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Mozambique, Malnutrition

Nourishing GMOs for the Malnourished

When Dr. Norman Borlaug spoke the famous words, "Food is the moral right of all who are born into this world," he could not have imagined the enormous weight they would bear (Rotunda, 2018). These words are the central message of the World Food Prize, an organization that has promoted equal access to food for all people. Access so that everyone from all corners of the world can go to bed with a full stomach and the assurance that they will eat tomorrow. However, that dream has not come true yet. Even as modernized countries are developing revolutionary tools and technology to make food production more efficient, many around the globe still struggle with the effects of food insecurity. These people include the citizens of Mozambique, a poor country that struggles to provide. For many Mozambicans, food insecurity has turned into starvation, which has now led to the terrifying and painful effects of malnutrition. However, with Dr. Borlaug's ideals in mind, this crisis could be reversed with the right solution to end the suffering. A solution to food insecurity and malnutrition involving modern biotechnology could be the change Mozambicans are more than desperate for.

The country of Mozambique is as humble as the people that live there. The African nation is home to 28.83 million people, 13.8 million of those are twelve years old or younger due to the extremely high conceiving rates (Population, 2016). The majority of citizens, 67.5%, live in rural villages or communities, while the remaining 32.5% of Mozambicans live in the urban cities (Population, 2016). The nation has a republic government as well as a multiparty democracy. Also, Mozambique has a president that is the head of state and head of the government. He or she can serve up to ten years in office, and appoints the country's prime minister and Council of Ministers that govern the nation (Sectors, 2018). With a large rural population, it is obvious that agriculture plays a vital role in the everyday life of Mozambicans. However, only 10% of all arable land is cultivated. This is due to the small and independent subsistence farms that can be found all over the countryside rather than large commercial farms. In these smallholder farms, the main crop raised throughout the nation is the cassava root. Other crops that Mozambique exports for profit include sesame, cotton, cashews, sugar, and tobacco (Mozambique, 2007). The average farm size is quite small, with the average land area per family at around 1.4 hectares, or 3.5 acres (Mozambique, 2007). In comparison, this is about the size of a small acreage on a farm in the United States. The farming practices and methods of Mozambique, as well as the variety of crops grown, correspond with the climate and geographical area that the country is located in. The coastal nation has a subtropical climate and two weather "seasons". There is a wet season from October to March and a dry season from April to September (Mozambique History, Geography and Climate, 2017). Mozambique is located geographically on the east coast of southern Africa. The country shares borders with Tanzania, Zambia, Zimbabwe, and South Africa. To the east of the country, across the Mozambican Channel, sits Madagascar, which acts as a weather barrier for Mozambique against even more dangerous tropical storms. Mozambique is a humble nation that values traditions and cultures of the people. To better comprehend this, I knew I would need to go above and beyond the Internet to fully grasp

the ways of the people and to understand what it is really like in this country. I reached out to Mrs. Karla Chestnut, a worship leader at the Orchard Hill Church in Cedar Falls, Iowa, who has gone to Mozambique for a missions trip and was leading another trip in March. Mrs. Chestnut has witnessed the country personally and has learned the traditions of Mozambicans firsthand. She has also seen the daily struggles these people must persevere through. Karla informed me, as we sat together in an interview, that, “Many rural Mozambicans live in ‘huts’ with stick framework and sealed with mud” (Chestnut, 2018). Karla also informed me that the cassava root is a huge part of the Mozambican diet and culture and is large in abundance and consumption. They also eat maize, sorghum, and tropical fruits such as mangos and bananas. On her trip, Karla saw that most rural citizens got their food through subsistence farming on their own plots of land. These smallholder farms are what 80% of rural Mozambicans consider their jobs, and the little profit they receive their “wage” (Mozambique - Education & Jobs, 2010). There are very few formal jobs, mostly due to the high illiteracy rates and the difficulty of attending school. Accessing an education can be hard because of the lack of infrastructure and properly trained teachers. Karla also discussed with me that, “It can be hard for communities to trust teachers... especially female teachers that come from other villages and communities” (Chestnut, 2018). A lack of proper roads can make the journey to a school house rough, causing some students to have to walk numerous miles to attend school. A high illiteracy rate, especially in women, can also be due to girls being married off in their teens (Mozambique - Education & Jobs, 2010). Also, access to proper healthcare for some, Karla explained, could be difficult because of the distance of quality hospitals from villages. The average Mozambican family, unfortunately, has limited access to services taken for granted in the US. The lack of infrastructure makes traveling to markets or other services very difficult, and only eighteen percent of all citizens have access to electricity (Flak, 2012). During the interview, Karla morosely told me that there are, in fact, major barriers that cause families to struggle to make a living and provide nutritious food. She says that, “[Mozambicans] are worn out from constant hunger and the struggle to support their family” (Chestnut, 2018). The country of Mozambique stays true to its traditions and values, even as adversity haunts its citizens.

