Kate Keresztes Ithaca High
School Ithaca, NY, USA
Malawi, Sustainable
Agriculture

Malawi: Long-Term Sustainability in Farming through Cassava and Mycorrhizae

Despite Malawi being a generally peaceful nation, survival is a daily fight for many Malawians. Most families and individuals in this Sub-Saharan nation, one of the world's poorest countries, have limited access to food. To many Americans and residents of other, richer nations the food crisis in Malawi would be an unthinkable horror. Food security in Malawi is threatened by the choice of crop, soil nutrient depletion, erratic weather patterns, lack of education, and ineffectual government policies. Beyond the immediate harmful effects of the lack of food, food shortages also have larger ramifications for social justice issues such as women's rights and LGBTQIAP+ rights. Replacing maize as the staple crop in Malawi with cassava and boosting crop yield with symbiotic fungi holds promise as a sustainable solution to improve food security.

In 2014 Malawi was the poorest country in the world (Tsunemine) and remains in the bottom six as of July, 2020. (Ventura) Malawi has the third lowest GDP per capita in the world, and ninety-one percent of countries have higher gross national savings. ("The World Factbook: Malawi") Half of Malawians live below the poverty line with a quarter of the total population living in extreme poverty. ("Food and Agriculture Policy Decision Analysis") Four out of five families live in poor housing conditions. Children face stunting from lack of food and nutrient deficiencies, which limits cognitive development. ("Malawi Facing Worst Food Crisis in Decade") Millions of children live in orphanages, ("Malawi" [Habitat for Humanity]) many because of the AIDS epidemic Malawi has been facing for decades. (Sharma) Currently, almost ten percent of the adult population has HIV or AIDS, placing Malawi among the ten nations with the worst HIV/AIDS epidemic in the world. ("The World Factbook: Malawi") In 2019, 923,000 people in Malawi were displaced by tropical cyclone Idai, which also caused significant crop destruction. In the wake of this disaster, many poor Malawians were left with nothing and are struggling to begin growing crops again and to provide for themselves. ("Malawi Struggles with Floods.") Malawi also suffers frequent droughts and floods, due to climate change. (Holland) Since 1964, when Malawi became an independent country from British colonialism, Malawi has maintained a peaceful democracy, despite autocratic-leaning presidents and severe corruption. The Malawian Government has a history of nepotism in bureaucratic appointments, (Chiuta) and theft and mismanagement of government funds, (Holland) which limit the effectiveness of government policies. The 2019 elections were annulled after widespread irregularities were reported and the election re-run in June of 2020 resulted in the peaceful transition of power from the incumbent Peter Mutharika to new President Lazarus Chakwera. ("Who Is Malawi's New Leader")

The extreme poverty of the nation is reflected in the living conditions of its citizens. Eighty-five

percent of Malawians live in rural areas, (“Shire Valley”) many in traditional mudbrick homes with dirt floors and thatched roofs that are damp and attractive to insects, posing a large health risk. Cities, such as the capital Lilongwe, have extensive urban slums with an average of five families per home and even more families sharing each latrine. Despite the work of organizations such as Habitat for Humanity, it is impossible to keep up with population growth. (“Malawi” [Habitat for Humanity]) The average Malawian woman will have five to six children, though many of these children will not survive to adulthood due to high infant mortality rates. Extended families live and work together. (“Malawi” [Countries and their Cultures]) Despite families barely surviving on what they have, Malawian neighbors tend to form close-knit communities that cooperate and support
each other, from sharing the cost of a bag of fertilizer to helping to pay for medicine for an ill member. (Marmion)

The Constitution of the Republic of Malawi explicitly guarantees the right to food and proper nutrition. This charter declares that the Malawian people have a claim to adequate food and that the government and legislators have an obligation to the people to promote and progress agriculture and food systems. (“Malawi” [Right to Food around the Globe]) Despite this, Malawi is plagued by food insecurity due to its overdependence on maize, which has proved to be an unsustainable crop choice. The majority of people who live in rural areas work in agriculture and seventy percent of farmers own less than a hectare of land, in what is known as smallholder farming or sometimes subsistence farming, although profits from farming alone are often not enough to support a family. (“Shire Valley”) Most of these families grow maize, which is the current staple crop, and many families subsist on boiled cornmeal called nsima. (“Malawi” [Countries and their Cultures]) Unfortunately the lack of agricultural diversification and focus on maize has caused severe soil depletion, which forces farmers to be dependent on subsidized synthetic fertilizers. Additionally, maize is very fragile and easily damaged by the erratic weather patterns caused by climate change, which are only worsening. (“Malawi: Maize Dominance”)

