente notariado del peticionario autorizando a otra persona (Agente o Consultor) a que en su nombre y representación solicite o tramite esta solicitud de permiso ante el Departamento, si aplica.
10. ☐ Copia, debidamente firmada, de cualesquiera otros permisos, endosos o autorizaciones relacionados con la actividad propuesta, otorgados por otras Agencias, Autoridades, Departamentos o Corporaciones Públicas del gobierno estatal, municipal o federal.
11. ☐ De haber acarreo de material excedente con fines de depósito, se deberá presentar una declaración jurada debidamente notariada de la persona o entidad que aceptará el depósito de material en sus predios y la correspondiente autorización y endoso expedido por las agencias concernidas, si aplica.
12. ☐ Certificación negativa de deuda con el Departamento por concepto de pago de franquicias de agua, regalías, multas, concesiones y autorizaciones, entre otras. También se podrá presentar evidencia de un plan de pago, que haya sido aceptado por el Secretario y que esté al día.
13. ☐ El Secretario, o su representante autorizado, podrá solicitar cualesquiera otros requisitos adicionales que estime necesarios y convenientes por consideraciones a la salud, a la seguridad, al orden o interés público; así como, para cumplir con los factores de evaluación requeridos por el Artículo 4 de la Ley Núm. 132 de 25 de junio de 1968, según enmendada.

☐ Certifico que la solicitud **está completa** y tiene anejado todos los documentos complementarios necesarios para la presentación.
☐ Certifico que la solicitud **no está completa** y/o no tiene anejado uno o más de los documentos complementarios necesarios para la presentación.
En el encasillado de Cotejo se le indica la información y/o documento(s) que le faltan a la solicitud para poder ser tramitada.

Firma del Funcionario de Secretaría o Subsecretaría	Número de Presentación (NUPE)	Fecha (Día – Mes – Año)

ESTADO LIBRE ASOCIADO DE PUERTO RICO
DEPARTAMENTO DE RECURSOS NATURALES Y AMBIENTALES
PO BOX 906660 PUERTA DE TIERRA STATION - SAN JUAN, PR 00906-6600

SOLICITUD DE PERMISO DE EXTRACCIÓN INCIDENTAL A UNA OBRA AUTORIZADA POR ARPE O DE INFRAESTRUCTURA EXENTA DE LA APROBACIÓN DE ARPE

PARA USO DEL DEPARTAMENTO SOLAMENTE	
NÚM. DE PRESENTACIÓN [NUPE]:	NÚM. DE RECIBO DE PAGO: (INCLUYA FOTOCOPIA DEL RECIBO)

EXTRACCIÓN INCIDENTAL A UNA OBRA:

☐ AUTORIZADA POR ARPE	☐ DE INFRAESTRUCTURA EXENTA DE LA APROBACIÓN DE ARPE

TIPO DE SOLICITUD:

☐ ORIGINAL (NUEVA)		☐ ENMIENDA	
NÚM. PERMISO:	**NÚM. PRESENTACIÓN ANTERIOR:**	Fecha **Expedido**:	Fecha de **Vencimiento**:

A. INFORMACIÓN DEL PETICIONARIO, AGENTE, CONSULTOR O REPRESENTANTE AUTORIZADO

Nombre del Peticionario (incluya ambos apellidos):			
Profesión:		Núm. Licencia Profesional:	
Dirección Física:			
Dirección Postal:			
Teléfono	Celular	Fax	Correo Electrónico (e-mail)
Nombre del Agente, Consultor o Representante Autorizado (incluir documento notariado):			
Nombre del Propietario/Titular del Terreno:			
Dirección Residencial:			
Dirección Postal:			
Teléfono	Celular	Fax	Correo Electrónico (e-mail)

B. INFORMACIÓN DEL LUGAR DE EXTRACCIÓN

LUGAR DONDE SE PROPONE LA EXTRACCIÓN:		
Carr. Núm.		
Km.	Hm.	
Sector		
Barrio		
Municipio:		
Acceso (Explique) :		
COORDENADAS LAMBERT (CENTROIDE – NAD83)	**X**	**Y**

C. DATOS SOBRE LA EXTRACCIÓN

CABIDA TOTAL DE LA FINCA:	cuerdas	m^2
CABIDA DEL ÁREA DE EXTRACCIÓN:	cuerdas	m^2

TIPO DE MATERIAL A EXTRAERSE:

☐ Arena de Río	☐ Arena de Playa	☐ Arena Sílice	☐ Arena Granodiorítica
☐ Grava	☐ Roca Ígnea	☐ Serpentina	☐ Roca Caliza
☐ Capa Vegetal	☐ Otro material (Especificar):		

CANTIDAD A EXTRAER m^3

USO DE EXPLOSIVOS ☐ Sí ☐ No

MATERIAL EXCEDENTE: ☐ Sí ☐ No

LUGAR DE DISPOSICIÓN DE MATERIAL EXCEDENTE :

AUTORIZACIÓN

Autorizo al personal del Departamento de Recursos Naturales y Ambientales, debidamente identificado, a entrar a inspeccionar la propiedad con el propósito de evaluar esta solicitud.

