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Tanzania - Sustainable Agriculture

Tanzania: The Next Chapter of “Green Revolution” Agriculture

When looking at the many developing countries worldwide in need of agricultural innovation and advancement for the purpose of providing a greater food security for the countries’ populations, no region of the world is in more need of agricultural and environmental reform than the region of Sub-Saharan Africa. With an environment plagued with malnourished soils, scarce natural (and man-made) irrigation, and virulent diseases capable of massive crop destruction, Sub-Saharan Africa has historically suffered deadly famine over entire regions for multiple years. Focusing specifically on the country of Tanzania, located on the east coast of Africa, with a plurality of agricultural, environmental, and infrastructural issues greatly hindering its agricultural yield capabilities, it is clearly seen that the major issue of hunger must be both considered and feared on a regular basis by a significant portion of Tanzania’s population. While the prospect of hunger and malnourishment for thousands of families in Tanzania is undeniably a serious concern, other countries throughout the second half of the 20th Century were able to effectively overcome many similar issues to the ones faced by Tanzania today. These countries, including India, Pakistan, Turkey, Bangladesh, and others were often able to become self-sufficient in wheat as well as many other cereal grains and rice and successfully grow agricultural production to the point where the growth of food in these countries outpaced the countries’ population growth. Such a massive agricultural change that was achieved in those countries throughout the 1960’s and 1970’s could only be conceivable in the minds of most people if some agricultural catalyst had been responsible for such a massive agricultural revolution.

This catalyst was found in the series of genetic and procedural agricultural advancements developed in the 1940’s to the 1960’s which made possible “The Green Revolution” throughout many parts of Asia and later Latin America. Before a strong understanding of the reasons for the overwhelming success of The Green Revolution in Asia and Latin America in preventing widespread famine can be obtained, first a rudimentary knowledge must be assembled of the many agricultural innovations which later led to those outstanding agricultural revolutions. For this reason, a basic description of the agricultural work of Dr. Norman Borlaug and his team of agronomists in Mexico will be detailed, specifically focusing on the advancements made in wheat crops, which would later prove to save hundreds of millions of lives across the developing world.

Without any doubt, it is clear that Dr. Norman Borlaug and his agricultural innovations in wheat have saved more lives in many developing countries from famine than has the innovations of any other agronomist or scientist in all of human history, and the impact of Dr. Borlaug’s work is omnipresent still in today’s world. Through an understanding of Dr. Borlaug’s genetic and procedural innovations in the Mexican wheat crop throughout the 20th Century, a greater understanding of the necessary criterion to solve the many agricultural issues seen in Tanzania and much of Sub-Saharan Africa can be established. Borlaug was first assigned the daunting task of developing wheat crops in Mexico that were resistant to the virulent and shifty stem, leaf, and stripe rusts, fungal diseases plaguing the old Spanish wheat being overwhelmingly planted in Mexico before Borlaug’s innovations. Furthermore, Borlaug was also tasked with creating higher-yielding strains of rust-resistant wheat crops, while also developing new agronomic practices to further increase wheat yields in Mexico.

Considering the magnitude of the tasks assigned to him, Borlaug understood that many instances of

innovation would be necessary to achieve his lofty aspirations. Dr. Borlaug pioneered a “shuttle breeding” program in Mexico, where he crossbred and developed new wheat varieties twice in a single year at two different planting locations in Mexico, contrary to the customary planting practice of planting only once a year. Specifically, shuttle breeding in Mexico was achieved through planting strains of wheat at two vastly different altitudes in Mexico, namely the Sonora and Bajio regions, which, due to their differing altitudes, had different planting and harvesting seasons for wheat. Borlaug was able to rapidly speed up the normally decade-long process of genetically breeding wheat crops for specific genetic traits. This unorthodox breeding method worked just as Borlaug had predicted it would, achieving Borlaug’s first goal of efficiently distributing improved wheat varieties to the rural Mexican farmers who were in great need of a disease-resistant wheat crop.

