DEVELOPING SUSTAINABLE TEAK PRODUCTION IN BATIPA, PANAMA

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An Interactive Qualifying Project Proposal
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Introduction

The farming and production of teak, a tropical hardwood tree species, originated in the late 17th century in the country of Sri Lanka (Owen, 2018). Teak is native to southeast Asia, mainly in countries such as India, Indonesia, and Myanmar (Panama Teak and Forestry Inc., 2012). For hundreds of years that region of the world was the only area with teak farms until 1926 when teak farming spread to Panama's Summit Gardens, an area located approximately 15 miles north of Panama City (Hansen, 2017). Subsequently, growing teak gained popularity throughout Panama as people recognized its potential for economic growth and environmental development, and began investing in finding sustainable and efficient methods of production.

One particular organization which has multiple projects centered around the sustainable development of resources like teak is Oteima University. Located in the city of David in the Chiriquí province, Oteima is a multifaceted organization dedicated to the long-term development of Panama. The stated goal of the university is to "train leading professionals and entrepreneurs who are committed to the human and sustainable development of the country" (Oteima, 2017).

Oteima works towards this goal by overseeing programs like the Batipa Field Institute (BFI). The Batipa Field Institute, a subsidiary research organization of Oteima that operates a regional scientific center, aims to introduce a market for environmental services and ensure sustainable management of the Batipa region (BFI, 2014).

BFI manages a 1000-hectare area of teak farms established twenty years ago in Batipa (BFI, n.d.). The institute understands the improvement capacity of the plantation because the plantation is so new. To support its aim, BFI consistently makes an effort to improve the functioning of these teak farms.

BFI and Oteima collaborate to improve and expand their teak operation to assist the population of local farmers. Poverty impacts approximately one-fourth of Panamanians (CIA, 2018) and many lack access to education and an opportunity to improve their wellbeing. With few alternatives to make a living, poor farmers in Panama raze the forests and resultantly contribute to the loss of 30% of Panamanian forest cover (Forests of the World, n.d.). Observing this, BFI and Oteima plan to research the efficiency of teak farming to establish an effective operation and ultimately promote its viability to local farmers and those throughout Panama.

Previously, a different WPI IQP team worked with BFI and researched teak farming in Panama. The issues they addressed concentrated on finding "solutions for teak by-products, reconnecting wildlife corridors, and the sustainability of the Chiriquí Province through education" (Amato et al, 2018). The research of teak by-products and regional sustainability the WPI team conducted provides a strong basis for future research and expansion, specifically, focusing on teak production and further improving sustainability.

The goal of our project is to find the most productive while least invasive method of producing teak in the Batipa region. We plan to evaluate various aspects of teak farming including the effects of amendments and modifiers on the Batipa Peninsula soil, teak propagation methods, the effects of multiplication methods on the quality and performance of the teak, and how other tropical crops interact with the teak in order to gain maximum productivity. The main objectives of our project include in-depth research of the teak farm operations at all levels and to develop recommendations for BFI to improve the efficiency of such farms. This report discusses accomplishing these objectives through interviews with BFI employees, from the management of the farms down to those harvesting teak, and thorough data collection and analysis. Our research

results will lay a foundation of information for the BFI to improve the efficiency of their teak farms while staying environmentally conscious.

Background

Oteima University and the Batipa Field Institute

Universidad Tecnológica Oteima Formadores de Líderes, also known as Oteima University, is a technical school in Central America. Established in 1985, the university has expanded itself into a nationally recognized institution. Its main campus is located about 200 miles west of Panama City in David of the Chiriquí province. Oteima University prides itself in providing high quality education focused in the areas of science and technology. The university offers many educational opportunities, degrees, and specializations, providing the opportunity for a fuller development of the students and consequently for the industries of Panama. The range of topics available to study is broad and applicable to industry. Oteima offers many relevant degrees that would benefit local communities, like those in reproductive biotechnologies in cattle and in agribusiness, as well as in other general fields such as physics and English. Besides dedication to educational growth, a main focus of the university is developing the economy and technology of Panama.

To supplement this goal, Oteima has multiple other programs dedicated to research and development of regions across Panama. One of these research programs is the BFI in western Panama. The BFI "promotes education, research and entrepreneurship in the Panamanian western region with agroecology as a framework to foster interests and action for a sustainable development" (BFI, 2018). It provides unique and valuable opportunities for students of Oteima University. Located on the Batipa Peninsula, about fifteen miles east of David, the BFI is home to 2000 hectares of land.

Panama Wealth Inequality

Since the United States granted sole ownership and control of the Panama Canal to Panama in 1999, Panama's national wealth has surged. From 2014 to 2019, Panama saw a 5.6% average annual growth rate of the economy, making it one of the fastest growing economies in Latin America (The World Bank, 2019). However, this wealth is unequally distributed throughout Panama as the country has the second greatest income inequality in Latin America, with approximately one fourth of Panamanians living below the poverty line (CIA, 2018). The Panamanian government has implemented actions that significantly reduced the number of people living below the poverty line, but the income disparity is still quite large.

This economic inequality impacts those living in rural areas of Panama and indigenous peoples the most. In Panama, 31.6% of the population lives in rural areas and 12.3% of the population is Native American. The non-indigenous impoverished population that lives in rural areas has slowly made the transition from rural to urban labor, which has aided them in rising out of poverty (CIA, 2018). Common professions in rural areas are often in agriculture and labor fields. These professions unfortunately do not generate a lot of wealth. While most of Panama's GDP stems from services, such as banking, tourism, Panama Canal access, logistics and insurance, only 2.4% of the GDP comes from agriculture and 15.7% comes from industries, such as "construction, brewing, cement and other construction materials, sugar milling" (CIA, 2018).

Despite representing such a small percentage of the GDP, agriculture accounts for 17% of the labor force (CIA, 2018).

The Trickle Down of Local Lumber Industry

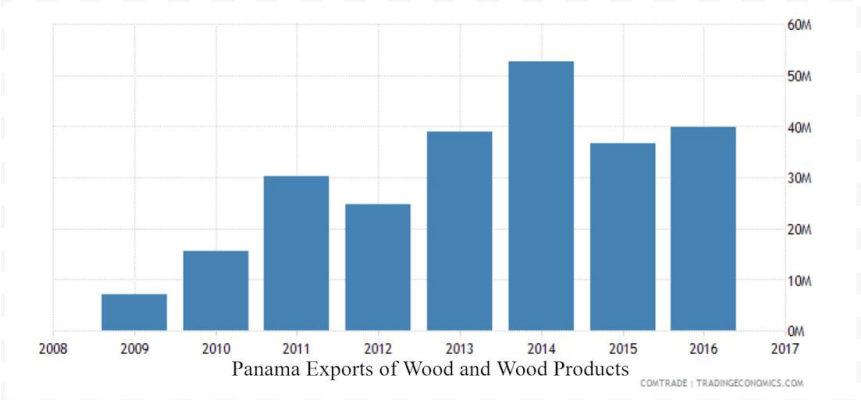

Figure 2.1 – Yearly Panama Exports of Wood and Wood Products

https://tradingeconomics.com/

The tree farming industry can benefit both local and national economies through the production and trade of lumber. Before lumber can be harvested for sale, farmers must first propagate the wood, which is a process to increase the number of plants by using a cutting of a parent plant. Then, the farmers plant the saplings. Lumbar, a particular type of teak, can take up to twenty-five years before reaching maturity. After reaching the proper age, workers cut down the trees with chainsaws and transport the logs to the back of trucks. The truck drivers bring the logs to a factory where machines remove the bark and cut the log into smaller and uniform planks. The logs then undergo a lengthy process of drying in kilns for up to a month to transform the planks from green wood to usable wood. After a final sanding, the wood planks are ready for sale (The Wood Technology Society, n.d.). On a national scale in Panama, the export of wood and wood products generated almost $40 million in 2016. The amount of wood exported from Panama has been steadily increasing over the past ten years, as seen in Figure 2.1 (Trading Economics, 2020). On a local scale, wood-related industries boost the economy either through the creation of jobs or through the access to materials. Artisans can use the wood planks to make furniture, bowls and cutting boards, or artwork, and building developers may use the planks for local construction projects.