DECLARO que la información suministrada por el suscribiente o poderdante, es verídica y ofrecida de la mejor buena fe.

ADMITO que el DRNA no tiene el deber de concederme el permiso y que su aprobación dependerá de la evaluación que se haga del mismo.

RELEVO al DRNA de cualquier responsabilidad legal por cualquier error en la aprobación del permiso, resultante de cualquier información falsa suministrada u omitida por el suscribiente.

Nombre del Peticionario o Representante Autorizado	Firma	Fecha (Día – Mes – Año)

Appendix V: Completed Agroforestry Assessment

1. Existing conditions
    a. As long as the farmer grows naturalized plants that already grow in the forest, should not have an issue with their cultivation. The area is lush with vegetation, showing that there is clearly enough nutrients for the plants to grow. A grower will need to worry about competition from other plants as it is a very competitive environment. This may require a small amount of management of lower shrubs but must be done using proper conservation techniques. Lastly, the remoteness of the forest in this section reduces the issue of interference from tourists or outsiders. However, the sites are right out of the backyard of the farmers, making access for them easy.
2. Type of agroforestry
    a. This will vary widely throughout, depending on the farmer's desires and the locations conditions. If open like the location for the bees (the first site visited), a farmer may have the opportunity to alley crop and grow on multiple vertical levels. However, when growing like the majority of sites in the unmanaged forest, forest farming will have to be used. If there is bodies of water that the farmer is encountering, riparian buffers may also be possible.
3. Size of the proposed location
    a. There are over 6216 acres zoned for this type of land management, however most of the farmers are small farmers, and based on discussion with Sr. Rivera and Sr. Cano , best to start this as small side projects so that the farmer can continue growing their current crops. The forest is also thick and unmanaged, making a large scale project harder to undertake. If the industry becomes rooted and the branding grows, there will be an opportunity to expand the forest farms.
4. Local support
    a. The local support will vary from region to region and farmer to farmer. The team did not have the time or resources for multiple indepth focus groups but based on the workshops the U.S. Forest Service already conducted, there are farmers along the border of El Yunque who are willing help start this industry. The more successful the industry is, the more local support will join.
5. Plant possibilities
    a. We reduced the list to naturalized, noninvasive plants that local farmers had suggested they want to grow as well as plants that will grow well under these conditions. The focus is on non-traditional fruits, vegetables, medicinal plants, mushrooms, and orchids.
6. Labor availability
    a. The unemployment in Puerto Rico is very high, meaning there are people without jobs that could work this agricultural industry. However, not many people may be willing to work labor intensive jobs such as this, as discussed with Carmen Santiago, the soil specialist at the NRCS and Hilda Bonilla of the Agricultural Extension Service. This will not be a factor if the projects are just small side projects for farmers but will be if the industry grows.

7. Crop processing requirements
    a. The team will focus only on plants that have low crop processing requirements. By this, it is meant that the crop will not have to be sent to a processing plant before sale, as is required with things such as coffee. Rather, the plant list will be kept to only processing that most farmers can do themselves, such as washing or peeling.
8. Laws and regulations
    a. The land management policy of the U.S. Forest Service allows for use of forest for this agroforestry purpose as long as proper conservation and cultivation techniques are used.
9. Invasiveness of possible crops
    a. Any crop that is invasive will not be included on the list.

Appendix W: Revised List of Plants

Miscellaneous

- **Honey**
- **Taro**
- **Parsley***

Fungi: Grown on Hardwood trees/logs

- **Shiitake (Florida 55)**
- **Hen of the Woods**
- **Golden Chanterelles**
- **Black trumpets**
- **Oyster**

Legumes

- Asparagus beans

Vegetables

- **Scallions**
- **Bell Pepper****
- Pak Choy

Orchids

- **Vanilla**
- **Ornamental Plants**

Trees

- Mamey sapote
- Fruit trees
- Guayusa (long term)

*Need for Nitrogen

** Could not find research on it working under tree cover but study showed they grew better with 30% more shade (with cover)

Bolded items were also found in supermarkets in Puerto Rico

Appendix X: Final Recommended List of Plants and Chart of Additional Information

Cross-referenced plant list (Plants both recommended and currently sold in stores)