Later, the discovery and widespread distribution of the Norin 10 dwarfing gene discovered in Japan, which Borlaug bred with improved Mexican varieties of wheat, was effective in developing improved, short-stemmed varieties of wheat resistant to lodging (falling over) due to fertilizer use, dramatically increasing Mexican wheat yields throughout the 1960’s and beyond. After viewing these stable and successful wheat yields, Borlaug then shifted his focus to agronomic practices capable of sustaining high wheat yields, developing and implementing techniques for irrigation, fertilizer use, as well as developing optimal times for planting and harvesting dwarf-wheat crops for the highest possible yield. The successfulness of Dr. Borlaug’s work can be seen through the fact that “[Mexico’s] national wheat yield rose from 750 kg./ha [in 1945] to ... 4100 kg./ha in 1980” (Borlaug, 1982), clearly displaying the massive growth and success of Dr. Borlaug’s high-yield agriculture and agronomic techniques throughout nearly all of Mexico.

Just as important to the agricultural and agronomic needs of Tanzania and Sub-Saharan Africa as Borlaug’s innovations and improvements in Mexico was the successful implementation of Borlaug’s crops and agricultural practices into developing countries (most notably India and Pakistan) - an implementation that could mirror a viable method of agricultural and agronomic implementation in Tanzania. For this reason of comparison, the implementation of Dr. Borlaug’s agricultural technology into developing India throughout the late 1960’s will be analyzed, and possible parallels between the agricultural development of India and a possible mode of further agricultural development in Tanzania’s future will be explored.

As will be necessary in Tanzania, bold decisions involving risk were instrumental to the agricultural and agronomic success of India’s Green Revolution throughout the late 1960’s and early 1970’s, ultimately leading to India’s self-sufficiency in all cereals by 1974 (Hesser, 2009). Dr. Borlaug’s first outstanding decision was the shipping of 200 tons of Mexican Dwarf Wheat seed into India for wide-scale farm testing (Hesser, 2009), giving the “common” Indian farmer the chance to plant the Mexican crops and, through seeing the drastic increase in crop yield in the new varieties, adopt Borlaug’s innovations in high-yield agriculture. This approach taken in India is one that has been attempted in Tanzania, but must be greatly expanded upon if the wide-scale success observed in India following the mass importation of Mexican varieties is to be seen in Tanzania. Likely even more important than Dr. Borlaug’s first bold decision was Borlaug’s ability to convince prominent Indian government officials into supporting his agricultural project in India. Both Borlaug’s convincing of S.C. Subramaniam, India’s Minister of Food and Agriculture, and later Indian Deputy Prime Minister Mehta would amount in the mass importation of 18,000 tons of Mexican Dwarf Wheat seed into India and later the adoption of much-improved fertilizer policies in India, both contributing greatly to India’s agricultural success. While previously India was heavily reliant on the United States in importing large amounts of grain to feed its growing population, India became self-sufficient in all cereals by 1974 and was able to sustain its large and growing

population, proving the Green Revolution to be a massive success in the Indian subcontinent. This clear method of strong leadership willing to take risks, government backing of improved agricultural technologies, and a constant flow of agricultural technology to the small-scale farmer is precisely what is needed to address the issue of agricultural sustainability in Tanzania.

Tanzania, a Democratic Republic on the coast of East Africa with a population of about 53 million and a national poverty rate of 28.2% (IFPRI, 2015), has been recently ranked 152nd out of 187 in the UN Human Development Index (IFPRI, 2015) and shows a high rate of inflation in addition to high agricultural imports relative to agricultural exports. This disparity between imports and exports is especially significant considering that 25% of Tanzania's GDP comes from agriculture, making agricultural exports essential to Tanzania's national economy (WFP, 2017). While Tanzania has shown a large increase in the production of both Maize and Rice (Tanzania's staple crops), rising from a combined yield of 6,589,143 MT in 2011 to 9,358,231 MT in 2014 (IFPRI, 2015), the major issue of food security and malnutrition for Tanzania's poor population is continuing to grow in its severity. As described by a UN report, "improving children's well-being at the earliest age must be an integral and systematic component of education and poverty reduction [in Tanzania]", further denoting the importance of improving the lives of the over 2.7 million Tanzanian children whose growth is stunted or are suffering from acute malnutrition (OCHA, 2018). While both the Tanzanian government and private organizations are taking steps in the right direction regarding commercializing agriculture and supporting local farmers through the SAGCOT (Southern Agricultural Corridor of Tanzania) initiative, an ongoing attempt to revitalize a large portion of south Tanzania with modernized crops and agricultural processing facilities, a desperate need of fertilizer and other Green Revolution-era techniques has caused the SAGCOT initiative to fall short of its true potential (OCHA, 2018).