Soil depletion is a large problem faced by many Sub-Saharan nations including Malawi. Phosphate fertilizers are in short supply in this region, cost four times more on average than in Europe or the United States, and unlike in the rest of the world, the cost is not decreasing. (“The World’s Most Expensive Fertilizer Market”) The United Nations Food and Agriculture Organization *(UNFAO or FAO)* calls for conservation agricultural practices such as no-till planting to prevent soil depletion, but studies show that this may decrease crop yield, which smallholder farmers cannot afford. Planting legumes to restore nitrogen to the soil has also been proposed but most farmers cannot bear the labor, time, and opportunity costs of growing a crop that does not provide as much immediate food as maize. (Gilbert)

The Ministry of Agriculture and Food Security launched many programs to support agricultural productivity in Malawi. Most of these programs focused on improving the yield of maize and cash crops. Past and current solutions implemented include government subsidies for

agricultural needs, such as seed and inorganic fertilizers, which did not reach production targets and have proved to be financially unsustainable. The Malawian government depended on foreign donors to support critical programs such as agriculture and when the former president Mutharika's administration shifted towards authoritarianism, this essential income for Malawi was lost. (Tafirenyika) In 2016, now President Lazarus Chakwera criticized Mutharika's agriculture and food security policies, speaking on the need for long-term solutions for food insecurity and falling agricultural productivity, rather than simply focusing on the immediate problem. He also called for policies that work for all stakeholders across value chains—farmers, non-governmental organizations, unions and others—and that provide improved access to supply chains for all. (Chakwera) President Chakwera's campaign promised to build a developmental state, and several of his initiatives focused on agriculture. He also promised to reform industries that are connected to agriculture in order to increase the value of crops and farm work, as well as to create one million new jobs. ("Who Is Malawi's New Leader") However, his proposed universal fertilizer subsidy is both very expensive for a poor government and will not boost crop yield in a sustainable fashion. Phosphate fertilizers must be reapplied annually and the poorest farmers will still not be able to afford the amount of fertilizer they would need to properly add nutrients to their fields. The Malawian government has acknowledged the risks they face using maize as their staple crop. The newsletter

of the Ministry of Agriculture, features an article that criticizes the Ministry's programs that solely promote maize and calls for a shift away from maize as the staple crop. The article continues that until there is greater crop diversification and a new governmental agriculture focus on other crops, Malawi will always be food insecure. (Kachaje)

Cassava has been growing in popularity in Sub-Saharan agriculture for several reasons and is the second most grown crop in Malawi, although still far behind maize. ("National Agricultural Investment Plan") Cassava is much hardier than maize, able to survive long droughts, can yield three times more food than maize on the same amount of land, (Madamombe) and requires lower quantities of valuable resources such as water and fertilizer . (Aye et al.) Cassava is also more long-term sustainable than other crops due to its resistance to climate change, an increasing threat to today's agriculture. (Sanders) The Malawi National Agricultural Investment Plan (NAIP), started in 2018, recognizes cassava as a significant crop in Malawian agriculture. In its analysis of the Agricultural Sector, it notes that the nation's dependence on maize in agriculture leaves the country at a serious risk in an uncertain future and suggests cassava as a needed crop for diversification. A look at recent performance in the agricultural sector shows maize production plateauing far below target production goals due to maize's vulnerability to climate change and need of resources, while cassava production has increased dramatically as genetically improved varieties enter Malawian markets. The Ministry of Agriculture's strategic considerations for the investment plan earmarks cassava as having "strong potential to contribute to food and nutrition security" and notes the many uses of cassava in both smallholder and commercial settings, as well as its useful biological traits and the potential for

value addition. (“National Agricultural Investment Plan”) Cassava can be used not only to feed smallholder farmers and families throughout the country, but could also become a valuable export in the global economy. Cassava can be eaten as a dish in itself, or made into high quality flour that can be used in baking, which would also allow Malawi to decrease wheat imports, and promote domestic agriculture. Cassava: Adding Value for Africa was a program that promoted growing cassava for the purpose of making flour, in order to provide income for poor families and disadvantaged groups such as women. The project was implemented in five African nations, including Malawi, and has impacted over ninety-thousand households. (“About CAVA II”) Excess cassava could be exported as there is demand for the crop in markets for animal feed, food processing, and biofuels. (Aye et al.) This would help Malawi become a greater player in global economic affairs and increase its low GDP. The Consultative Group on International Agricultural Research (CGIAR) maintains that if improperly planted, cassava can cause soil erosion, but that this is true for most crops and the group argues that this erosion can be combated. The International Center for Tropical Agriculture, a division of CGIAR, has researched best growing practices to mitigate any negative effects, improving the already powerful crop. (Aye et al.)