Miscellaneous

- Parsley
- Honey
- Taro

Fungi: Grown on Hardwood trees/logs

- Shiitake
- Hen of the Woods
- Chanterelles
- Black trumpets
- Oyster

Vegetables

- Scallions
- Bell Pepper

Orchids

- Vanilla
- Ornamental Plants

Recommended Focus List (plants with the best chance of success

Miscellaneous

- Parsley

Fungi: Grown on Hardwood trees/logs

- Shiitake
- Hen of the Woods
- Chanterelles
- Black trumpets
- Oyster

Vegetables

- Bell Pepper

Additional information for recommended plants:

Table 4: Growing requirements for recommended plants

Plant	Where it is grown	pH requirement	Water requirement	Climate requirement (°F)
Taro	Soil	5.5-6.5	Well drained	70-80
Parsley	Soil	5.6-7.5	Well drained	75
Shiitake Mushroom	Tree	6	Well drained	50-85
Hen of the Woods	Tree	5.5-6.0	Well drained	70-85
Chanterelles	Tree	4.0-5.5	Well drained	tropical
Black Trumpets	Soil	5.5-6.5	Well drained	tropical
Oyster Mushrooms	Tree	3.0-7.0	Well drained	tropical
Asparagus Beans	Soil	6.5-7.5	Well drained	70-80
Scallions	Soil	6.0-6.5	Well drained	55-75
Bell Pepper	Soil	6.0-7.0	Well drained	>70
Pak Choy	Soil	6.5-7.0	Well drained	60-75
Vanilla	soil	~ 7.0	Well drained	75-80

Appendix Y: Criteria for Determining Successful Market Location

1. Population Density
2. Ease of access
3. Visibility to the passerby
4. Amount of traffic that travels by
5. Near or in location with other stores and activities that people would attend
6. Near or in already established public gathering area

Appendix Z: Preliminary Seal Design

Figure 13: Preliminary seal design

Design by: Kirsten Dessert

Appendix AA: Website Outline

About the Project

Team Bio

A team of five students from Worcester Polytechnic Institute (WPI), located in Worcester, MA spent two months living in Puerto Rico and working on a project required as a part of their studies at the university. The team worked with the U.S. Forest Service to provide a set of recommendations for the development of an agroforestry industry in El Yunque National Forest.

Figure 14: The project team, from left to right, with names and area of study: Tom Harless (Chemical Engineering), Lindsey Wilson (Chemical Engineering), Andrea Caprio (Civil Engineering), Rachel Hesse (Biomedical Engineering), Greg Kornichuk (Civil Engineering).

U.S. Forest Service and Their Mission

- The U.S. Forest Service works in El Yunque National Forest and focuses on the preservation of the land. It promotes the use of the land for agricultural projects, but maintains a focus on the conservation of the environment and the ecosystem.

Figure 15: U.S. Forest Service logo

Agroforestry

What is it?

Agroforestry is a type of agricultural land management policy that combines crops, trees, and livestock. This form of land management strives to reduce the impact that agriculture often has on the environment. The land-use becomes more sustainable and benefits both the farmer and the ecosystem. Interactive benefits between the combination of crops, trees, and livestock are taken advantage of. There are multiple methods within agroforestry including forest farming, alley cropping, silvopasture, and riparian buffers.

Why is it Special?

By combining crops, trees, and livestock as well as taking advantage of the benefits that are realized, both the farmer and the environment are left better off. Agroforestry allows for minimal deforestation and a more natural growing environment. Agroforestry reduces the monoculture that is currently on most commercial farms resulting in less need for pesticides. There is also an increase in the amount of biomass on the farm, helping to introduce more organic material and nutrients into the soil. If planted correctly, agroforestry can also allow for multiple vertical levels of growing, increasing the farmers crop yield and income.

Why was it Used for this Project?

A central theme of this project is that no harm can be done to El Yunque from the growing of any products. For this reason, agroforestry was the natural land management policy to assure no harm was done. The use of agroforestry will allow for no deforestation or trimming of the canopy and no disturbance to the wildlife living in the area while the products grow. The only disturbance will be from the farmer planting and harvesting the products, a very minimal amount of disturbance.

Different Methods

<u>Forest farming</u>

Forest farming is the central focus of this project and is relatively self-explanatory. In this method, the farmer goes out into a natural, unmanaged forest and plants crops on the forest floor where there is space. These crops must be tolerant of the shade for this to be successful. The benefit of this method is that there is little to no disturbance to the forest. The downside is that crop possibilities can be limited due to the shade and the competition with existing vegetation.

Figure 16: Example of forest farming

Alley cropping

Alley cropping is best used when the land is already been cleared. Trees and crops are planted in alternating rows. While the trees are small and immature, the crops will need to be tolerant of a lot of sun. As the canopy forms above them, the farmer will have to switch to more shade tolerant crops. The trees themselves can and should be fruit bearing, providing additional crops for the farmer to sell. Advantages of this system are that it increases the biomass over traditional farming, helps with erosion as the trees act as water breaks, and creates multiple levels of crop production. The disadvantages are that the land will need to be cleared first and that there are large start-up costs with a long time for return on the investment.

