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Tanzania: Five Methods for Increasing Maize Production in Tanzania

Over a billion people suffer from hunger worldwide. In just one country, Tanzania, there are over one in three people living in poverty and large families are frequently crammed into small windowless huts, eating largely one energy crop daily such as maize. Tanzania is a country with 42 million people (World Bank), 14,280,000 (AGRA) people are living undernourished, being starved on a daily basis, without a chance to improve their lives. When people are being starved, they don't have the energy for work and are more likely to become ill with diseases and to die from them (over 600,000 children under five die of malnutrition per year). Tanzania is agriculturally dependent country, as 80% of the population works in the farm sector (AGRA). Prices for food are higher than they might be because of poor farm management, harvesting and storage practices, which result in 40% of produced food being lost. Tanzania is a poor East African country that is heavily dependent on maize for calories, but maize yields are low. This paper highlights five methods for increasing the quantity of maize produced and its nutrient content.

An important ally for the US, Tanzania has overall displayed political stability and national unity for the past forty years. Per capita income in Tanzania is \$400 (AGRA). As Tanzania faces tough challenges, the government has increased investment and commitment towards the small farms. It has done so by giving at least 10% of the countries national budget towards the development of agriculture and rural areas (AGRA). Though taking this initiative towards improving the country has helped some, it has still left thousands of people starving.

Education, health, water, and services available all depend on the household, as the typical family consists of 6.1 persons (Anderson, Tanzania Agricultural Sector Overview). The wealthier the family, the smaller the size of the family (an average of 7 people in poorest/lowest quartile of income, while 5 household members in the wealthiest quartile). Also, larger households tend to be rural and children are a major source of farm labor due to very labor intensive farming practices. The average age of the household head is 43 years old (75% of households are headed by men). Also, life expectancy in Tanzania is 58 years at birth, which is moderate for a poor country. Most commuting involves walking; only 12% of household own bicycles and a much smaller percentage own cars (Anderson, Tanzania Agricultural Sector Overview). Poor people can be identified based on expenditure and housing conditions. Only 1.4% of Tanzanian rural houses have access to electricity, but access is higher in urban areas (World Bank, Tanzania). Wealth in rural area is associated with land, some households are landless and others own small amounts of land while wealthy households own large amounts of land (roughly 88%). The average amount of land owned is 5.9 acres per household. A second asset is owned farm animals, with farm households averaging owning approximately 6.9 animals. Maize is a highly preferred source of food and leading source of calories for Tanzanians. Per capita consumption of maize in Tanzania is approximately 115 Kg per year and 75% of cereal consumption in the country. National consumption of maize is projected to be three to four million tons per year and it accounts for 31% of the total food production. It has been estimated that 85% of Tanzania's population depends on maize as an income-generating commodity. Although maize is one of the most important crops needed in Tanzania, a major barrier to improving agricultural productivity is no access to high yielding corn varieties (Anderson, Tanzania Agricultural Sector Overview).

The average farm size in Tanzania is 2.4 hectares, and the most common crops produced are maize, cassava, sweet corn, bananas, and sugarcane. Also, 82% of farmers produce maize and the average maize yield is 20-25 bushels per acre, which is very low. Maize also accounts for 30% of the agricultural Gross

Domestic Profit (GDP) in Tanzania. However, only 28% of maize grown is marketed and the rest is consumed by the farmer. Most of the staple crops are marketed informally such as in front of their house or farm gate because formal markets tend to be five to ten kilometers away from their house, and traveling this distance is difficult because the only method of transportation for most people is by foot. Thirty-seven percent of farmers have livestock (Tanzanian Ministry of Agriculture).

The adaptability and popularity of maize is evidenced by the fact that it is grown in all the agro-ecological zones in the country. Over two million hectares of maize are planted per year with average yields of between 1.2–1.6 tons per hectare. Maize accounts for 31% of the total food production and constitutes more than 75% of the cereal consumption in the country (Anderson, Tanzania Agricultural Sector Overview). About 85% of Tanzania's population depends on it as an income-generating commodity. Since maize is the leading food crop and farm produced crop in Tanzania, farmers and consumers could be made better off if maize yields and nutrient concentration could be increased at a modest investment in resources. Possibilities include (1) increasing fertilizer application, (2) adopting StrigAway technology to control a parasitic weed (3) improving drought tolerance, (4) enhancing vitamin A content to improve eyesight, and (5) developing improved plants that contain enhanced insect resistance. The later pest control is a substitute for unavailable insecticides or as a replacement for insecticides that are toxic to the environment and to workers. The last three of these options require plant breeding research on corn varieties planted in Tanzania and the first two are an improved farm management practice using currently available technology.