Cassava yield can be further increased and made more sustainable through a partnership of the tuber with mycorrhizal fungi. Mycorrhizal fungi, or mycorrhizae, are microscopic fungi that live in the root system of a plant. They work in symbiosis with the plant, exchanging water and nutrients from the soil for the sugars made through photosynthesis. The majority of all plants are dependent on this symbiosis for healthy growth. Despite already being present in most soils, boosting the mycorrhizae in soils has a large impact on crop yield. Mycorrhizal fungi inoculum, or lab-produced mycorrhizae, can come in several different forms. Pure innocula, or a gel with concentrated mycorrhizae would be one option. Easier options for Malawian farmers would be mixed inocula, where mycorrhizal fungi are combined with other materials such as charcoal or plant matter to form powders that can be sprinkled in planting holes, or in the form of pre-inoculated cassava cuttings. For seed crops, the fungi can be mixed into the seed packs. Mycorrhizal fungi are much more

efficient than fertilizers. They are a renewable resource as they are living organisms, unlike phosphate supplies, which may soon run low, posing a threat to agricultural practices that depend on them and raising the price of fertilizer, which has large ramifications for poor farmers. (Sanders) Already, it is clear that mycorrhizal fungi could be much cheaper for farmers. In 2016 in Illinois, fertilizer for corn cost 380 USD per hectare (Schnitkey), which is about a quarter of the cost of fertilizer in Sub-Saharan Africa, (“The World’s Most Expensive Fertilizer Market”) while mycorrhizal fungi are already produced commercially for as low as 135 USD per hectare. Additionally, a single application of mycorrhizal fungi typically lasts a minimum of two years, (“Mycorrhizae FAQ”) while inorganic fertilizers need to be applied more frequently. Mycorrhizal fungi can also boost disease resistance and prevent soil erosion. (Chen, et al.)

Large field tests in Columbia showed that mycorrhizal fungi could greatly boost cassava yield in tropical soils, especially in Sub-Saharan Africa. One of the research goals was to assess the environmental impact of introducing mycorrhizae on native soil cultures, but as scientists can use local species in their inoculum blend this potential environmental risk can be mitigated, reduced, or avoided. (Sanders) The European Commission has successfully studied mycorrhizal fungi in smallholder agriculture in cooperation with China. ("Mycorrhiza Technology") A German-Chinese research project that conducted field tests all over the world concluded with a recommendation to "emphasize the importance of integrating AM [arbuscular mycorrhizal] fungi in sustainable agriculture." (Zhang)

The tests in Columbia successfully used a combination of media attention, scientific publications, and outreach at universities to get Columbian farmers involved. The team worked with mycorrhizae producers to develop better inoculum that could be sold at a lower price to not only encourage the use of it by commercial entities, but also small-scale farmers. (Sanders)

Implementation of mycorrhizal fungi to boost Malawian agriculture can take several pathways. Under their Agriculture Sector Wide Approach (ASWAP) guidelines ("ASWAP") and their agriculture extension methods, the Malawian Ministry of Agriculture and Food Security has many outreach methods in place to effectively reach farmers and this system could be harnessed to implement this project. ("Agricultural Extension Services") These extension services could be key to disseminating information about cassava and mycorrhizal fungi and bringing about the needed cultural shift towards cassava from a dying system and towards trusting a novel technique such as mycorrhizae that work better than phosphate fertilizers. The Internet-based dissemination of farming practices, generally referred to as agricultural digitalization, has shown promise in Africa as it allows farmers to better understand agricultural processes and have better access to materials, maximizing the productivity of their crop. (Kah) The current wave of digitalization could help provide education to farmers, teaching them how to maximize cassava productivity and minimize soil erosion. However, while these programs may increase the efficiency of farming, much of Malawi lacks the technological infrastructure required to benefit. (Marron, et al.) Additionally, the project should be done in cooperation with non-governmental organizations or an international coalition both to help attract foreign donors and to protect the program from corruption, which, as President Chakwera notes, has happened to vital agricultural programs in the past. (Chakwera)