Environmental Conditions of the Batipa Peninsula

The Batipa Peninsula, located on the southwestern edge of Panama (see Figure 2.2), covers an area of about 2000 hectares. BFI oversees this area, dedicating 1000 hectares to growing teak, 600 hectares to wildlife preservation, and 400 hectares to pastures and cattle (BFI, 2014). Classified as a tropical climate, Batipa has an average temperature of 26.5°C or 79.7°F and receives substantial rainfall for most of the year (see Figure 2.3), with a five-month dry period during the winter months (Climate-Data, 2012).

Figure 2.2 – Map Illustrating Oteima University and Batipa Field Institute Locations

https://www.goway.com/

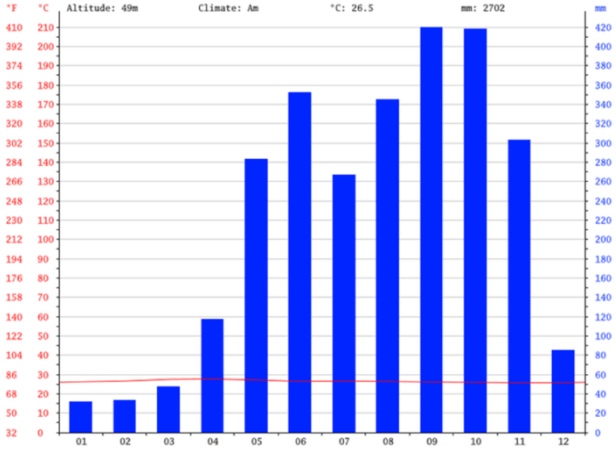

Figure 2.3 – Yearly Rainfall in mm; Average Temperature for Chiriquí Province, David

https://en.climate-data.org/

Mangroves

The Batipa Peninsula houses other significant vegetation, including mangroves. Worldwide, mangrove populations have been deteriorating, so preserving still existent populations is imperative. A mangrove is a tree with highly tangled roots found along a tropical shore, river, or estuary (see Figure 2.4). Mangroves are able to withstand harsh conditions that other plants cannot begin to bear, such as water with a heavy concentration of salt as well as flooding twice a day. They even survive the severe circumstances brought forth by storms and hurricanes. In order to survive these conditions, mangroves readily extract freshwater from the constant flow of saltwater and retain whatever freshwater they withdrew. Furthermore, they have adapted to the flooding by growing snorkel-like roots that absorb oxygen from the air provided the roots do not become clogged or excessively submerged (AMNH, 2004).

There is a large population of mangrove trees on the shores of the Batipa Peninsula (BFI, 2018). Although mangroves and teak have immensely contrasting living conditions, it is important to understand the possible impact that each tree can have on the other in order to protect and conserve the mangroves while still optimizing teak production.

Figure 2.4 – Mangroves

https://www.conservation.org/

Teak

Teak is a tree native to southeastern Asia that spread to various tropical regions throughout the world, including those in Africa and Latin America, throughout the last two hundred years (The Wood Database, 2015; Panama Teak and Forestry, Inc., 2012). It can withstand a dry period ranging from 3-5 months, appropriate for the Batipa climate (Rush et al, 2012; The Editors of Encyclopedia Britannica, 2019). Natural teak thrives in hilly land with soil that drains well and remains fertile deep enough for the roots, which spread vertically down (see Figure 2.5) rather than horizontally out (Rush et al, 2012; Panama Teak and Forestry Inc., 2012). Usually teak plantations have flat land (see Figure 2.6), but if the soil composition is correct, teak will grow anywhere (Rush et al, 2012). Interestingly, pure teak plantations fail quicker than those with mixed species because the non-teak vegetation decreases the impact of soil erosion and defoliating pests (Panama Teak and Forestry Inc., 2012). Thus, introduction of other species aids teak growth rather than hindering it. Teak also needs unobstructed light for proper growth, a characteristic the Batipa climate provides (Panama Teak and Forestry Inc., 2012).

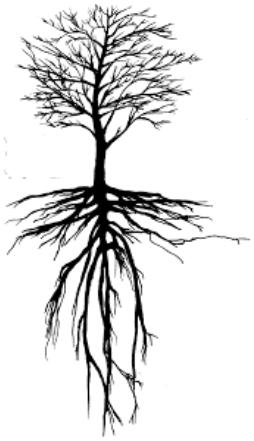

Figure 2.5 – Deep Root Diagram

https://www.researchgate.net/publication/229992035_Phenotypic_plasticity_-_Contrasting_species-specific_traits_induced_by_identical_environmental_constraints

Figure 2.6 – Tectona grandis

https://www.solomonstarnews.com/index.php/news/business/item/18379-benefits-of-teak-tree

The wood teak (see Figure 2.7) produces is highly desirable and expensive due to its significant dimensional stability (the degree to which wood shrinks and swells in response to moisture gain or loss), decay resistance, and durability in a variety of weather conditions including sun, frost, and snow (The Wood Database, 2015; The Editors of Encyclopedia Britannica, 2019; Cuenin, 2016). These ideal qualities require anywhere between twenty-five to thirty-five years of tree growth, with flexibility in this range based on the stem form and diameter of the individual tree (Panama Teak and Forestry Inc., 2012).

Figure 2.7 – Teak Hardwood

https://www.hearnehardwoods.com/

Recently, the demand for teak has been increasing while natural forests have been decreasing worldwide. Introduced to Panama in the late 1920s, teak farming has had ample time to expand throughout the country (Panama Teak and Forestry Inc., 2012). Through the nearly one hundred years teak has existed in Panama, Panama has adapted and learned how to become a

unique seller of the product. For example, today, any investment in forestry in Panama yields a full deductible in terms of income taxes and resultant land prices have been steadily increasing due to more interest and purchase of investments (Panama Teak and Forestry Inc., 2012). Additionally, Panama is one of the four countries (out of the thirty-five total that produce teak) that has an internationally acknowledged forest product certification: a recognition that increases the price of hardwood. Consumers in Europe and North America are more likely to afford this wood, thus most of the demand comes from those regions (Panama Teak and Forestry Inc., 2012). These distinct characteristics---full deductibles and internationally certified teak---reflect the country's dedication to optimizing its plantations and increasing the teak market.

Soil Modifiers

Because soil is such a crucial factor in determining the growth success of a plant, it is essential to strive for the best soil conditions for that plant. Often, achieving this involves the use of soil modifiers---various additives that can improve vegetation growth and health (Pal, 2013). With these modifiers, farmers can change the drainability of the soil and help mimic the soil in other climates. Specifically, they adjust the composition, regulate the pH, or alter the absorptivity (measure of taking in or sucking up a compound), adsorptivity (measure of a compound's tendency to bind to soil particle surfaces), and desorptivity (release of compounds from soil particle surfaces). Categories of soil amendments include "other soil, organic materials, plastics, ion exchange resins, and rubber." Each modifier serves a different purpose in the soil, whether it modifies in multiple ways or mitigates one succinct problem. The best time to incorporate modifiers is before land cultivation to ensure uniform integration. Furthermore, avoidance of layering in the soil prevents future failure due to inadequate soil homogenization (Griffin, 1972).

