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Madagascar, Sustainable Agriculture

Madagascar: A Natural Solution to Soil Degradation and Slash-and-Burn Agriculture

Madagascar is the world's fourth largest island and is home to over 264,000 species of plants and animals. It is one of the only megadiverse countries that holds a majority of the world's biodiversity with over seventy percent of the organisms on Madagascar found nowhere else in the world. (Smith, Rene) The climate is also diverse being tropical along the coast, temperate on the inland, and arid in the south. The land goes from being flat near the coast, to plateaus, and finally mountainous in the center. Due to Madagascar's isolation from a mainland continent and its diverse climate and terrain, this is likely what caused the explosion of biodiversity in Madagascar. (Butler, Rhett)

The modern nation of Madagascar began as a colony of France in 1895 where its main job was to supply France with raw resources. In 1960 Madagascar gained its independence and in 1993 it is now known as the Republic of Madagascar. There are two main heads of the Malagasy executive government. There is a president which is elected by the universal suffrage and a Prime Minister which is elected by Parliament. The president is the leader of foreign policy and the symbol for national unity. The Prime minister oversees the functioning of the government. (Butler, Rhett)

The current population of Madagascar is twenty-four million people. Of the twenty-four million people forty-nine percent are employed and of that, seventy percent of the force works in agriculture. Most Malagasy people live in the rural areas who comprise sixty-four percent of the total population. (Madagascar – Rural Population) A typical family has roughly four to five people living together. While the people living in urban areas have a greater chance of public works like sewage and water sources, overall only thirty-five percent of the population has access to safe drinking water and forty-five percent do not have toilet facilities. Only one-fifth of households have electricity. (Iarivony, Randretsa)

School for children is required for students between the ages six and fourteen years of ages. This consists of primary and middle schools where most children will end their education after middle school. The schools are often" ramshackle" in rural areas consisting of simple arbors and without any clean water. The curriculum is common across the nation through these years. At the end of middle school, students are awarded with a certificate. After children receiver their certification, they may go to high schools and vocational schools or universities which are open to students who can afford them. (Education System in Madagascar)

The main food crop of Madagascar is rice, but they also grow several fruits such as apples, pears, plums, citrus, and grapes and even produce such as coffee, cloves, and sisal. The chief crop industry however, is the vanilla bean. Madagascar produces sixty percent of the global supply of natural vanilla making it the most valuable export. Several measures are kept in place to ensure the movement of these pods are strictly regulated. (New Agriculturist)

Much of Madagascar has very rich farming land however, it is degrading in soil quality and is eroding at an alarming rate which is limiting crop production. One of the main causes is Slash-and-burn agriculture also known as *Tavy* or *hatsake* by the locals. *Tavy* is the most common response to failing harvests from locals and is also is one of the primary threats to Madagascar's forests which leads to a vicious circle of

deepening poverty and shrinking forest area. (Sipa, Masika) In places where Malagasy people must provide food for their families, *Tavy* is one of the most expedient ways to do so. (Butler, Rhett) Their immediate need for subsidence greatly shadows the long-term consequences on the land. *Tavy* is currently the largest contributor to deforestation in Madagascar which is having devastating effects to the diverse wildlife of Madagascar. An estimated ninety percent of the Madagascar's original vegetation has already been destroyed, mostly by *Tavy* and the collection of resources by the logging industry. This leaves little space for the remaining wildlife and makes *Tavy* the number one cause of habitat loss for many species that are currently facing extinction. These animals include fossas, tenrecs, geckos, birds, and ninety-four percent of all lemur species. The stress on the native populations due to habitat loss makes it extremely important to retain the remaining land. Because the deforestation is small scale but widespread, it often creates small patches of forest that have been cut off from surrounding forests. These are known as 'fragmented forests,' the consequences of which limits species into smaller areas where competition for resources increase as well as separating populations and creating a lack of genetic diversity. (Romberg, Corey)

Though *Tavy* is used to produce suitable farmland, after a period of about two or three years the soil becomes unfarmable and lacks nutrients needed for plant growth. Therefore, new land must be sought and burned. The old land, however, is not able to reestablish plant growth in such a dearth of nutrients. In consequence the soil is exposed to more rain than before. The onslaught of water in the rainy season leads to extreme soil erosion, removing the topsoil and beyond. The eroded ground can no longer be inhabited by animals or humans due to the complete lack of vegetation. (Sipa, Masika) The run-off goes into rivers where it pollutes the water and finally the ocean. This pollution has had severe effects of the aquatic wildlife and significantly affects the health of fish which in turns creates several problems for the fishing industry.

The alternative to slash-and-burn agriculture would be to maintain on a single plot of farmable land rather than moving to new plots every other growing season. This will not only save the environment from the effects of *Tavy* but also save a village time and effort. The resulting farms will remain close to the village which will be easier to maintain. The village would be closer to the forest as well keeping the main source of resources close. Allowing the communities to spend less travel between the fields and home so that it is more accessible to the farmers.

Modern technology has solved this problem already with synthetic chemical fertilizers. By amending the soil (directly adding nutrients) crops can then thrive in the fertile soil that previously was not sufficient enough to support healthy crops. The fertilizer can be bought though the selling of the wood that is harvested during *Tavy*. Rather than burning the logs, the wood can be sold prepared as charcoal, firewood, or for the more prime wood it can be sold for lumber. From the money collected of the selling of the wood, the community could use this money to purchase fertilizers that they can add to the soil when they sow their crops. This enriched soil would be able to better sustain crops as well as intensify their production. This means the same land can be farmed repeatedly without the need to perform *Tavy*. However, the fertilizer will have to be reapplied eventually and without the funds from the lumber, there is not currently another way to continually purchase this fertilizer. (Assuming the community did not already have the resources to do so their selves.)