Mozambicans struggle daily with the impact of malnutrition in their communities, their youth, and themselves. My interviewee stressed several times over the severity of the issue throughout the entire country, informing me that, “you could see the signs everywhere... a lot of stunting, red hair, bloated bellies... there is no way you could ignore it” (Chestnut, 2018). The crisis is so severe that one third of all Mozambicans live with food insecurity, resulting due to the lack of vital nutrients in their diets (Mozambique: Nutrition Profile, 2018). Undernutrition is also caused by low meal frequency, poor feeding practices, high levels of disease, and teenage pregnancy, events that occur regularly in this nation (Mozambique: Nutrition Profile, 2018). These staggeringly high statistics continue on, especially in children. Out of the four million citizens under the age of five, 43% are stunted and even more experience other symptoms of malnutrition, such as red hair and bloated bellies (Mozambique: Nutrition Profile, 2018). In addition, 69% of children under five are anemic, and 74% of children under five are Vitamin A deficient, which negatively impacts growth, immunity and other forms of development (Mozambique: Nutrition Profile, 2018). This deficiency can also cause permanent blindness. Sadly, current attempts to cure the issue are not making a huge impact on the severity of it, only making dents in the grand scheme of the crisis. There are many contributing factors of this life-threatening issue, in Karla’s opinion, including the lack of infrastructure, underdevelopment, poverty, lack of education and salary jobs, corruption, and geographical location. There are not enough roads and paths for

Mozambicans to travel to different places to attend schooling or sell produce in different areas. The underdevelopment of the third world country limits the educational opportunities of Mozambicans. The amount of the population living under the international poverty line is frighteningly high, at sixty-three percent (Population, 2017). Millions of citizens cannot provide food for their families, let alone nutritional food. There are several reasons many Mozambicans can not access education, in result causing there to be few jobs with steady salaries. Though the country has been at peace from civil war for a few decades, corruption still resides in political parties and tribes. Also, the position of Mozambique at a geographical standpoint causes the country to be vulnerable to disastrous weather patterns and storms. These storms can wipeout whole harvests and leave hundreds without food for months (Chestnut, 2018). The malnutrition crisis affects everyone, whether they live in a small, humble village or in the cities (Chestnut, 2018). It can cause permanent, intellectually impaired minds, stunted heights, and many other irreversible development complications in children that could lead to early death and problems in adulthood (Nordqvist, 2017). Malnutrition also causes men to not have enough strength to work so their families can eat, and malnourished women do not have enough nutrients to support a developing baby during pregnancy (Nordqvist, 2017). Blood loss during childbirth, especially from constant pregnancies that are common in this nation, can become dangerous with mothers that have iron deficiency due to being undernourished (Nordqvist, 2017). Malnourishment extremely affects marginalized populations excluded from society, including the lower class and the indigenous. The impact of the malnutrition crisis in Mozambique is severely life-threatening to every citizen and is fueled by several domestic factors.