Figure 17: Example of alley cropping

Silvopasture

Silvopasture is the same idea as alley cropping with trees in rows but rather than crops, grass and livestock are raised below. The advantage of this system is that the trees help protect against erosion in the pasture as well as continue absorbing greenhouse gases. There are not many disadvantages except for the cost of planting trees if there are not any already existing.

Figure 18: Example of silvopasture

Riparian Buffers

Riparian buffers are buffers of grasses and plants that are grown along the edges of rivers and water bodies to help reduce the amount of runoff from the fields. These fields often contain fertilizers and pesticides that will end up in the oceans and have negative effects on aquatic wildlife. The riparian buffers help to block this water and allow it to infiltrate through the ground, the soil acting as a filter. These buffers can also add to a farmer's productivity if the chosen plants also produce crops. The advantages are decreased runoff, decreased erosion, and increased crop yield. There again are no real disadvantages other than the cost of planting and maintaining the buffers.

Figure 19: Example of riparian buffers

Agriculture in Puerto Rico

The Problem

Currently Puerto Rico imports over 85% of the food it consumes. This is mainly due to a lack of sustainable agricultural production on the island; the agriculture sector only accounts for 2.1% of the labor force and 0.7% of the island's Gross Domestic Product (GDP). However, experts have found that the island currently has the capability of producing nearly 45-50% of its food consumption and projected that in the future, it has the potential to grow and produce almost 90% of the food it requires if farmers take advantage of all available resources.

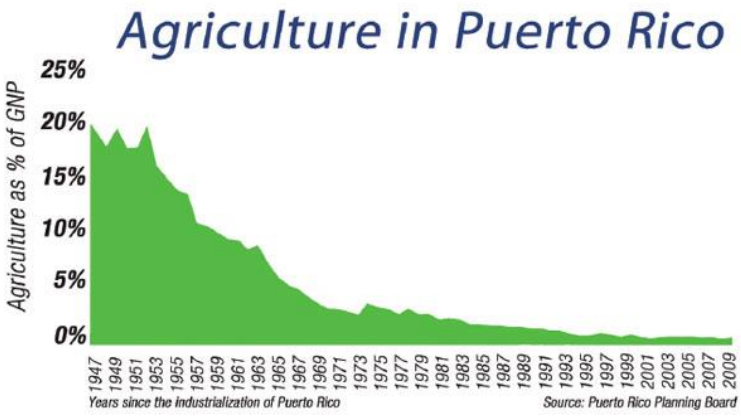

Figure 20: The decline of agriculture in Puerto Rico since the 1940s, shown in percentage of the gross national product

The Need and Desire to be Self-Sufficient

When locals were informed of the pending agroforestry project and asked for their opinion, all of them were very excited about the possibility of becoming more food self-sufficient and all were interested in supporting locally grown food. Puerto Rico's food supply is extremely dependent on the shipping and trade industry. If something were to happen to the supply chain, Puerto Rico's food supply would be completely exhausted in three weeks. Therefore, becoming more food self-sufficient would reduce this risk while boosting the island's economy and independence.

Possibility to Reduce Unemployment

Another major benefit of establishing a new agroforestry industry is that it has the potential to combat the unemployment issue that currently plagues the island. Although the industry is currently intended to consist of small, on the side projects for farmers adjacent to the forests borders, it has the potential to grow and become a large, very profitable industry. This will require a large workforce when larger and larger farms become dedicated to agroforestry practices and the amount of food produced on the island increases. The potential for more jobs could positively impact the entire region of Puerto Rico by decreasing unemployment and poverty percentages across the island.