Soil amendments alter various properties of the soil, thus, addition of the correct modifier(s) to the teak plantation soil can improve its composition to better imitate the ideal mixture for teak trees. As mentioned earlier, teak flourishes in well-drained soil. Specifically, the best type of soil for teak is alluvium---a mixture of fine particles (namely clay, silt, sand, and gravel) that water eroded and reshaped then redeposited in a dry setting (Panama Teak and Forestry Inc., 2012). The ideal alluvium pH for teak growth ranges from 6.5 to 7.5 (Panama Teak and Forestry Inc., 2012). A soil composition that yields these parameters, whether it is because of the introduction of modifiers or not, increases the probability of enhanced teak production.

Plant Propagation Techniques

Plant propagation describes the process which grows new plants from parent plants. There are two overarching types of plant propagation, sexual and asexual, each of which categorize various methods of plant extension. Sexual propagation involves the flower of the plant, joining the pollen and the egg to create a new plant from two parents. The main method of sexual propagation involves planting and fostering the seed created as a result of joining the pollen and the egg (University of Maine, 2016).

When there is a highly desirable individual of a species, a grower typically uses the asexual technique of propagation. Different from the sexual technique, the asexual technique has the ability to clone the parent. This cloning is not just for a single parent, rather, it is possible to join one parent with another to produce mixed offspring. However, these offspring are clones of

the original joined parents. There are four principal methods of asexual propagation: cutting, layering, division, and budding and grafting (University of Maine, 2016).

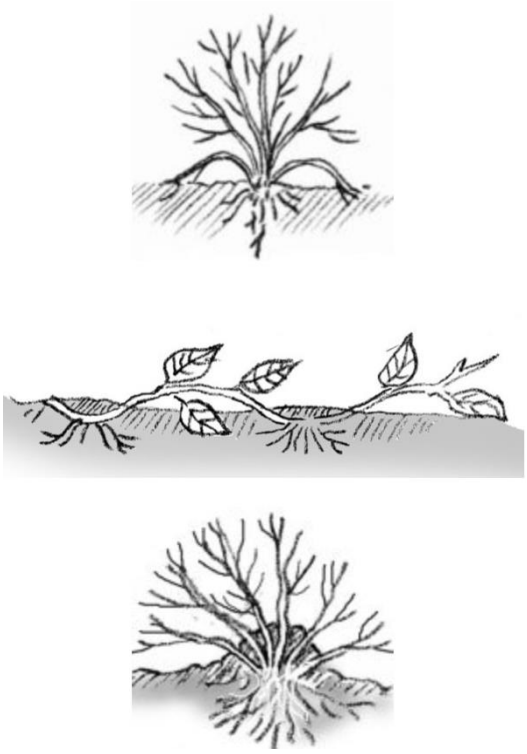

Figure 2.8 – Layering Propagation Method

https://extension.umaine.edu/gardening/

Cutting involves trimming the parent plant and planting that part, whether it is a stem, leaf, or root. Layering requires any part of a stem that is still attached to a parent plant to pull the nutrients required to sprout roots from the soil, as shown in Figure 2.8. Division splits the visible part of the plant down to the roots, making two new plants in the time it takes to cut the original. Budding and grafting each define a different method to join plant parts so they can grow as one plant. Joining parts allows mixing of parents, thus forming a new plant by means of asexual propagation (University of Maine, 2016).

Although teak produces abundant seeds nearly every year, the asexual propagation technique is the more universal technique because it is readily repeatable as long as there is a plant, which does not typically pose any issue in a plantation setting (Panama Teak and Forestry Inc., 2012). Thus, any of these methods---cutting, layering, division, or budding and grafting---are preferable to the time-consuming sexual technique. As any tree matures, its bark grows stiffer and more difficult to cut. Propagation methods are most effective in the early stages of growth, before tough bark develops. Furthermore, bark growth reduces the effectiveness of asexual propagation as a whole and removes the plausibility of layering method success due to lack of a stem. In conclusion, the possible successful methods are cuttings, division, and budding and grafting, as long as the teak tree is young.

By definition, plant propagation produces offspring. However, it can also increase the quantity of plants and in accordance with the asexual technique, this can happen more readily

than is typical in nature. To produce the most teak in a sustainable manner, it is essential to thoroughly test plant propagation techniques and the resultant effect on the teak plantation in Batipa.

Deforestation

As construction activities repurpose land for agriculture, roads, and residence, Panama loses its forest area which causes large carbon emissions and a reduction in clean water. Furthermore, logging, both legal and illegal, has augmented the rapidly decreasing numbers of trees across the country (Mongabay, 2006). Over a span of 30 years, 1980-2010, the Panamanian overall deforestation rates have increased to a parameter of -1 to 0 (see Figure 2.9). The figure quantifies the loss of forest coverage and compares the deforestation rates of the central and south American regions. Although this rate seems low in comparison to other countries, it is necessary to keep in mind the relatively small land mass of Panama.

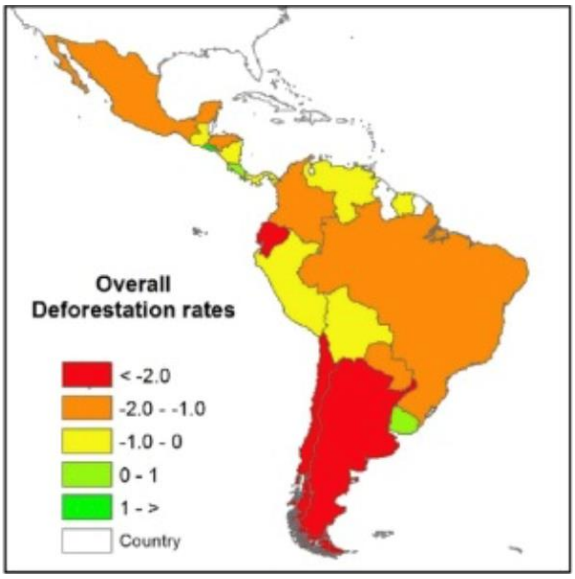

Figure 2.9 – Overall Deforestation Rates Map: Central and South American Regions

https://doi.org/10.1016/j.gloenvcha.2017.09.002

Climate Change and Reforestation

As the world continues to develop and evolve, it faces the consequences of human actions, namely climate change. Many countries and companies neglect the repercussions of this global threat in lieu of profit and personal gain. However, simply ignoring climate change does not alter its global effects, such as increased temperature and more irregular weather patterns. These effects lead to larger sociological, economic, and agricultural impacts.

Climate change puts the Central American region in significant jeopardy. Large sections of Honduras, El Salvador, Guatemala, and other affected countries exist within the Central

American dry corridor, a region of land that experiences incredibly severe weather---drought, flooding, and torrential rain---resulting from climate change (Chapman, 2017).

Many people in these regions must choose between evacuating the communities they live in or risking the consequences of staying. Climate change causes crop growth and food reserves to steadily diminish because of drought. Farmers from the dry corridor state that their most substantial problems are lack of water, erosion, and poor soil. These problems are so pronounced that in 2018, Honduras, El Salvador, and Guatemala all declared emergencies because food shortages affected over 2 million people (NBC News, 2019). Over 1 million families living in the dry corridor survive off of subsistence farming: the practice of only growing enough food to feed one's own family. The erratic conditions of the corridor result in economic woes and increased food insecurity for these families.