If nutrients used in growing crops can be returned to the soil year after year, then the land can be farmed on consecutively without the need to prepare new land. A way to achieve this is with a special species of tree can be implemented into the growing grounds. These types of trees, known as Nitrogen Fixing Trees or NFTs, can use bacteria in the soil to generate usable nitrogen. (Sitler, Ryan) The trees first can be planted in rows through a field with the farmable land in between the hedges. The trees would be allowed to mature for one to two years in which they re-establish the soil's nutrients through nitrogen fixation. NFTs also recycles phosphorous and nitrogen by dropping its leaves in the dry season. The dropped leaves land on the farmable land and create a thick mulch for the plants to grow in. The trees would then

be pruned every season allowing the trimmings to compost in the farmland and the larger branches can be used as firewood, decreasing the need of outsourcing wood from the forest.(Hands, Mike) While trees are growing back, it provides shade for the crops keeping them out of intense sunlight and retaining moisture on the ground. When the crops are harvested the trees should be left to continue growing. During this time, they will outcompete wild grasses in the fields keeping them free of weeds. The trees will be ready to prune again at the beginning of the next season. (Hands, Mike) While the trees are planted in rows through a field, they can be contoured to slow run-off, help with water absorption and finally reduce soil erosion. In addition to the main crop, the NFT trees provide a natural terrace to support additional crops such as yams or vanilla that could share the space of the farm enabling more food to be farmed on a smaller area.

A possible NFT tree variety would be the *Gliricidia sepium*. This tree is adapted to climates like those in farms at Madagascar. These trees have already been proven to efficiently recreate forest floor like conditions for the growth of coffee beans in the Congo. They have also been used in Alley-crop farming in Honduras with a similar tropical environment. (Rojas-Sandoval, Julissa) In addition, the wood of the *Gliricidia sepium* is particularly high caloric wood, burning slower with little sparking and smoke than several other woods. This clean burning feature causes this wood to be sought after in the kitchens to use in stoves and cooking fires in Madagascar. The excess wood can easily be made into charcoal and stored. This tree can also be used as a rodenticide and basic pesticide as most parts of the tree are sweet yet poisonous. This trait protects crops in the field from common pests that assists in increasing yields. The flowers of the *Gliricidia sepium* can also be cooked and eaten or fried with a high nitrogen value. Finally, the plant has also been found to have medicinal application including being used as an expectorant, sedative, suppurative, and a folk remedy for several common medical issues (cuts, bruises, cough, burns, headache). (Fern, Ken)

A similar attempt at improving diminished tropical soils using Alley cropping was performed by Mr. Mike Hands in the rainforests of Costa Rica. In his article “Innovation in Action: A Sustainable Alternative to Slash and Burn Agriculture!” Mr. Hands tested several agricultural systems, in which he concluded at the end of his study that the tree species known as: Inga -which is in the same family as the *Gliricidia sepium*- in an alley-cropping system had shown to be the most effective in maintaining soil fertility and produce good harvests. Mr. Hands found that the Inga alley-cropping was able to effectively control weeds, provide nutrients in the form of mulch, and retain top-soil and soil moisture which all contributed to higher agricultural yields. Implications of *Gliricidia sepium* can learn from this research as alley-cropping was optimized in this experiment. From trimming to spacing, all the details of how to implement the Inga alley-cropping system can be replicated with the *Gliricidia sepium* in Madagascar due to the plant’s similarities.

Another study performed by Chirwa, Paxie, et alia, showed cropping systems that included both *Gliricidia sepium* and Maize were shown to increase levels of nitrogen in the soil. The tree was able to do this by generating substantial biomass in a short period that can be used as mulch as well as directly through nitrogen fixing nodules on its roots. This technique was observed in Malawi where many farmers are beginning to practice this type of agricultural system. In the study, they found that the green leaf manure produced by *Gliricidia sepium* trees released up to 30% of the nitrogen contained in them but took 24 weeks for 60%. This process was changed however, when small amounts of fertilizer is added (75% less than the normally recommended amount) the green leaf manure can release up to 60% in just three weeks. (Chirwa, Paxie) This is significant because when Malagasy communities begin to have a steady supply of crops, they will eventually have some to sell. From here they can invest their money to buy more fertilizers to continually increase their yields and further their economic development.

The NFT plants would be purchased and implemented by individual farms. The money for the trees could be obtained by selling the wood found on the land that would be cleared to make the field. Obtaining the Gliricidia sepium tree would be not be challenging as the plant has already been introduced into

Madagascar and is not labeled as an invasive species. The tree is also easily grown from seeds that are sown directly into the ground where, when mature, the trees produce seeds in plentiful amounts.

Collectively, the NFT trees provide a sustainable alternative to slash-and-burn agriculture which, in turn, will reduce deforestation, limit soil erosion, and aid in regaining biodiversity of Madagascar. Farms that adopt this solution would be able to reuse land season after season to grow their crops closer to the village along with preserving the natural forest around them which houses countless other resources necessary for their community. Rather than performing *Tavy* every other growing season, the NFTs would be pruned every season and would provide the village with useable wood for cooking fire and mulch to fertilize the fields. The alley-cropping system will slowly increase soil fertility so that better agricultural yields can be produced each season so that eventually a surplus can be made and invested into more sustainable crop intensification techniques. NFTs are a natural way to combat soil degradation and promote sustainable agriculture in Madagascar.

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