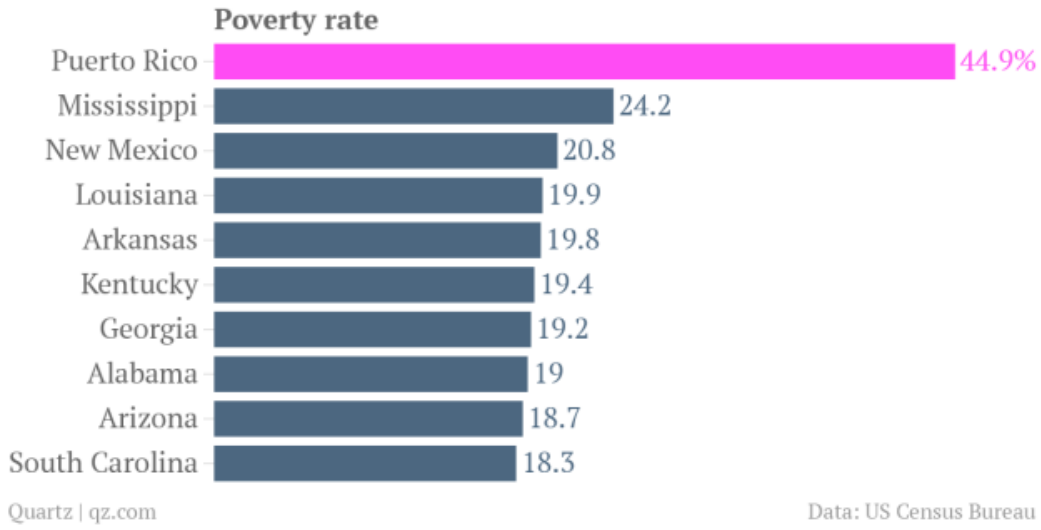

Figure 21: Comparison of poverty rates between Puerto Rico and U.S. states with high poverty rates

The Brand

El Yunque Natural

Figure 22: Example of a preliminary seal or brand to be placed on products when sold at the market.

About the brand

El Yunque Natural is a new brand that was developed from the agroforestry industry in El Yunque National Forest. All of these products are grown in an agroforestry setting, which benefits the environment as well as the economy.

Why Purchase this Brand?

This unique brand is both locally grown and natural. The natural and organic products are not grown using any synthetic chemicals (fertilizers and pesticides), which provides benefits for the health of the consumer and also the preservation of the environment. The other major specialty of this brand is that all products are grown locally. All products are grown on farms located in El Yunque National Forest, in an attempt to foster self-sustainability in Puerto Rico. As this industry grows, it will provide more jobs for the unemployed and also require Puerto Rico to import less food and be less dependent of other countries for food.

Where Does your Food Come From?

Importance of Knowing your Farmer

A major benefit of this new industry is the opportunity to know your farmer and where your food comes from. When products are sold in large, chain supermarkets this isn't always possible, so the consumer doesn't know everything about the product they are buying. However, when products are sold in farmers markets, it gives the consumer the opportunity to connect with the farmer and learn how the products are grown and handled. This allows the consumer to make more informed choices about the food they are eating while still supporting locally grown food. Consumers will know that their food is safe and of the highest quality, which is something that cannot be guaranteed when buying food that is imported.

Farmer Bios and Contact Info (to buy directly)

- If you are unable to attend the farmers market where these new products will be sold, the following is a list of farmers who are working in this new industry and their respective biographies:
    - Insert farmer bios and contact information here

Interested in Farming?

This section is designated for locals who are interested in becoming a part of the agroforestry industry. After continued research, the following sections should be included:

- Contacts of farmers who need employees
- Start-up plans
- U.S. Forest Service contacts
- Department of Agriculture contacts
- People that repossess farms (USDA FSA – Farm Services Agency)

The contacts of farmers will allow people who are interested in farming, but are not landowners, be able to become a part of the industry. Start-up plans will help landowners start their own agroforestry on their land. U.S. Forest Service contacts will be available for people who wish to start agroforestry within El Yunque's borders. The section Department of Agriculture will include contact information of who to contact about farming. Finally, people that repossess farms will include contact information for the FSA that interested people can purchase repossessed farms from.

Land Management Policies

This section will be used to inform users of important land management policies.

Agricultural Incentives

The Environmental Quality Incentive Program (EQIP) is a program sponsored by the Natural Resources Conservation Service (NRCS) that provides technical and financial support to agricultural producers to aid the planning and implementation of conservation practices in these agricultural areas. The purpose of EQIP is to help agricultural producers meet Federal, State, and local environmental regulations. The Farm Bill legislation passed in 2008 provides a budget for EQIP in order to promote forest management and energy conservation and practices related to organize production and fuels management. Funding for each fiscal year grows each year. It was $1.2 billion in 2008; $1.337 billion in 2009; $1.45 billion in 2010; $1.588 billion in 2011; and $1.75 billion in 2012 (Natural Resource Conservation Service, 2013).

Land owners engaged in agricultural, forest, or livestock production are eligible to apply for participation in the EQIP program, and eligible land includes cropland, rangeland, pastureland, private non-industrial forestland, and other farm or ranch lands. NRCS works with the participants to develop the EQIP plan of operation, this plan being the basic contract between the participant and NRCS. Payments made to landowners under these contracts can be made up to 10 years in duration.

Organic Certification

The main, most recognized form of organic certification is USDA Organic. While this is the goal for many farmers, it is not always possible due to certain restrictions such as the cost or the certification process.

> USDA Definition of Organic: "Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony."

There are other organic certifications that can be used as intermediate steps to gain USDA Organic status. The main certification in Puerto Rico is known as Certified Boricuá. This agency was the first Puerto Rican specific organic certification. It is aimed at small farmers who are looking to sell locally as well as those hoping to make the jump to USDA Organic.