Communities face increased pressure to act because the conditions are so detrimental. Furthermore, instances of attempted emigration to the United States are increasingly more common. From 2010 to 2016, the number of people apprehended at the southwestern border of the U.S. increased from 50,000 to approximately 408,870 people. Many of the emigrants blamed the lack of employment and economic hardship for their attempted crossings, and most suffered from some degree of food insecurity (Chapman, 2017).

Although only a small portion of Panama lies within the dry corridor, the area outside that region also endures side effects from climate change. Panama faces the same risks many other struggling countries face, especially within its agricultural sector. If mitigation of climate change does not occur, Panama could suffer many debilitating effects: higher unemployment rates, lower crop yields, and lower exports.

The devastation of La Niña exemplifies the recent effects of climate change. This surface ocean water cooling induced losses of 6 billion dollars and 15,000 hectares of land (The World Bank, n.d.). Climate change will likely continue affecting the nation, as studies hypothesize that the production of primary crops in Panama will decrease as temperatures rise. Temperature, however, only accounts for one of the numerous inhibitors of crop growth resulting from climate change. Other factors affecting crop production include erratic rainfall and more frequent, intense hurricanes.

Table 2.1 – Climate Change in Tierras Altas: Quantified Response Chart

Hobeika & Wagner, 2018

Rank	Observed Climate Changes in Tierras Altas	Frequency of Answer in % (Multiple Answers)
1	More Drought	46.6
2	Irregularity Between Years	43.3
3	Changes In End/Beginning Of Wet/Dry Season	43.3
4	Irregularity in Month of Rainfall	36.6
5	Higher Levels of Rainfall	30
6	Higher Temperatures in the Dry Season	30
7	Harder Rain/ Higher Rain Intensity	23.3
8	Extreme Temperatures	16.6
9	More Extreme Weather Events	16.6
10	Lower Temperatures	16.6
11	Higher Intensity of Dry Season	16.6
12	Stronger Winds	16.6
13	Higher Intensity of Wet Season	16.6
14	Less Sunlight	16.6
15	Higher Intensity of the Sun	6.6

Evidence of the effects of this global crisis on Panamanian farmers is increasing. A study by Hobeika & Wagner (see Table 2.1) investigated the impact of climate change in Tierras Altas, a region of Panama in the Chiriquí Province which provides approximately 14.3% of the country's total agricultural production. Researchers asked farmers in Tierras Altas if they noticed any changes in the environment as a result of climate change. The farmers explained that they experienced more drought, observed increased irregularity of rainfall between years, and endured a shift in dry and wet seasons. When asked how these environmental fluctuations affected their crops, the farmers responded that crop quality decreased and the prevalence of crop damage increased. Consequently, farmers faced smaller yields. In addition, the study found that countless farmers outside the corridor started experiencing similar conditions like drought, harder rains, and soil erosion (Hobeika & Wagner, 2018).

These shifts and irregularities drastically affect small farmers' ability to earn a living and provide food for themselves. If Panamanian farmers ignore these trends, Panama could undergo waves of emigration and community devastation. In 2004, the UN reported that 67% of these small farmers lived below the poverty line and had an average income of around $11,110, making them extremely vulnerable to any economic instability from these inconsistencies (FAO, 2003). The prevalence of these issues begs for a large-scale response to inhibit the negative effects of climate change on the wellbeing of the Panamanian population.

Reforestation outlines a potential solution to combat climate change and benefit the environment and economy. A suspected contributor to climate change, deforestation augments the effects of climate change. Sumatra, an Indonesian island, cleared most of its forests to cultivate palm oil (Pearce, 2018). Since then, the temperature in deforested regions has been considerably higher than the temperature in forested areas---six to ten degrees Celsius in some cases.

Trees and forests cool the environment and subsequently assist evapotranspiration, the transfer of water from the land to the atmosphere. Evapotranspiration could conceivably help resist notable effects of climate change like drought (Pearce, 2018). Reforestation can also improve water quality, biodiversity and soil health and provide sustainable timber fiber and fuel. In addition, it creates rural jobs, thus slowly boosting the economy (Faruqi et al, 2018).

The striking benefits of reforestation have increased reforestation advocacy around the world. The UN, through its UN-REDD (United Nations Collaborative Programme on Reducing Emissions from Deforestation and Degradation) Program, delivers help to countries that partner with it by providing support on the design and implementation of REDD programs. In addition, the UN shares knowledge, methods, data and other information to educate participating countries (UN-REDD, 2016).

Panama took advantage of this unprecedented opportunity and has accepted and utilized more than five million dollars from the program. As of 2016, UN-REDD has supported 14 different projects centered in Panama (UN-REDD, 2016). Panama's effort to support reforestation is clear, especially in setting the goal in 2015 to restore 1 million hectares of deforested land in the next 20 years (Initiative 20 x 20, n.d.).

The "Alianza por el Millón" or "Alliance by the Million" movement helped establish this goal. "Alianza por el Millón" is a partnership led by Panama's ministry of environment and consists of civil society organizations, the private sector, and the government. With government backing and support, the program has planted five million trees since the goal's inception (Initiative 20 x 20, n.d.). One species of tree favored by those seeking to profit from the program is teak.

Teak stands out for multiple reasons, but most pronounced are its physical hardness and popularity in the global market. Teak also fares better under drought-like conditions than other trees and is a highly researched tree variety in forestry. Because of these beneficial attributes, scientists have investigated different variants of the tree to learn more about what genes make teak better suited to survive under extreme conditions (Galeano, 2019).

BFI would benefit from expanding and optimizing its teak production on various levels. First, it could contribute to national reforestation efforts of reforestation and subsequently combat climate change. Second, the BFI could help restore local land and assist local farmers to adopt an alternative income source. Lastly, with the teak plantation as a source of revenue, Batipa could accrue funds for research regarding future practices promoting the sustainable development of Panama.

Ecotourism

Panama, like many other countries in Central America, enjoys the economic benefits of their tourism industry. The country attracts an impressive number of foreign visitors every year, boasting 2.48 million tourists in 2018 alone. This large influx of people generated 4.6 billion dollars in just 2018 (The Panama Good Times, n.d.). This money accounts for approximately 14.5% of the country's GDP (Knoema, 2018). The tourism industry not only brings in monetary gains through the direct spending of foreign tourists, but it provides more job opportunities for the locals in Panama. However, drawbacks to tourism in Panama still exist. For instance, too much focus on attracting mass tourism can undermine the rights of indigenous communities, displace people from their homes, worsen income inequality, and cause environmental damage (Moguel, 2013).

One method to combat these negative effects is to implement ecotourism and make the environment a central focus of the tourism industry. Ecotourism as defined by the International Ecotourism Society is "Responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education" (TIES, 2015). In the past, Panama neglected to capitalize on the abundant beauty of its landscape by using ecotourism. The results of a 2008 study found that only around 15% of tourists in Panama engaged in any form of ecotourism (Klytchnikova & Dorosh, 2012). Encouragingly, in 2015 Panama made a formal commitment to ecotourism, and is working with global NGO Sustainable Travel International to make the most of the country's natural beauty. Despite this, Panama has yet to capitalize on much of the country's natural beauty and attractive areas.