Malawi's existing countrywide Farm Input Subsidy Programme (FISP), which aims to improve the access of poor farmers to fertilizers and seed, is focused on increasing the production of maize and cash crops. ("FISP") Although this program is problematic due to the financial unsustainability of subsidies and their uneven benefit to farmers of different wealth, it could be expanded or converted

to cover mycorrhizal inoculum and cassava cuttings that are used to propagate the plant, and help drive the shift among Malawian farmers. Mycorrhizal fungi could also be one of the methods disseminated by the Sustainable Agricultural Productivity Programme's (SAPP). SAPP aims to achieve sustainable agriculture intensification through teaching farmers ways to improve the productivity of their current fields. ("SAPP") While mycorrhizal fungi in combination with cassava would be ideal, research has shown that many other common crops can also benefit from growing in symbiosis with mycorrhizal fungi (Zhang) and providing information and inoculum to poor farmers should help decrease the yield gap in Malawi.

There are numerous possible sources for foreign aid to fund these programs. The EU and the European Commission have already shown an interest in the use of mycorrhizal fungi in smallholder agriculture, ("Mycorrhiza Technology") the FAO has acknowledged that mycorrhizal fungi are essential for cassava growth, ("Save and Grow") and USAID has previously helped design and fund Malawi food security projects. ("USAID Partners Govt") These major organizations could partner with the Malawian Ministry of Agriculture and Food Security in order to try to create lasting solutions for Malawian hunger through the implementation of programs to shift Malawian agriculture away from maize and towards cassava and mycorrhizae, as well as to grow and sell mycorrhizal inoculum at its actual low cost or at a subsidized price.

With a new, internationally-funded program to improve food security and generate acceptance for new farming techniques, cassava and mycorrhizal fungi will begin to make a large difference for the people. Cassava will allow poor farmers to harvest more food than they do with maize and at better times of the year, be better prepared for climate change, and spend less money on their crops at the same time as making more from them. Mycorrhizal fungi will further improve crop yield, increase sustainability by reducing the use of fertilizers, and allowing farmers to better utilize the resources in their soil, while decreasing the cost of farming.

With sustainable agriculture practices, Malawians can begin to survive, and then thrive, in the long term. While they may need assistance to start the shift, this solution offers future food independence for Malawi so the fates of Malawians are no longer tied to the whims of foreign donors and ineffective policies. If the people of Malawi were nourished, more resources could go towards human rights and social justice. With enough food, the status of women in society could rise as they are able to support themselves and their children, granting them more independence and the ability to look to a more equal future, not just the next meal. (Madamombe) Children will be healthier and safer when properly nourished, and with more money for the family more children could go to school and stay in school for longer, educating the future generation of the country and the world. There would also be greater government funds available to invest in improving housing and medical care. The effects of a well-fed population would make a world of difference to Malawians, beyond fulfilling the constitutional promise that makes food security a right. Sustainable agriculture has the power to feed a nation, empower its people, and through this raise a country to a brighter future, which is just what

cassava and mycorrhizal fungi could do if given the chance.

5

Works Cited

"About CAVA II." *CAVA II* , CAVA II.

"Mycorrhizae FAQ." *AgBio* , AgBio, Inc..

"Agricultural Extension Services." *Ministry of Agriculture and Food Security* , Ministry of Agriculture, Irrigation & Water Development.

"ASWAP." *Ministry of Agriculture and Food Security* , Ministry of Agriculture, Irrigation & Water Development .

Aye, Tin Maung, et al. "Debunking Myths on Cassava." *Thrive* , CGIAR, 3 Mar. 2016.

Chakwera, Lazarus. "Response to the State of the Nation Address by the Head of State." State of the Nation Address, 23 May 2016, National Assembly of Malawi, Lilongwe, MWI. Address.

Chen, Min, et al. "Beneficial Services of Arbuscular Mycorrhizal Fungi – From Ecology to Application." *Frontiers in Plant Science* , vol. 9, Sept. 2018. *PubMed Central* , doi:10.3389/fpls.2018.01270.

Chiuta, Wongani. “Chilima Chides Nepotism in Malawi Government.” *Nyasa Times* , Malawi
Nyasatimes, 23 Feb.
2020.