Furthermore, a general lack of access to markets, banks, and infrastructure in parts of rural Tanzania, such as well-maintained roads and crop storage facilities, has further dampened Tanzania's potential agricultural exports, helping to explain why Tanzania is classified as a low-income country by the IFPRI (International Food Policy Research Institute). While Tanzania is undoubtedly in a dire situation, marked most clearly by the fact that 34% of children under five in Tanzania suffer from malnutrition (WFP, 2017), a cooperating Tanzanian government combined with a strong amount of global and regional aid in Tanzania can provide a stable foundation upon which Tanzania's major issues of sustainable agriculture and malnutrition can be successfully addressed.

Tanzania will need to utilize Green Revolution-era technologies and recent agricultural innovations on a far greater scale if it hopes to see agricultural results anywhere close to those observed in India's Green Revolution. Broadly speaking, Tanzania will need to improve its distribution of high-yielding crop varieties, fertilizer, and irrigation techniques, while also dedicating more government resources to agricultural-related infrastructure and greatly improving Tanzania's agribusiness sector, an underdeveloped but highly lucrative market for Tanzania. To generalize the agricultural aspects of Tanzania's necessary improvement, Tanzania must move as a whole nation from subsistence farming to being able to sell and export crops to regional and global markets, allowing both the majority of Tanzanian farmers and Tanzania's national economy to benefit greatly. The great need for this change in Tanzanian agriculture is seen in one economist's analysis of Tanzania's agribusiness sector: "Tanzania could be a major food-exporting country but currently struggles to meet its own food requirements due to low productivity and the predominance of subsistence farming." (Wolter, 2008). Through a government focus on improving infrastructure, most importantly being improved roads, and greatly improving Tanzanian farmers' access to improved maize varieties (maize being the predominantly grown crop in Tanzania) and other necessities such as fertilizer and improved irrigation techniques, farmers in Tanzania

will have both a far greater crop yield and the means to move their crops to a local or global market for large profits.

Furthermore, while the transition from subsistence farming to regional and global agricultural economies in Tanzania is established, something must be done concerning the massive issues of malnutrition and hunger in much of Tanzania, and a solution must give increased support to the large number of Tanzanian children, who suffer greatly from malnutrition and who will likely suffer from growth stunting and impaired physical development if they are not provided with essential nutrients for their growth (UNICEF, 2017). While many options are available to temporarily alleviate (or improve) malnutrition in Tanzania, what is being done now in Tanzania is far from adequate, seen in UNICEF's claim: "Key high-impact interventions such as the promotion of infant and child feeding practices and management of severe acute malnutrition are underfunded, resulting in inadequate coverage" (UNICEF, 2017).

One organization that could greatly improve Tanzania's current child-based malnutrition problem is "PowerFlour International, Inc.", an organization that, understanding the difficulty of providing adequate nutrients necessary for the short and long-term growth of a weaning child, provides food-grade malted barley (in a powder form) used for the improvement of the Tanzanian infantile staple food of porridge. With many essential vitamins and nutrients necessary for both infantile and child growth, this improved and easily digestible porridge has improved the nutrition of thousands of families across Africa, Latin America, and Asia. It is known that many infants in parts of Africa are weaned off of breastmilk with a maize-based porridge called togwa, which is often heavily diluted with water so that infants will be able to safely swallow and consume it. Because the porridge is so heavily diluted with water, many infants in Tanzania are not receiving anywhere close to the necessary nutrient requirements for their optimal growth from this heavily diluted porridge (this is true regardless of the use of QPM, or high-quality protein, varieties of maize) (Hesser, 2009).

The purpose of PowerFlour is to make the togwa porridge more palatable for infants while still holding the essential amount of vitamins and nutrients essential for child growth and development. PowerFlour creates the improved porridge through the addition of malted barley, a powder rich in starch-digesting enzymes capable of liquefying all starches (including maize), into the maize-based porridge. A chemical reaction known as fermentation occurs between the malted barley and the starch-based porridge, resulting in the transformation of the solids in the porridge into liquids, allowing infants to consume the porridge with ease without the sacrifice of essential maize-based vitamins and nutrients being lost due to dilution of the porridge with water. As explained in the Handbook of Indigenous Fermented Foods, "the energy density of such [fermented] gruel is 1.2 kcal/g as compared to 0.4 kcal/g in nonfermented gruel at the same capacity", demonstrating a threefold increase in the potential nutrient density of the essential infant meal of porridge (Steinkraus, 1995). With this knowledge, it is clear the strong positive impact that PowerFlour could have on improving the lives of many Tanzanian infants and their families.