Increasing fertilizer application. Maize responds well to nitrogen fertilizer application. However, very poor farmers primarily use animal manure as a source of nutrients but it yields very low nutrient content, and applications of synthetic fertilizer are at low levels. Increased nitrogen application of something like 40 kg/ha would boost yields significant. This fertilizer might be made available to farmers by a government assisted cooperative, which would acquire the fertilizer and arrange the distribution to farmers and for payment, which might come at harvest time.

Adopting StrigaWay technology. Striga is a widespread parasitic weed in Tanzania that causes a devastating amount of crop loss, totalling up to \$1.2 billion in maize and cowpeas in Sub-Saharan Africa alone (Seed Quest). Striga weed can reduce corn yields by up to 80% . Because four out of five people depend on agriculture for food and making a living, it is necessary to battle the weed. StrigAway technology uses a corn seed coated with a special herbicide that kills the roots of striga as it attempts to enter a germinating corn kernel as it attacks the corn kernel underground. StrigAway is a joint public-private sector development technology, and it kills Striga weed and allows corn plants to develop normally.

Improved drought resistance. Plant breeding can be used to improve the ability of corn plants to tolerate low water availability and high temperatures. The corn plant is cross pollinated--reproduce by pollen being carried by the wind or pollinators from plant to another. For example, one line or variety of corn is crossed with another line or variety of corn that sometimes leads to greatly enhanced performance relative to both parent plants. Improve drought tolerance can be achieved by using both conventional plant breeding and genetic engineering, or genetic modification.

Enhanced vitamin A content. The deficiency in vitamin A results in blindness, weak immune system, and premature death, and between 250,000 and 500,000 children in Africa go blind each year because of vitamin A deficiency (World Health Organization). Half of them die within one year of going blind. Historically, Tanzania has eaten white corn. Yellow corn has been associated with a western country giving it for food aid. Biofortification is the process of breeding crops to increase nutritional value using genetic engineering. According to Wendy White, of Iowa State University, "Biofortification is a revolutionary approach to combating micronutrient malnutrition in developing countries and it has the

potential to be self-sustaining. The seeds are bred by plant breeders to be naturally high in key micronutrients, such as vitamin A, zinc, and/or iron. And then the seeds will ultimately be distributed to poor farmers in developing countries and they'll be able to reproduce the seeds so they can share them with their communities." Rocheford, a professor at Purdue University, said that increasing beta-carotene level in corn, is a huge approach to addressing the deficiencies in Africa. A study at Purdue University showed that the increase in vitamin A can significantly reduce blindness and mortality rates.

New research has shown how to raise the levels of vitamin A in corn. Yellow corn has small amounts of vitamin A, while white corn has none. Increasing the amount of vitamin A in corn is achieved by inserting genes for beta carotene production from another species into a corn variety (Charles, "New Yellow Corn Could Boost Vitamin A, Save Sight). In the human digestive system, it is converted to vitamin A. Corn kernels with beta carotene become very orange colored due to high levels of carotenoids (ie. beta-carotene). The high vitamin A results in orange corn kernels and is similar to Golden rice.

Improved insect resistance. Corn is vulnerable to insects, including ear and stem borers and rootworms. A high priority in the biotechnology industry was developing a new and effective biological insect control, or a trait that, when inserted into a corn plant, developed insect resistance (IR) against harmful and hard to control insects, for example, corn borers. Researchers turned to naturally occurring bacteria in the soil and Bt. Organisms such as *Bacillus Thuringiensis* have been used the power version since the 1920's to help control insects. Insect resistance in corn can be obtained by using genetic engineering to transfer *Bacillus Thuringiensis* into the plant, and toxin can either be expressed selectively in the plant or throughout the plant. The key to it is that the toxicity must be present during the period that the target pest is actively attacking the plant. Hence, only the insects that feed on the plant are directly affected, such as the corn borer. Insect resistance GM technology also replaces the practice of applying some chemical pesticides, which frequently carry environmental and health risks. Another advantage is that the Bt toxin expressed in plants is not toxic to either humans or animals. Also, insect control can be obtained without the use of chemical insecticides, which they may not have access to. However, maize varieties with Bt are likely to cost more than conventional seed. In addition, one can obtain broad herbicide tolerance in a similar way. A gene is transferred from soil bacterial into a corn variety that makes it resistant to the chemical herbicide such as Roundup. When seeds with this resistance are planted, the young plants are resistant to Roundup but all other plants are killed, especially the weeds growing among the corn plants. Hence, insect resistance and herbicide tolerance are the two main GMO types.