USDA Certification Process

The organic regulations for the USDA are written in 7 CFR Section 205. This federal law contains all the standard and prohibited practices involved in Organic Certification. These rules are summarized for easier reading in the National Organic Program (NOP) handbook. This hand book is available electronically at the link below as well as in paper copies upon request to the USDA.

http://www.ams.usda.gov/AMSv1.0/ams.fetchTemplateData.do?template=TemplateR&navID=NationalOrganicProgram&leftNav=NationalOrganicProgram&page=NOPProgramHandbook&description=Program%20Handbook&acct=noppub

To become certified by the USDA, a third party certification agency must visit the farm and certify it. There are five agencies in Puerto Rico, including one located at the University of Puerto Rico. The cost of this certification can range from a couple hundred dollars to a couple thousand dollars. However, if the certification is completed and approved, the farmer can apply for cost sharing, receiving up to 75% of the cost back.

Once the farmer applies to the USDA accredited certifying agent, they will be asked for

- Farmers must be recertified annually
- A detailed description of their operation
- A three year history of all substances applied to the ground
- A list of the organic products grown, raised, or processed
- A written organic system plan describing the practices and substances to be used, including:
    - Crops to be grown
    - Farm Acreage—amount of acreage to be organically grown
    - Source of the seeds and plants
    - Maintaining soil fertility
    - Preventing pest outbreaks
    - Controlling weeds
    - Managing diseases
    - Sales and marketing

The USDA also provides a guide for farmers who are thinking of becoming organically certified. This guide for organic crop producers can be found at the link below.

http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5101542

A certifying agent must be contacted to begin the application process. Farmers can search for certifying agencies based on location at the link below.

http://apps.ams.usda.gov/nop/

Boricuá Certification Process

The Boricuá Certification process is not quite as in-depth as the USDA process. However, it will still require time and effort by the farmer. The certification is renewable every 12 months. Inspections are completed by members qualified by the Independent Organic Inspector's Association (IOIA). The farmer must fill out and submit an application to Boricuá, found at the link below.

http://organizacionboricua.blogspot.com/p/certificacion-boricua.html

Boricuá then handles assigning a qualified certification agent to the farm. Multiple documents in the application must be delivered to the Certification Committee of the Boricuá Organization who will review the paperwork and determine if the farmer is a good candidate. A physical inspection will then occur to determine if the farmer will be certified or not.

Cooperatives

What is a Farmers Cooperative?

The Merriam-Webster dictionary defines a cooperative as "a business or organization that is owned and operated by the people who work there or the people who use its services." In this case, a farmers cooperative is an organization owned and operated by the farmers who are members where they can receive support and share resources among one another. Benefits of being part of a cooperative include: negotiating power, price advantages, support from other members, access to a greater amount of resources, and the offset of production to provide continuous income throughout the year.

Interested in Getting Involved in One?

- **Comisión de Desarollo Cooperativo de Puerto Rico**
- **Public meetings they could attend**

Farmers Markets

Benefits of a Farmers Market Over a Supermarket

- Locally grown
- Organic
- Know your farmer
- Fresher, guaranteed quality food
- Specialty products

Markets in the Area

Here information of markets in the area will be kept so that others can find local markets. Below is a preliminary list of markets after discussions with farmers market operators.

Mercado Agricola Natural
Saturdays; 8:00 am- 1:00 pm
Museo de San Juan: Norzagaray St #150

Placita Roosevelt
Every other Sunday
Calle ING Arturo Idrach
San Juan, Puerto Rico 00918

Plaza Las Americas
Thursday-Sunday
525 Ave. F.D. Roosevelt
San Juan, Puerto Rico, 00918

El Mercado Urbano
The first Sunday of every month
9:00 am-5:00 pm
La Ventana al Mar
Condado

Recipes

Here you can find a few recipes you may be interested in trying with the products that have been grown by el Yunque Natural. This is another option that the suggested QR code could bring the smartphone user to. It gives them a variety of ideas on how to prepare the product.

Chanterelle, Bell Pepper, and Bacon Pasta

Ingredients:

1. 250 g pasta
2. 140 g bacon, diced
3. 1 yellow bell pepper
4. 1 yellow onion, coarsely chopped
5. 1 garlic clove, minced
6. 200 g golden chanterelles, cleaned and cut into smaller pieces
7. 300 ml cream
8. 100 ml parmesan, grated
9. 1 tbsp fresh Parsley, finely chopped
10. black pepper

Directions:

1. Boil the pasta until tender, drain
2. Fry bacon, bell pepper, onion and garlic for a few minutes. The bacon should get crispy and the pepper should soften.
3. Remove to a plate and set aside
4. In the same pan, fry the mushrooms until they've released all their liquid and started to brown a bit.
5. Add back the bacon and vegetables, and then add the cream. Let bubble for a few minutes.
6. Add the pasta and the parmesan, and cooking water if it's too thick.
7. Season with black pepper and fresh Parsley.