Figure 2.10 – Volcán Barú

https://www.lonelyplanet.com

There are many renowned locations in Panama such as Coiba Island, known as an ideal spot for diving and whale watching, or Volcán Barú, the only place in the world that has views of both the Caribbean Sea and the Pacific Ocean. However, most of these spots are either difficult to get to or do not have the infrastructure needed to support tourism (Christoff, 2015). The development of ecotourism in Panama will only serve to improve the tourism industry, as well as the revitalization and protection of the country's environment and wildlife.

By reforesting its land through teak optimization, BFI can improve the natural beauty of the Chiriquí province and expand its own ecotourism efforts. Currently, BFI offers four different types of guided tours to show off its multiple projects including the teak plantation (BFI, n.d.). Further development of Batipa's teak plantation could potentially attract more tourists for BFI and consequently provide it with a larger source of revenue. If BFI can properly optimize its teak production, it could also share its approach with local farmers. This could benefit the region in two ways: first, farmers planting more teak and reforesting the area would visually enhance the region, and second, increasing the production of teak at Batipa would benefit both local farmers and artisans. The overall profit would help boost the economy and the revitalized landscape would attract more tourists.

Stakeholders

The project's primary stakeholders are Oteima University and BFI. Both organizations involve themselves in the teak plantation and both invest in it. Providing a recommendation to optimize and improve the plantation and its sustainability could strongly affect the stakeholders. Ideally, the recommendations would elicit positive effects across the teak farms and assist the stakeholders in fulfilling their respective organization missions.

Several potential project stakeholders include local farmers, local artisans, and local industries. As BFI implements these recommendations, local farmers can subsequently implement and learn from them. Depending on the teak hardwood's next destination post-harvest, local artisans that make furniture and international consumers constitute additional potential stakeholders.

Currently, the team does not completely understand the relationship between Oteima and BFI and the local farmers, artisans, and industries, but plans to gain a better understanding of the situation during our seven weeks in Panama.

Methodology

The goal of our project is to find the most productive while least invasive method of producing teak in Panama and maximize the overall sustainability of the plantation. The components of this research are to evaluate various aspects of the teak growing process including the effects of amendments and modifiers on the Batipa Peninsula soil, teak propagation methods, the effects of multiplication methods on the quality and performance of the teak, and the interaction of other tropical crops with the teak in order to gain maximum productivity. To achieve this goal, we developed the following objectives:

1. Understand the scope, expectations, and resources of our sponsor.
2. Assess the site through data collection and interviews.
    2.1. Collect relevant data on site at Batipa Field Institute.
    2.2. Interview workers to understand their role, the current upkeep process, and any prevalent limitations.
    2.3. Quantify current growth of teak through existing data at Batipa.
3. Recommend the best techniques for a sustainable teak plantation in Batipa.

This chapter details the methodology established to collect information from our sponsor, the plantation workers, and from the plantation itself to maximize teak production and sustainability of the plantation.

Objective 1: Understand the scope, expectations, and resources of our sponsor.

In order to move forward the project team must establish and maintain a dialogue with the project's main sponsor, the Batipa Field Institute's research coordinator Señor Edmundo González, so the project has a specified scope and direction. To accomplish this, the team sent the sponsor a list of 25 questions (see Appendix A) asking for details with respect to multiple aspects of the project. The resultant clarifications will help ascertain the main direction of the project in Panama.

Additionally, the team seeks to gain a better appreciation for the materials, equipment, and site information available for the project to facilitate the study's efficiency and effectiveness provided that the team arrives at the Batipa Field Institute. The study's usefulness will increase with awareness of the equipment provided on the site. The team needs this information to be productive in addressing the other objectives of the project. To gather the needed information (see Table 3.1), the team plans to execute three methods: collect relevant data on site, conduct interviews and administer questionnaires, and suggest recommendations.

Table 3.1 – Useful BFI Information and Data and Acquisition Methods

Useful BFI Information and Data	Acquisition Method
Daily Operations on the Plantation	Interview and Questionnaire
Inefficient Processes on the Plantation	Interview and Questionnaire
Growth and Age of Teak	Onsite Observation, Existing Data
Teak Harvest	Existing Data
Local Crops and Vegetation	Existing Data, Onsite Observation
Propagation Rate	Existing Data
Distance Between Teak	Existing Data, Onsite Observation
Soil Composition	Onsite Observation
Height and Width of Teak	Onsite Observation, Existing Data
Propagation Methods	Onsite Observation, Existing Data

Method 2.1: Collect relevant data on site at Batipa Field Institute.

A method the study would employ is direct collection of data from the teak plantation at the Batipa Field Institute. By conducting a deep analysis of various conditions on site, the study could suggest recommendations relevant to the environmental conditions and limitations of BFI. The team would draw connections to determine factors that positively impact the growth rate and quality of teak from the data. To accomplish this, the team would collect data on various aspects of the teak plantation by surveying the site in two two-person teams for efficiency.

The project would also collect data on the height, width, and age of the teak trees in various locations through direct measurement of these values at various plots around the plantation with the assistance of our BFI hosts.

Next, the team would gather soil samples from discrete areas of the plantation. Gathering the soil samples would require members of the team to dig and collect soil from distinct plots and record approximately where the team gathered each sample on a plantation map. Afterwards, the study would measure the calcium content, pH, and general composition of the samples. The project team would analyze and record the data for the employees to utilize in the future.

After obtaining the data, the team will use quantitative analysis to develop meaningful results. These results would then inform our team's evaluation of the effects of the peninsula's specific soil composition on the growth rate of teak. Collecting these samples would also help the team gain a better perception of the environment in Batipa and provide relevant suggestions for future soil modifications.

In addition, the team will collect data on the propagation method or methods currently in use at the plantation. Because farmers implement propagation techniques at certain times in the

development of teak, the team would regroup and survey the site along with a member of the Batipa Field Institute staff who could answer specific questions related to the various plots. The team would traverse through the plantation with the guide and ask about the propagation methods used in different areas.

These growth and propagation factors are merely a preliminary list of information that we currently believe needs investigation and are subject to revision based on sponsor input. To assist in further solidifying this list, the team would also benefit from confirmation of equipment available at BFI in order to determine the viability of the team or staff collecting other pertinent data.

In the event that the team cannot go to Panama, this method of data collection would need major revision and possibly complete removal. It is feasible that someone at BFI could collect this data with precision and relay it to members of the team. In either situation, the study would analyze data based on information from scientific literature, past records collected from BFI, and the responses collected from the questionnaires (see Appendices C and D).

The team would attempt to establish relationships between characteristics like rate of growth in different soil compositions, propagation methods, and amount of direct sunlight from the data, and then use these relationships to find the combination of elements that would allow teak to grow more efficiently.

Method 2.2: Interview workers to understand their role, the current upkeep process, and any prevalent limitations.

An important component of this study is understanding the role of BFI workers in the process of teak farming at BFI, especially in the teak upkeep process. Although the farming process may be as simple as planting a seed and nurturing the teak plant, the team hopes to familiarize itself with each detail of the process, especially the actions and roles of BFI workers.

The team would interview the Batipa Field Institute employees that work directly with the teak farm operation, such as plantation managers, maintenance workers, and the teak farmers themselves. These semi-structured interviews would ask pre-determined questions whose responses would provide information relevant for the team to suggest a helpful recommendation. Along with these questions, the interviewer would formulate additional questions based on the responses of the interviewee to go into a more in-depth discussion rather than holding a very structured interview.

Additionally, the team would collect information through face-to-face interviews and questionnaires distributed amongst employees (see Appendices C and D). High-level questions specific to our goal would inquire about worker opinions on the current processes of the teak farm with the hope of gaining information about any inefficient processes. The interviews conducted and questionnaires distributed will be very similar in terms of questions asked. However, the decision to use either an interview or a questionnaire will depend on the availability and preferences of the various employees.