Tanzanian President Jakaya Kikwete is a large supporter of GMO's (Visram, All Africa). He has started research to prove GMO's usefulness and safety to his country, which is currently split on the issue. The president has supported the use of GM technologies and organizations such as Monsanto, and has placed blame on challengers of GMO's saying they have been "uninformed" and need to be educated. Some organizations such as the Tanzanian Alliance of Biodiversity have been against the idea of implementing GMO's because they believe using GMO's isn't the correct way of solving poverty and hunger. Continuing research in the country towards showing how GMO's are useful and can successfully decrease poverty and hunger in the country is necessary for gaining local support. To gain support of groups worried with the safety of the crops, the government can work to educate them on proper use and how to ensure safety. Once the research is proved successful, GM technologies need to be priced at costs that farmers can afford to avoid farmer debt, a current problem in the country. If the president can continue to spread support for this technology, a major transformation in the country will be on its way. For example, South Africa, which is relatively close by, grew 8 million hectares of white and yellow GM maize in the decade 2000-2009 (ISAAA Brief 41), and it can be cited as an African country that has successfully developed and grown GM maize.

Other factors (barriers) can also affect corn production. Climate change is likely to increase the variability in weather which is likely to lead to variability in crop yields. It may also lead to generally higher temperatures towards an increased tendency for droughts and water scarcity. This would cause reduced

corn yields. However, using genetically modified organisms, crop yields can be altered to be more resistant to drought. This genetic alteration would cause an increase in crop production and food supply during periods of drought and water scarcity.

An organization that could be involved in increasing maize production is the CGIAR (Consultative Group on International Agricultural Research) where they study and improve food plants. With a mission to improving food security and ridding poverty in developing countries through research and partnership, CGIAR can help Tanzania improve food production through genetic improvement. In particular, International Maize and Wheat Improvement Center (CIMMYT, one research center of CGIAR) is engaged in maize and wheat improvement and distribution in improved varieties to help developing countries improve their maize yields through research on maize improvement and distribution of genetically improved crops. Together, CGIAR and the national government of Tanzania's Ministry of Agriculture can cooperate to improve local corn varieties. With assistance from South Africa, barrier to the acceptance of the GM technologies can be reduced. Farmers can be educated to ensure proper use and effectiveness of GM corn varieties. However, the Tanzania Ministry of Agriculture can assist with the reproduction and distribution of new corn varieties to farmers. The government could help by creating a stable economy, such as running stable monetary and fiscal policies providing an easier environment to make future investment decisions. On a local level, farmer cooperatives should be formed to facilitate more efficient distribution of fertilizers and crop varieties, along with making decisions about local farming practices and methods to improve corn production. Modifying the maize plant is essential in Tanzania due to its large growth rates and importance of farming, as it allows farmers production to greatly increase. Tanzania can become a country benefitting from new maize production methods and the gene revolution.

In conclusion, five methods are highlighted for increasing the quantity and quality of maize produced in Tanzania. These methods are to increase fertilizer application, adopt StrigAway technology, improve drought tolerance, enhance vitamin A content, and increase insect resistance. To achieve these changes, a farmer cooperative system can be developed to increase nitrogen fertilizer and new maize variety availability to farmers. In addition, the CGIAR, the Consultative Group on International Agricultural Research, and the maize industry of South Africa can assist the Ministry of Agriculture in Tanzania to obtain new maize germplasm (genetic resources for an organism) to be incorporated in to location varieties to improve drought tolerance, vitamin A content, and insect resistance. If the country of Tanzania could carry on Norman Borlaug's green revolution, which tremendously increased food production in third world countries, millions of lives could be saved.

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