Wild Mushroom and Bell Pepper Sauté

Ingredients:

1. 1/4 cup (1/2 stick) butter
2. 2 small red bell peppers, cut into bite-size triangles
3. 2 small orange bell peppers, cut into bite-size triangles
4. 8 ounces oyster mushrooms (cut large mushrooms into thirds)
5. 3 tablespoons fresh parsley
6. 3 ounces soft fresh pepper-coated goat cheese, crumbled

Directions:

1. Melt butter in heavy large skillet over medium heat
2. Add bell peppers and sauté until tender, about 8 minutes
3. Stir in mushrooms. Season to taste with salt and pepper.
4. Sauté until mushrooms are golden brown, about 5 minutes.
5. Mix in Parsley; cook 1 minute.
6. Sprinkle with goat cheese and serve.

Quinoa Bowl

Ingredients:

1. 1 teaspoon organic canola oil or extra virgin olive oil
2. 1/2 jalapeno chopped(optional, to taste)
3. 1/2 green bell pepper chopped
4. 1/2 cup cooked/canned/Sprouted Chickpeas
5. 2-3 Tablespoons herbs of choice(I used fresh Parsley and a teaspoon of thyme)
6. a few oyster mushrooms
7. 1/3 teaspoon salt or to taste
8. 1.5-2 cups cooked quinoa

9. Additions: Add almond slivers, sunflower seeds, hemp seeds for an even more protein/nutritious punch

Directions:

1. In a medium pan, add oil and heat on medium.
2. Add the bell pepper and Jalapeno and cook for 2-3 minutes, uncovered, until slightly golden on the edges.
3. Add chickpeas, herbs and mix for a few seconds. You can add some greens at this point and mix in.
4. Add dried mushrooms, water, salt just enough to cover most of the veggies. (You can use vegetable broth instead of water for a thicker sauce)
5. Cover and cook on low-medium for 10 minutes.
6. The mushrooms will be soft by now, Break the mushrooms a bit and cook on low, uncovered, until the sauce simmers down to a few Tablespoons. (10-15 minutes).
7. Taste and adjust salt and spice. Add black pepper if needed.
8. Add the veggies and sauce to the quinoa bowl.
9. Top with fresh parsley, optionally with seeds and nuts and serve.

Fricasee of Chanterelles

Ingredients:

1. 6 tablespoons (3/4 stick) unsalted butter, divided
2. 2 tablespoons extra-virgin olive oil, divided
3. 1 small yellow onion, finely chopped (about 1 cup)
4. Kosher salt, freshly ground pepper
5. 3 garlic cloves, finely chopped
6. ¼ cup dry white wine
7. 1 pound chanterelles, brushed clean (halved if large)
8. ½ cup heavy cream
9. Pinch of freshly grated nutmeg
10. 1 teaspoon fresh oregano plus more for garnish
11. Fresh lemon juice
12. ¼ pound pappardelle, cooked al dente, or 1 pound boiled new potatoes

Directions:

1. Melt 3 tablespoons butter with 1 tablespoon oil in a large skillet over medium-high heat.
2. Add onion, season with salt and pepper, and cook, stirring occasionally, until softened and lightly golden, 4-5 minutes.
3. Add garlic and cook for 1 minute.

4. Stir in wine and cook until liquid is reduced by half, about 2 minutes.
5. Add remaining 3 tablespoons butter, remaining 1 tablespoon oil, and mushrooms.
6. Cook, stirring occasionally, until mushrooms are lightly golden, about 5 minutes.
7. Add cream and nutmeg and cook until slightly thickened, about 2 minutes.
8. Stir in 1 teaspoon oregano. Season to taste with salt, pepper, and lemon juice.
9. Toss in a skillet with cooked pasta, or serve over smashed boiled potatoes.
10. Garnish with oregano.

Crispy Oyster Mushrooms

Ingredients:

1. 2 packets (300g) of fresh oyster mushrooms
2. 2 eggs
3. 1 tsp salt
4. 150 plain flour
5. 50 g corn flour
6. 5g baking powder
7. Oil for deep frying
8. Garlic salt

Directions:

1. Mix together plain flour, corn flour, baking powder
2. Wash clean mushroom, cut lengthwise (remove the stem)
3. Dip mushrooms in the egg whites, drain
4. Put mushrooms in the flour mixture, make sure all are fully coated
5. Heat oil in frying pan, and deep fry until crisp
6. Remove from oil and drain, let cool
7. Sprinkle with garlic salt and toss well