It is imperative that a solution for malnutrition in Mozambique must be as complex, widespread, and community-based as the crisis itself. Many different organizations and nonprofits have brought in recommendations and solutions to fix the problem, in both Mozambique and other neighboring African countries. One of these is Food for the Hungry, the organization that Mrs. Karla Chestnut partners with on her mission trips to Mozambique. The key piece of Food for the Hungry's vision for the end of food insecurity and malnutrition is their child sponsorships. Anyone around the globe can choose a child from their website, of any age group or gender, and can donate \$38 a month towards resources for the child. This organization has focused its efforts on, "Life-changing resources such as clean water, medical aid, food, equal educational opportunities to girls and boys, vocational training and empowerment in the midst of unimaginable hardships" (Mozambique, 2018). This organization has definitely left its impact on the children of Mozambique, allowing them to grow up healthy through the generous donations of people lucky enough to have been born in stable nations. However, due to Food for the Hungry's primary focus on the children, some adults and elderly are left out of some of the benefits the program is offering to the minors. The full front of the program's mission does not help the entirety of the people. Another country that has faced the similar issues of food insecurity and malnutrition is Ghana, an African country almost five thousand kilometers northwest of Mozambique. In recent years, Ghana has had incredible success in eliminating poverty and malnutrition in its citizens. This is due to the improvement of the country's agriculture industry and an immense amount of social reforms, both promoted by the Ghanaian government (Rau, 2015). Due to these improvements, Ghana was the first Sub-Saharan African country to meet the Millennium Development Goal of halving extreme poverty by 2015 (Rau, 2015). Before the reforms, this country also had severe malnourished citizens. In 1990, twenty-seven percent of the Ghanaian population was malnourished. However, by 2005, this number fell to less than five percent (Rau, 2015). Sadly, programs led by the government of Mozambique would likely not have this exponential effect. With the instability and unorganization of the government, it could not put together

programs like these on its own without external guidance and motivation. Due to the occurrence of only partial relief by the programs previously conducted in Mozambique to put a stop towards food insecurity and the effects of malnutrition, I have developed a solution involving modern biotechnology used in the United States currently that could provide all Mozambicans with an abundance of nutritional food they have already been accustomed to. Currently in the US, the label of “GMOs” and “GM Products” has received mixed reactions. However, I believe that our ability to genetically modify crops may be the key to providing the citizens of third-world countries with wholesome food that can thrive in the African climate. In Mozambique, the most-widely distributed and consumed crop by far is the cassava root. Cassava is a drought-tolerant, staple food crop grown in tropical and subtropical areas, which explains the large yields of it all throughout Mozambique (Montagnac, Davis, & Tanumihardjo, 2009). Also, according to Mrs. Chestnut, it is widely consumed in all different forms by Mozambicans because the crop is surrounded by decades of tradition. The root is full of protein and starch, the carbohydrates in the starchy vegetable also making it a great source of energy. However, it contains no Vitamin A and little Iron, two essential micronutrients that a large group of the population are deficient in (Montagnac, Davis, & Tanumihardjo, 2009). A lack of these minerals causes preventable blindness and anemia, both a reality for many Mozambicans and their families. Here lies the problematic phenomenon: How can Mozambicans consume vital nutrients to prevent disorder or mortality when the food that is available does not contain them? My solution to this crisis entails the utilization of the biotechnological tools available to us to edit the genome of the cassava root, which will create a new hybrid that is filled with the micronutrients currently not found in the original plant. Scientists today have the skills and equipment for the task that could potentially save millions of lives and prevent millions from the suffering of preventable disorders. By simply altering the DNA, or even adding new strands from relative plants with the revolutionary tool of CRISPR, we can be certain that with these newly fortified hybrids, the people of Mozambique would no longer be malnourished. My plan for the management of my solution in the early stages is to partner with nonprofits like Food for the Hungry that can effectively distribute these newly created plants to area farmers through mission trips put on by partners of their own, such as Orchard Hill Church. This way, the new cassava root crops can be accessible by all smallholder farmers in the Mozambican countryside, and can also be part of other nonprofits’ missions to aid the people of Mozambique with other services or resources. The only downside to genetic modification is the expensive cost that comes with it. However, with the help of well-funded companies and organizations, this project’s expenses can be covered. A similar solution to mine has been in the trial process for sometime, and the results are promising. The scientists involved claim that “the development of foods with increased nutritional value and/or content of vitamins and minerals, a process termed biofortification, is required to solve part of the problem of micronutrient malnutrition” (Adenle, Aworh, Akromah, & Parayil, 2012). The project coined “BioCassava Plus” has already been offered a 7.5 million dollar commitment by the Bill and Melinda Gates Foundation and Monsanto has also invested 6 million dollars towards this project (Adenle, Aworh, Akromah, & Parayil, 2012). If these credible and knowledgeable organizations have donated so much to a project as promising as my own, surely they will financially support mine as well. Especially with the tremendous impact on the millions of currently malnourished citizens of Mozambique. The government of Mozambique has already been very supportive of organizations like Food for the Hungry coming to the country and helping citizens there, according to Mrs. Chestnut in our interview, and I am sure they would play a supportive role in the distributing and promoting process of these new crops. This support is key in the project’s success in bringing nutrient-rich cassava into the country. Though this project promises immediate success, there are a few cultural barriers that may stand

