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## **Kenya: Biotechnology Innovations to Improve Sustainable Agricultural Practices and Increase Farmer Productivity**

Kenya, an African nation, is fraught with instability, poverty and violence. With over 43 million people, Kenya ranks 31<sup>st</sup> place in the world for population. Stunningly, Kenya ranks higher than this on the poverty scale being one of the thirty poorest nations around the globe. Roughly 50 percent of Kenya's total population sits below the poverty line, compared to the 15 percent in poverty in the United States ("Poverty"). Nearly 10 percent of Kenya's population also struggles with food insecurity. Kenya's workforce is heavily invested in agriculture, with over 70 percent of workers being involved in some aspect of producing food or cash crops. Rural farmers in this country face harsh environmental conflicts such as droughts and pests that impede their average productivity. Kenyans must also overcome a shortage of clean drinking water, and little space upon which to grow their crops. Diseases such as HIV/AIDS, pneumonia and malaria also continue to take a toll on the Kenyan people. These issues, and many others, prevent the average Kenyan farmer from growing enough food to feed his family, let alone to sell for a profit to help pay for the schooling of his children. In fact, the average monthly income of a Kenyan in the Nyandarua district is only 5,557 Kenyan shillings, or about 65 United States dollars (Republic). Although steps have been taken to improve Kenyan self-sufficiency, through education and the development of better agricultural tools and methods, Kenyan farmers have a long way to go before their small farms will be adequately productive for their families. It is important to note though, for every barrier and obstacle through which Kenyans must persevere, solutions are being offered. Educational services, health clinics and government programs are slowly becoming readily available to assist Kenyans in times of need.

A typical subsistence farm family in Kenya lives on a plot of land smaller than five acres. Families are generally composed of a mother, a father and a large number of children. Having many children is an advantage to rural farmers because there are more hands to share the burden of labor, making growing food less of a struggle. Families often lack knowledge of modern biotechnological farming techniques, instead using basic traditional plowing and seed scattering techniques. Farmers use these techniques to grow the majority of the food that makes up their diets. The family's diet is almost exclusively cereal food based, made from corn (maize), rice, other grains and potatoes. Vegetables such as okra, beans and radishes that the family has grown are also not uncommon. Meat, in most families, is an expensive delicacy only eaten during times of celebration or special occasion. Lunch is often a family's largest meal of the day. When a family purchases other foods that cannot be grown themselves, it is often from local markets. Water sources in Kenya are also an area of concern for rural families. While most areas of Kenya have some water sources such as lakes or rivers for the family to drink from, the water is not suitable drinking water; contaminated water is often found in shallow wells and surface bodies of water. Only 57 percent of rural communities are within reach of cleaner water ("Kenya" Water.org). The consumption of dirty water often leads to the spread of disease among Kenyans and the need for proper health care facilities. Luckily, 75 percent of the population has access to health clinics (Republic). Education for Kenyan children has also become easier to obtain in recent years. Typically, both male and female children go to eleven out of twelve possible years of free public school, a service not available in the nation until 2003. Literacy rates are higher as well, with 87.5 percent of citizens over 15 able to read and write (World Factbook).

The major factor causing food insecurity in Kenya is that agricultural practices there haven't advanced with those in the rest of the world. Current Kenyan agricultural practices involve simple tillage of the soil

and the planting of crops needed for food. This method of farming impedes agricultural productivity because it causes problems such as soil erosion and soil-nutrient loss. These problems are amplified in the arid regions of the country where desertification is already a growing conflict; soil erosion increases the rate at which desertification takes place. The loss of soil and soil nutrients results in a much smaller net yield of product from a farm. Small agricultural productivity directly affects a family's nutrition as potential caloric intake is lost.