“FISP.” *Ministry of Agriculture and Food Security* , Ministry of Agriculture, Irrigation & Water
Development
.

Food and Agriculture Policy Decision Analysis: Malawi . Food and Agriculture Organization of the
United Nations, Mar.
2015.

Gilbert, Natasha. “African Agriculture: Dirt Poor.” *Nature News* , vol. 483, no. 7391, Mar. 2012, p.
525.
doi:10.1038/483525a.

Holland, Cornell. “Answering a Question: Exactly Why Is Malawi Poor?” *BORGEN Magazine* , The
Borgen Project, 24 Aug.
2017.

Kachaje, Henry. “Food Security- Wrong Formula.” *Agri-e News* , Vol. 3, May
2015.

Kah, Muhammadou M. O. “Africa Is Leapfrogging into Digital Agriculture.” *Africa Renewal* ,
United
Nations.

Madamombe, Itai. “Is Cassava Africa’s New Staple Food?” *Africa Renewal* , United Nations, July
2006
.

“Malawi.” *Habitat for Humanity* , Habitat for
Humanity.

"Malawi." *Countries and Their Cultures* , Advameg, Inc..

"Malawi." *Right to Food around the Globe* , FAO.

"Malawi Facing Worst Food Crisis in Decade, Requires $81 Million in Relief Aid." *Africa Renewal* , United Nations.

"Malawi: Maize Dominance Worsens Food Crisis" *ReliefWeb* , OCHA, 4 June 2002.

"Malawi Struggles with Floods." *Habitat For Humanity* , Habitat for Humanity.

Marmion, Suzanne. "Living on a Dollar a Day in Malawi." *NPR* , NPR, 1 Oct. 2006.

Marron, Orla, et al. "Factors Associated with Mobile Phone Ownership and Potential Use for Rabies Vaccination Campaigns in Southern Malawi." *Infectious Diseases of Poverty* , vol. 9, no. 1, June 2020, p. 62. *BioMed Central* , doi:10.1186/s40249-020-00677-4.

"Mycorrhiza Technology for Staple Food Crop Production in Small-Scale Sustainable Agriculture in China." *European Commission* , EU Publications Office.

National Agricultural Investment Plan . Ministry of Agriculture, Irrigation and Water Development, Jan. 2018.

Sanders, Ian. "Our Long-Term Goals: Reducing Poverty and Hunger." *The Mycorrhizal Symbiosis* , University of

Lausanne.

Save and Grow: Cassava . Food and Agriculture Organization of the United Nations, 2013.

“SAPP.” *Ministry of Agriculture and Food Security* , Ministry of Agriculture, Irrigation & Water
Development
.

Schnitkey, Gary. “Fertilizer Costs in 2017 and 2018.” *Farmdoc Daily* , University of Illinois Board
of Trustees, 11 June
2017.

Sharma, Manohar. “Orphans in Malawi.” *International Food Policy Research Institute* , CGIAR,
2005
.

“Shire Valley Transformation Programme-1.” *Ministry of Agriculture and Food Security* , Ministry of Agriculture, Irrigation & Water Development.

Tafirenyika, Masimba. “What Went Wrong? Lessons from Malawi's Food Crisis.” *Africa Renewal* ,
United Nations, Jan.
2013.

Tsunemine, Kenshi. “Vol. 13: Malawi”. *Marubeni* . 10 Aug. 2015.

“The World Factbook: Malawi.” *Central Intelligence Agency* , Central Intelligence Agency, 1 Feb.
2018
.

“The World’s Most Expensive Fertilizer Market: Sub-Saharan Africa.” *Gro Intelligence* , Gro
Intelligence, 2 Dec.
2016.

"USAID Partners Govt to Promote Livelihood." *Agri-e News* , Vol. 3, May 2015.

Ventura, Luca. "Poorest Countries in the World 2020." *Global Finance Magazine* , Classeditori, 22 July 2020.

"Who Is Malawi's New Leader Lazarus Chakwera?" *DW* , Deutsche Welle.

Zhang, Shujuan, et al. "Arbuscular Mycorrhizal Fungi Increase Grain Yields: A Meta-analysis." *New Phytologist* , vol. 222, no. 1, Apr. 2019, pp. 543–55. *DOI.org (Crossref)* , doi:10.1111/nph.15570.