Appendix AB: Completed Existing Conditions Assessment

1. Pitch of slope (average, measured in degrees)
    - Both sites were relatively flat. The first site at the location of the failed recreation area was almost completely flat. The second site was flat with a sharp increase in slope several hundred feet into the woods.
2. Accessibility (number and conditions of current roads)
    - One site was accessible by a 100 foot dirt road off a main route. The road was blocked by a steel gate to keep cars out. It was not located around any tourist areas so the farmer wouldn't have to worry about interference from outsiders but was still accessible.
    - The second site was closer to what the majority of sites will be. To access the site in the forest, we had to cross through the landowners or farmers property. The property was surrounded by a fence and a locked gate so outsiders would need to have an agreement with landowner. If it's not the landowner who abuts the forest isn't the one doing the farming, an outside farmer will have a hard time gaining access. If it is the landowner then the land is very accessible to them, only short walk out of their back yard.
3. Elevation (measured in feet above sea level)
    - The first site had an elevation of roughly 300 feet above sea level.
    - The second site had an elevation of roughly 600 feet above sea level.
4. Light conditions under the canopy (average, measured in foot-candle or lux)
    - Unable to secure a light meter to test the light conditions. Due to the forest being unmanaged, will only look at plants that grow well on forest floors in shade conditions for areas under the canopy.
5. Light conditions in the open (average, measured in foot-candle or lux)
    - Again unable to secure a light meter to test the light conditions. In the open, the plants will obviously have to like the sun.
6. Temperature conditions (average, measured in degrees Fahrenheit)
    - The average temperature in the forest is mid-seventies. At the lower elevations where the proposed sites are, up to 80s, plant will need to be able to handle heat.
7. Rainfall conditions (average, measured in inches)
    - On average, 60 inches annually on the lower outskirts of the forest. There are no measurements for the exact site location but an average for the area.
8. Soil Conditions (measured in a series of tests)
    - Soil conditions vary along the north, east, and south sides. Predominately, the soil in the rainforest is a clay base. There is no measurable amount of $CaCO_3$ anywhere in the areas under question, helps keep the soil neutral. Forest overall on the acidic side. The north side, to a one foot depth, contains 67% crital-zarzil, well-draining clay. Roughly 2/5 of the area has poor drainage but the rest is good.

- East side soil was a combination of crital-zarzil and humatas-zarzil, both well-draining clays.

9. Management of the Area
    - The first site was managed since it had been cleared for a recreation area. However this is not typical of most undeveloped sections of El Yunque. Most sites are similar to the second site that is completely unmanaged.

Glossary

Agroforestry – land management involving the growing of trees in association with food crops or livestock to create a diverse, profitable and sustainable land-use system

Alley Cropping – an agroforestry technique in which crops are grown in rows between newly planted trees so the trees can act as windbreakers and help eliminate soil erosion

Biodiversity – the existence of many different kinds of plants and animals in an environment

Carbon Sequestration – the process by which certain types of trees absorb carbon dioxide from the air to mitigate global warming and other dangerous effects of climate change

Easement – an agreement to use the property of a landowner without possessing it

Erosion – the gradual destruction of something by natural forces, such as the degradation and loss of soil due to the effects of wind or water flow

Forest Farming – an agroforestry technique that uses the cultivation of specialty crops under the canopy of an existing forest

Greenhouse Gas Emissions - gases in the atmosphere that absorb and emit thermal infrared radiation

Livestock Grazing – the feeding of animals, generally on grass in a large, open area

Logging – the process of cutting down trees for lumber or to clear land for other uses

Organic – Organic agriculture is an ecological production management system that promotes and enhances biodiversity, biological cycles, and soil biological activity. It is based on minimal use of off-farm inputs and on management practices that restore, maintain and enhance ecological harmony. The principle guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and that integrate the parts of the farming system into an ecological whole

Riparian Forest Buffers – a form of agroforestry in which trees or shrubs are planted along the banks of streams and rivers to protect the water quality by reducing the amount of sediment and chemicals entering the water

Shade-grown Coffee – a coffee plant that can be grown under a canopy of assorted trees

Shelterbelts – a barrier of trees and shrubs that protects crops from wind and storms to help lessen erosion (also see windbreak)

Silvopasture – an agroforestry technique that is similar to alley cropping but incorporates livestock instead of crops

Slash-and-burn – a process involving the cutting down and burning of plants and trees to clear an area of land for the growth of crops or other forms of agriculture

Superfund Site – an uncontrolled or abandoned place that has an abundance of hazardous waste that can be harmful to local people or ecosystems

Synergistic Relationship – an interaction between two or more agents such that the total effect is greater than the sum of the individual effects

United Nations Man and Biosphere Program - a collection of reserves around the world that innovate and demonstrate its approach of conservation and sustainable development by sharing ideas and experiences nationally, regionally, and internationally within the World Network of Biosphere Reserves

Urban Sprawl – the expansion of an urban area through the development of large stores, groups of houses, etc. in an area around a city that was formerly undeveloped

Windbreak – a barrier of trees and shrubs that protects crops from wind and storms to help lessen erosion (also see shelterbelt)