in its way. As Mrs. Chestnut informed me, the cassava root is a huge part of the Mozambican culture. To ensure that the people of Mozambique will not reject this new type of cassava, the hybrid will be physically identical to the original plant and will still follow the same growing conditions that makes cassava yield well in this country. The only change from the original will be the added nutrients that make it so much more wholesome for malnourished men, women, and children. A barrier that might stand in the way of the project's immediate success is the GMO rules and regulations currently held in legislation in Mozambique. In the past, the government had banned importing and planting genetically modified seed. Despite their regulation in place, they still accepted GM food from countries across the globe, including the US through the USAID (Mozambique - GMO, 2006). They have since renewed the legislation and have harvested many GM crops, proving their usage necessary to obtain better yields in the nation. They have also used experimental plots to test these out, including with the first genetically modified maize, and Mozambicans are starting to understand the use that the research can have on their yields and their survival (Mozambique Harvests, 2017). Another cultural barrier that would affect this project is the ethical debate over GMOs that the United States is facing as well. However, when I asked Mrs. Chestnut if the time, money, and moral struggle was worth the project's success, she answered almost immediately that, "Yes, it is worth the try" (2018). I believe that once my hybrid cassava root solution is fully distributed and we see the incredible results of fully nourished Mozambicans living healthier lives, the project will be sustained in the country as a beacon of hope for the further development of Mozambique and its people for years to come.

I believe that my solution involving the creation and distribution of nutrient-rich, genetically modified cassava plants to all Mozambicans will be the remedy to alleviate the severe malnutrition facing everyone in the country. With many of Mozambique's citizens suffering from the effects of malnutrition, especially the children, it is imperative that a fast-acting solution that adds more important nutrients to the diet of all Mozambicans is enforced. During our interview, Mrs. Karla Chestnut told me many times over that the people of Mozambique are tired and worn, and that they need motivation to make their lives better and healthier. With these important nutrients more accessible, the suffering of malnutrition will become extinct and Mozambicans will be motivated to create modernizing changes in their daily lives that will move them forward as a nation. There is an old Mozambican proverb that states, "He who led me in the night, will be thanked by me at daybreak" (Mozambican Proverbs, 2018). We, as fellow human beings, must strive to help those less fortunate than us to live healthily and freely. With my solution, the biofortified cassava root could lead Mozambicans from the darkness of malnutrition to the daybreak of healthy life.

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