Afterwards, the team plans on transcribing the responses and performing qualitative analysis via inductive coding. Inductive coding is "...a data analysis process whereby the researcher reads and interprets raw textual data to develop concepts, themes or a process model through interpretations based on data" (Chandra, 2019). Following the establishment of themes in our interviews, the team will be more cognizant of possible improvements to the plantation's efficiency and minimize any uncertainty about what problems BFI experiences.

The team's ideal plan is to execute the questionnaire in person through conversations with workers at BFI. The team's sponsor or a BFI staff member will assist in translating the questionnaire in both English and Spanish if there is a language barrier. However, as travel to Panama is less certain than before, the team would distribute the questionnaire electronically or through a service that sends the questions directly to cell phones. Instead of collecting data on the spot through interviews, the team would receive electronic responses and use them in the same way as outlined previously. In the case that employees could not access the Internet or a device capable of responding to the survey, the team would ask that the questionnaires be physically distributed by a member of the Batipa Field Institute staff. The team would request that the staff document the responses and send the results back for the project team to analyze.

Method 2.3: Quantify current growth of teak through existing data at Batipa.

In the final method to assess Batipa's teak plantation, the team would analyze data the Batipa Field Research Institute previously collected. The team would sift through documented information on the plantation as a whole and combine this with specific data on the harvesting and propagating of teak which the team would acquire from employees at Batipa (see Appendix C). With a thorough analysis of the statistics supplied on teak growth, propagation, and harvest, the team hopes to determine which factors impact the production of teak the most.

The team would request data regarding the growth and harvest cycle of teak across the entire farm and in various smaller areas of the plantation from the managers of BFI (see Appendix C), either via email or in person upon arrival in Panama. Then, the team would compare the data from specific locations throughout the farm against the data of the whole plantation. From any data provided, the team would determine which areas produce the greatest amount of teak and, with a comparison to data collected in Method 2.1, would locate where the plantation exhibits the best teak growth.

Additionally, the team would request information from managers of BFI on the different species of local vegetation and crops found in areas near or on the teak farm (see Appendix C). The team would analyze any other vegetation close to teak to determine if different types of local crops influence the rate and quality of teak production. In the case of any correlation determined through quantitative analysis, the next step would be to further investigate the properties of the local crops to ascertain their specific effects on teak and decide whether those effects are negative or positive.

Statistics from BFI on the number of seedlings propagated and planted would determine the rate at which Batipa plants new teak and how this rate compares to the amount of teak harvested. This comparison could decide if Batipa is efficiently expanding its plantation. Furthermore, the team would acquire details about how Batipa currently propagates and plants the seedlings, specifically the measured distance between each planted sapling and the measured distance between rows of saplings (see Appendix C). Analysis of data collected in this objective would conclude the overall growth rate of the teak farm along with which factors---which location within the plantation or crops nearby---have the greatest effect on the growth of teak.

Objective 3: Elect the best techniques for a sustainable teak plantation in Batipa.

The final objective of this investigation is to collect all the information from our sponsor as well as that from the questionnaires, interviews, and plantation data, and draw conclusions on the details of the teak farm at Batipa. From these conclusions the team would compile and suggest a set of recommendations to implement at the plantation so BFI and Oteima could benefit from maximum teak production and sustainability. The recommendations would likely specify what methods to use to plant new trees, suggest an updated schedule that details upkeep of the plantation and harvest, or fixate a set distance for future planting. Strong interaction with sponsors would lead to the desired outcome and careful data analysis should generate appropriate recommendations. Additionally, the team would review these suggestions in a final meeting with the sponsors to hear the sponsors' initial reactions.

Improvement, revision, and addition to the proposal is inevitable. The current plan factors in all aspects of the immediate situation but requires further analysis for adaptation in the case of change. Situations readily change, whether that change is climactic, economic, political, or social. Repeating an approach like the one described in this chapter after any change would yield an updated result and could yield improved methods at Batipa.

The plantation improvements have the potential to positively impact the lives of the local inhabitants in the future. In addition to gradually pulling poor farmers out of poverty, the overall economy of the area could advance and further improve life in western Panama.

Bibliography

Amato, N., Johnson, R., Lemay, C., & Lundblade, T. (2018). Teak Efficiency and Environmental Education Methods for Batipa. Retrieved May 4, 2020, from https://web.wpi.edu/Pubs/E-project/Available/E-project-101118-111043/unrestricted/Teak_Efficiency_and_Environmental_Education_Methods_for_Batipa.pdf

AMNH. (2004, May). What's a Mangrove? And How Does It Work? Retrieved April 13, 2020, from https://www.amnh.org/explore/videos/biodiversity/mangroves-the-roots-of-the-sea/what-s-a-mangrove-and-how-does-it-work

BFI. (n.d.). Background. Retrieved April 12, 2020, from https://batipafieldinstitute.com/en/17-2/quienes-somos/historia/

BFI. (2014). Research and Education for Conservation and Sustainability. Retrieved April 13, 2020, from https://www.oteima.ac.pa/web3/wp-content/uploads/2017/09/BATIPA-FIELD-INSTITUTE.pdf

BFI. (2018). Giras Ecoturísticas: Giras Académicas. Retrieved April 13, 2020, from https://batipafieldinstitute.com/en/

Chapman, Regis and Ponce-Segura, Byron. (2017, August). Food Security and Emigration. World Food Programme.

Christoff, J. (2015). How Ecotourism is Changing Panama (For the Better). Retrieved April 12, 2020, from https://www.travelpulse.com/news/destinations/how-ecotourism-is-changing-panama-for-the-better.html

CIA. (2018, February). The World Factbook: Panama. Retrieved April 13, 2020, from https://www.cia.gov/library/publications/the-world-factbook/geos/pm.html

Climate-Data. (2012). Chiriquí Climate. Retrieved April 13, 2020, from https://en.climate-data.org/north-america/panama/chiriqui-1017/

Cuenin, P. (2016, May). What is Teak Wood? Retrieved April 13, 2020, from http://www.eastteak.com/teak-wood/

FAO. (2003). Smallholders Dataportrait. Retrieved April 12, 2020, from http://www.fao.org/family-farming/data-sources/dataportrait/income/en/

Faruqi, Sofia, et al. (2018, January). The Business of Planting Trees: A Growing Investment Opportunity. World Resources Institute and The Nature Conservancy. ISBN: 978-1-56973-928-5.

Forests of the World. (n.d.). Forests of the World in Panama. Retrieved May 4, 2020, from https://www.forestsoftheworld.org/programs/panama

Galeano, Esteban, et al. (2019, September). Physiological and Molecular Responses to Drought Stress in Teak (Tectona Grandis L.f.). Plos One, 14(9), 1–26.

Griffin, H. M. (1972, September). Sources and Uses of Soil Modifiers in Turf. *USGA Green Section Record*, 10(5), 7–9.

Hansen, O. K. (2017, July). Worldwide Translocation of Teak—Origin of Landraces and Present Genetic Base. *Tree Genetics & Genomes*, 13(87), 1–16.

Hobeika, M., & Wagner, A. C. (2018, April). The Impacts of Climate Change on Agriculture in Tierras Altas, Panama and Recommendations for Adaptation: Perspectives of Local Farmers. Retrieved April 12, 2020, from https://www.mcgill.ca/pfss/files/pfss/the_impacts_of_climate_change_on_agriculture_in_tierras_altas_panama_and_recommendations_for_adaptation_-_perspectives_of_local_farmers_.pdf

Initiative 20 x 20. (n.d.). Alianza Por El Millón: Panama's Restoration Movement. Retrieved May 4, 2020, from initiative20x20.org/restoration-projects/alianza-por-el-millon-panamas-restoration-movement.