Founded by Dr. Noel Vietmeyer, both a prominent researcher and humanist on the topic of economic growth in much of developing Africa, PowerFlour has donated enough material across the developing world to create 50,000,000 meals for malnourished children in an essential stage of their lives (PowerFlour, 2017). The effects of PowerFlour are already pronounced in parts of Africa and Vietmeyer's organization has continued to import its modified barley malt for over 20 years, showing a clear dedication to the topic of infantile and child malnutrition in Africa. While the expansion of PowerFlour into Tanzania would undeniably provide a strong short-term solution to Tanzania's issue of infantile malnutrition, PowerFlour's agricultural aid in Tanzania should not be over-relied upon, as PowerFlour's activity in Tanzania is only meant as an immediate relief to a dangerous food-related situation while the

overarching issues of infrastructure, high-yield maize crops, improved agronomic practices, and a general transition from subsistence farming to farming for financial gain is established.

While the issue of child-based malnutrition in Tanzania is being addressed, more must be done in Tanzania to stabilize and grow agricultural yields to alleviate hunger and promote economic gain for the majority of Tanzanian citizens, prompting the need for further investment by both Tanzanian and western governments into the broader issue of agricultural sustainability in Tanzania. One initiative working to strengthen Tanzania's infrastructure, economy, and agriculture in the hopes of achieving sustainable agriculture in Tanzania is the United States' global hunger initiative called "Feed the Future", an initiative already providing aid to many parts of central Tanzania. Feed the Future has already had a positive impact in Tanzania, as the initiative has previously provided revolutionary agricultural technologies and practices to over 185,000 farmers in central Tanzania and provided nutritional support to over 1.1 million children under five in Tanzania in less than a decade (FeedTheFuture, 2016).

Regarding the specific goals of "Feed the Future" in Tanzania, the US initiative holds three main goals in promoting agricultural sustainability. Firstly, Feed the Future hopes to provide greater access to beneficial agronomic practices, such as affordable fertilizer and improved irrigation techniques, while also improving and expanding roads in rural Tanzania, giving farmers the means to bring their maize and rice yields to local and global markets (FeedTheFuture, 2016). Secondly, Feed the Future has decided to dedicate a substantial amount of resources specifically to maize farming, with the hopes of improving maize cultivation and further implementing biofortification (meaning cross-bred or transgenically altered crops with a higher nutritional content) in maize crops across Tanzania, giving a long-term solution to the issue of malnutrition in Tanzania (FeedTheFuture, 2016). Equally important is Feed the Future's final goal, regarding sustainable agriculture, of making further investments into horticulture and a wide variety of agronomic and agricultural improvements for the general Tanzanian population, giving all Tanzanians a greater chance to make the difficult shift from subsistence farming to fiscally beneficial farming through the sale of crops at a local or regional level (FeedTheFuture, 2016). Feed the Future has already made significant progress in bringing the previously mentioned goals to fruition in smaller regions of Tanzania, but further expansion of Feed the Future in Tanzania will be necessary to bring the most amount of improvement and economic opportunity to the greater Tanzanian population.

Through the U.S. government's support of many of the same biotechnologies and agronomic processes in Tanzania favored by Dr. Borlaug throughout the Green Revolution, as well as the U.S. government's clear support behind Tanzanian agriculture and Feed the Future's clear impact on the continued growth of Tanzania's agro-business sector, Feed the Future has established itself as an important asset in need of strong support from the Tanzanian government. Just as many other developing countries struggling with famine have relied on global powers such as the United States to strengthen their economies, Tanzania should support the significant agricultural, infrastructural, and nutritional aid being provided by the United States, and needed by many Tanzanian citizens, until Tanzania is at least a strong enough economic force in its region to provide a stable source of nutritious food for its developing and growing population.

If both these short-term and long-term goals are established in Tanzania, Tanzania will undoubtedly improve itself economically, financially, and have a generally healthier population as its driving workforce into the mid-21st Century. This will allow Tanzania to firmly establish itself on both a regional and global scale in a matter of decades and achieve sustainable agriculture for the Tanzanian people.

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