Klytchnikova, I., & Dorosh, P. (2012, August). Tourism Sector in Panama: Regional Economic Impacts and the Potential to Benefit the Poor. Retrieved April 12, 2020, from http://documents.worldbank.org/curated/en/784381468286211423/pdf/wps6183.pdf

Knoema. (2018). Panama Contribution of Travel and Tourism to GDP (% of GDP), 1995-2018. Retrieved April 12, 2020, from https://knoema.com/atlas/Panama/topics/Tourism/Travel-and-Tourism-Total-Contribution-to-GDP/Contribution-of-travel-and-tourism-to-GDP-percent-of-GDP

Moguel, S. (2017, December). Costa Rica, Panama and Mexico: Lots of Tourism, Little Sustainability. Retrieved April 12, 2020, from https://aida-americas.org/en/blog/costa-rica-panama-and-mexico-lots-tourism-little-sustainability

Mongabay. (2006, February). Panama: Environmental Profile. Retrieved April 13, 2020, from https://rainforests.mongabay.com/20panama.htm

Nations Encyclopedia. (n.d.). Panama - Agriculture. Retrieved April 12, 2020, from https://www.nationsencyclopedia.com/economies/Americas/Panama-AGRICULTURE.html

National Forest Foundation. (n.d.). Why Plant Trees? Retrieved May 4, 2020, from www.nationalforests.org/get-involved/tree-planting-programs/benefits-of-reforestation.

NBC News. (2019, July). Climate Change Is Devastating Central America, Driving Migrants to the U.S. Border. Retrieved May 4, 2020, from, www.nbcnews.com/news/latino/central-america-drying-farmers-face-choice-pray-rain-or-leave-n1027346.

Oteima. (2017). Misión, Visión y Valores. Retrieved April 13, 2020, from https://www.oteima.ac.pa/oteima/mision-vision-y-valores-2-2/

Owen, K. (2018). The History of Teak Plantations. Retrieved May 4, 2020, from https://www.tkofarms.com/blog/2018/1/15/the-history-of-teak-plantations

Pal, D. K. (2013). Soil Modifiers: Their Advantages and Challenges. Clay Research, 32(2), 91–101. Retrieved April 12, 2020, from https://www.researchgate.net/publication/262611682_Soil_modifiers_Their_advantages_and_challenges/references

Panama Teak and Forestry Inc. Green Investments. (2012). Retrieved April 30, 2020, from https://www.panamateakforestry.com/

Pearce, F., et al. (2018, July). Rivers in the Sky: How Deforestation Is Affecting Global Water Cycles. Retrieved May 4, 2020, from https://e360.yale.edu/features/how-deforestation-affecting-global-water-cycles-climate-change

Rush, C., et al. (2012). Investigating the Potential of Plantation Pochote as a Lumber Source in Sámara, Costa Rica. Retrieved April 12, 2020, from https://digitalcommons.wpi.edu/iqp-all/1593/

The Editors of Encyclopedia Britannica. (2019, April). Teak. Retrieved April 13, 2020, from https://www.britannica.com/plant/teak

The Panama Good Times. (n.d.). Tourists Impact Panama's Economy. Retrieved April 12, 2020, from https://thepanamagoodtimes.com/tourists-impact-panamas-economy/

The Wood Database. (2015). Teak. Retrieved April 13, 2020, from https://www.wood-database.com/teak/

The Wood Technology Society. (n.d.). Wood Processing. Retrieved April 13, 2020, from https://www.iom3.org/wood-technology-society/wood-processing

The World Bank. (n.d.). Climate Change Knowledge Portal. Retrieved April 12, 2020, from https://climateknowledgeportal.worldbank.org/country/panama/impacts-agriculture

The World Bank. (2019, October). Panama Overview. Retrieved April 13, 2020, from https://www.worldbank.org/en/country/panama/overview

TIES. (2015). What Is Ecotourism. Retrieved April 12, 2020, from https://ecotourism.org/what-is-ecotourism/

Trading Economics. (2020, April). Panama Exports of Wood and Articles of Wood, Wood Charcoal. Retrieved April 13, 2020, from https://tradingeconomics.com/panama/exports/wood-articles-wood-wood-charcoal

UN-REDD. (n.d.). Our Work. Retrieved May 4, 2020, from www.un-redd.org/how-we-work-1.

University of Maine. (2016, December). Plant Propagation - Cooperative Extension: Garden & Yard. Retrieved April 13, 2020, from https://extension.umaine.edu/gardening/manual/propagation/plant-propagation/

Appendix A: Sponsor Questions

Below is the list of preliminary questions aimed to clarify the project that the project team distributed to Sr. Edmundo González.

1. Is our understanding of the project the same as yours? Is there another direction that you would like to take with the project?
2. We plan to conduct interviews/case studies. Who can we interview?
3. Does everyone who we would be able to interview speak either English or Spanish, or are there others that speak only native languages?
4. Is there an already set up testing area at Batipa for teak evaluation or do we need to create testing areas of different conditions?
5. What are the desired properties (hardness, plank width, etc.) of the teak you sell?
6. How many farms in the area around Batipa cultivate teak?
7. Which (if any) propagation methods to expand the teak plantation are commonly used? Are there any in use right now?
8. What soil amendments are prevalent in Panama?
9. What other things are grown around your plantation and in farms around the peninsula?
10. Are you planning to keep the 1000 hectares of area for the teak or will that number be increasing or decreasing?
11. Does any of the local wildlife interfere with the growth of teak (destroying saplings, invasive species, etc.)?
12. How long has the teak plantation been a part of the Batipa Field Institute?
13. Is this project being done to help reforestation efforts, to improve the wellbeing of poor farmers, to create a revenue stream for the Batipa Field Institute, or some combination?
14. Is the teak wood processed by Oteima or by an external organization?
15. What do you see as potential barriers in expanding this project?
16. Is there anything unique about teak's growth, especially about its growth on the peninsula, that you think is worth mentioning?
17. Do you pay the caretakers of the plantation based on how much teak is sold?
18. What percentage of revenue for the Batipa Field Institute comes from the teak farm?

19. How frequently do you cut down the teak trees? Is it scheduled?
20. In the case that we are not able to come to Panama in the fall, do you think that it is possible to conduct interviews and remain in contact with the workers at the Batipa Field Institute online? If so, what would be the best platform?
21. Do you know why teak was brought to Panama? Was the industry/market for it ever larger than it is now? If it has declined do you know the reason for the decline?
22. Why was teak chosen as a project for the Batipa Field Institute?
23. Is the teak currently on the peninsula growing well or poorly?
24. Are there local farmers that look to Batipa for guidance in growing their own crops?
25. Is there a preferred terrain for teak to grow?

Appendix B: Informed Consent Script

A sample of the script read to every interviewee before any interviews begin in versions of English and Spanish

Hello _____. We are American students from Worcester Polytechnic Institute doing a research project on optimizing the sustainable growth of teak at the Batipa Field Institute. As you are an employee of Batipa and are familiar with the location, we would like to interview you on _____. If it's okay with you, could we get your permission to record this interview on our phones to make sure we capture your responses? If you would rather not, it's perfectly fine, we can take notes instead. Any information you share with us is completely confidential and will only be used for research purposes with your permission. Do we have your permission to quote you in our report? You have the option to remain anonymous. We will not identify you by name in any of our writing to make sure the information you share with us is confidential, unless you would like to be quoted.

Our report will analyze various factors affecting teak growth such as soil modifiers and plant propagation techniques and recommend the optimal conditions for Batipa. We hope to assist Batipa in maximizing the efficiency of its operation and finding the ideal properties to grow teak. The report will be available online after we finish writing it, and we can also email it to you if you wish. If we ask a question that you do not want to answer, just let us know and we will move to the next one. If you don't understand our question, please let us know and we can try to rephrase. Do you have any questions for us before we begin?

Hola _____. Somos estudiantes americanos del Worcester Polytechnic Institute haciendo un proyecto de investigación para optimizar la sustentabilidad del crecimiento de la teca a Batipa Field Institute. Como eres un/a empleo/a y conoces la localización, nos gustaría entrevistarle sobre _____. Si le parece bien, ¿podríamos conseguir su permiso para grabar esta entrevista en nuestros celulares para asegurarnos de que captemos su respuesta? Si prefiere no, está perfectamente bien, podemos tomar notas en lugar. Cualquier información que Ud. comparte con nosotros es completamente confidencial y solo se usará para propósitos de investigación con su permiso. ¿Tenemos su permiso para citarle en nuestro informe? Tiene la opción quedarse anónimo/a. No le identificaremos por nombre en ninguna escritura para asegurar la información que Ud. comparte con nosotros es confidencial, a menos que Ud. gustaría ser citado.

Nuestro informe analizará varios factores afectando el crecimiento de la teca como modificadores de la tierra y técnicas de propagar las plantas y recomendará las condiciones optimas para Batipa. Esperemos ayudar a Batipa en maximizar la eficiencia de su operación y encontrar las propiedades ideales para crecer la teca. El informe estará disponible en línea después de que terminemos escribiéndolo, y también podemos mandarle un mensaje electrónico si lo desea. Si preguntemos una pregunta que no quiere contestar, por favor haznos saber y podemos tratar de expresar de otro modo. ¿Tiene alguna pregunta para nosotros antes de empezarnos?

Appendix C: Batipa Current Manager Questionnaire

A sample of the questionnaire distributed to managers at Batipa.

WPI Project Questionnaire
Cuestionario para el Proyecto de WPI

Hello Batipa Field Institute worker. We are students from WPI, an institution in the U.S., and we are working with BFI to promote teak growth and plantation sustainability. We hope that you would be willing to answer a few questions about yourself and your role at BFI.

Hola trabajador de Batipa Field Institute. Somos estudiantes de WPI, una institución en los EEUU, y estamos trabajando con BFI para promover el crecimiento de la teca y la sustentabilidad de la plantación. Esperamos que estaría dispuesto contestar algunas preguntas sobre su mismo y su papel en BFI.

Disclaimer to all Participants in Interviews and Questionnaires: Your confidentiality will be maintained. Any personal information that is obtained about you will not be affiliated with the responses you have towards the questions.

Descargo de Responsabilidad en Entrevistas y Cuestionarios: Su confidencialidad se mantendrá. Cualquier información personal que se obtiene de usted no estará afiliada con las respuestas que usted tiene hacia las preguntas.

If you are comfortable, we would like to record this interview. Your confidentiality will be maintained. Any personal information that is obtained about you will not be affiliated with the responses you have towards the questions. After the project finishes, this recording will be deleted: there will be no record of it.

Si esté cómodo, nos gustaría grabar esta entrevista. Cualquier información personal que se obtiene de usted no estará afiliada con las respuestas que usted tiene hacia las preguntas. Después de que el proyecto se acaba, esta grabación será borrada: no será ninguna anotación de la.

Gender:
Sexo:

Job title at Batipa:
Título del trabajo en Batipa:

Hometown:
Pueblo Natal:

1. What is your job?
   ¿Cuál es su trabajo?

2. How long have you worked at Batipa?
   ¿Por cuánto tiempo ha trabajado a Batipa?

3. What's the toughest part of your job?
   ¿Qué es el parte más difícil de su trabajo?

2. In your opinion, is the plantation running well? If not, what would you improve?
   En su opinión, ¿funciona bien la plantación? Si no, ¿qué mejorará?

3. If you could change one thing about your job, what would it be and why?
   Si podría cambiar una cosa sobre tu trabajo, ¿qué será y por qué?

4. Have you made any changes in operation of the teak farms in the past 5 years?
   ¿Ha realizado algún cambio en la operación de las granjas de teca en los últimos 5 años?

5. What other vegetation grows near or on the teak plantation?
   ¿Cuál otra vegetación crece cerca de o en la plantación de teca?

6. Which (if any) propagation methods are you currently using?
   ¿Cuáles (si cualquieres) métodos de propagación está usando actualmente?

7. What is the distance between each new seedling planted? Also, what is the distance between each row of seedlings?
   ¿Cuál es la distancia entre cada nueva planta de semillero plantado? Además, ¿cuál es la distancia entre cada fila de plantas de semillero?

10. What is the current harvest cycle?
    ¿Cuál es el ciclo actual de cosecha?

Appendix D: Batipa Current Worker Questionnaire

A sample of the questionnaire distributed to workers at Batipa.

WPI Project Questionnaire
Cuestionario para el Proyecto de WPI

Hello Batipa Field Institute worker. We are students from WPI, an institution in the U.S., and we are working with BFI to promote teak growth and plantation sustainability. We hope that you would be willing to answer a few questions about yourself and your role at BFI.

Hola trabajador de Batipa Field Institute. Somos estudiantes de WPI, una institución en los EEUU, y estamos trabajando con BFI para promover el crecimiento de la teca y la sustentabilidad de la plantación. Esperamos que estaría dispuesto contestar algunas preguntas sobre su mismo y su papel en BFI.

Disclaimer to all Participants in Interviews and Questionnaires: Your confidentiality will be maintained. Any personal information that is obtained about you will not be affiliated with the responses you have towards the questions.

Descargo de Responsabilidad en Entrevistas y Cuestionarios: Su confidencialidad se mantendrá. Cualquier información personal que se obtiene de usted no estará afiliada con las respuestas que usted tiene hacia las preguntas.

If you are comfortable, we would like to record this interview. Your confidentiality will be maintained. Any personal information that is obtained about you will not be affiliated with the responses you have towards the questions. After the project finishes, this recording will be deleted: there will be no record of it.

Si esté cómodo, nos gustaría grabar esta entrevista. Cualquier información personal que se obtiene de usted no estará afiliada con las respuestas que usted tiene hacia las preguntas. Después de que el proyecto se acaba, esta grabación será borrada: no será ninguna anotación de la.

Gender:
Sexo:

Job title at Batipa:
Título del trabajo en Batipa:

Hometown:
Pueblo Natal:

1. What is your job?
   ¿Cuál es su trabajo?

2. How long have you worked at Batipa?
   ¿Por cuánto tiempo ha trabajado a Batipa?

3. What's the toughest part of your job?
   ¿Qué es el parte más difícil de su trabajo?

4. If you could change one thing about your job, what would it be and why?
   Si podría cambiar una cosa sobre tu trabajo, ¿qué será y por qué?

5. Do you ever worry about your safety while working on the plantation?
   ¿Alguna vez se preocupas por su seguridad cuando trabaja en la plantación?

6. What things do you have to consider in order to care for the trees efficiently and effectively?
   ¿Qué cosas tienes que considerar para que puede cuidar a los arboles eficientemente y efectivamente?