To improve this factor, citizens would have to develop and adopt sustainable agricultural practices. These practices include environmentally friendly methods such as crop rotation and no-till farming that would increase small farmer yield. One example of a sustainable agricultural practice is called Push-Pull farming (Khan). Push-Pull farming is a method developed by the UN Food and Agriculture Organization to help manage pests without using any pesticides. It is well known that pests called "stemborers" are a common cause of harvest loss in Kenya. Push-pull farming is particularly effective at preventing stemborers from damaging staple crops. To do this, two plants are used, napier grass and desmodium, which naturally attract and repel the pests away from the staple crop. This staple crop is often corn. Push-Pull, using these extra plants, also helps to prevent soil erosion and because both napier grass and desmodium can be used for animal fodder, it allows farmers to own more livestock while simultaneously being able to feed them. A few farmers have already adopted this method of Push-Pull farming and word of its success is quickly increasing its popularity. Another example of a more sustainable agricultural practice is called crop rotation. Crop rotation is a method in which different crops are grown on farming plots each season to replenish nutrients taken out of the soil from some of the crops, with plants that put nutrients back into the soil. This simple method helps to minimize soil nutrient loss. A third more sustainable method is the "no-till" farming method. This method prevents the use of any disturbance of the soil, save what is needed to put the seeds in the ground. Without the turnover of the topsoil, soil isn't mixed heavily with air which can contribute to erosion and nutrient loss. If methods such as these were more widely adopted throughout Kenya, productivity would dramatically increase and food insecurity troubles would become less common.

Other factors that influence the development of sustainable agricultural practices include climate change and population growth. In terms of climate change, Kenya is currently going through a long relentless drought period that doesn't seem to be ending any time soon. This drought results in increasing water scarcity and increasing rates of desertification; consequently this parched land is often unsuitable for Kenyans to farm, as they lack skills and water to properly irrigate dry land. This dilemma of water scarcity is also a problem for Kenyans who raise livestock. Without sufficient water, livestock are more prone to dehydration and their grazing sources are stunted and moistureless. These animals are unable to produce as much food or goods for their handlers due to the hardships of malnutrition, thus drastically affecting a family's income and having a serious impact on their quality of life.

Another factor that influences the development of new agricultural practices is the danger of population growth. As populations grow, more space is needed for the people to occupy, or they are forced to live in closer proximity of one another. This can create potential conflicts such as the spread of disease and disputes over land to work and farm upon. Diseases are always more prevalent and dangerous the nearer people live to each other because the distance that must be traveled from person to person is much shorter. This is often how mass outbreaks of disease occur. A few diseases that occur frequently within Kenya are HIV/AIDS, pneumonia and typhoid fever, all of which Kenyans are more at risk of catching through close contact with others. Land conflicts may also break out due to population growth. A Kenyan family's land is often their direct source to any sort of income. It is understandable then, if others were to encroach upon their tether to capital, the family would respond with hostility. This hostility may be heightened by the tribal ties and values that many families still hold in Kenya.

In order to improve the food insecurity crisis in Kenya, many steps would have to be taken to develop and adopt sustainable agricultural practices. This development could be done both directly and indirectly. By developing in this way, rural farmers may achieve healthier, more stable and more profitable lifestyles. To help directly improve agricultural practices, Kenyans would have to be educated on more valuable biotechnology plans such as Push-Pull. This education could come from charitable organizations, government programs or even school systems. One example of such an organization would be FAITH Kenya. Although small, this community organization works to educate families about environmental management and provides the families with the tools and skills needed to grow trees and food crops more effectively. This group also introduces the idea of recycling waste to the Kenyan farmers. All of these practices work together to decrease food insecurity within the families, and improve the modern Kenyans' agricultural techniques. Another example of a project to educate farmers is the Kenya Food Security Cooperative Development Project (Clusa). The leaders of this project work to train farmers on the misconceptions of past agricultural practices and hold workshops to teach them more effective ways to grow food. The project has shown that improvements in food security were made by participants within the first year.

In the interest of indirectly developing agricultural practices, one would have to work to improve aspects of the Kenyan farmers' lives that, while not involving food, would improve a farmer's wellbeing to the point where working to grow food is less difficult for them. To clarify, if a farmer who suffered from a disease such as HIV/AIDS were to receive better medical treatment they would be more able to work on their farms and increase productivity for their family. Any area of improvement, from more adequately funded healthcare clinics to education towards the transmittance of disease would apply in this category. There are many available programs working to improve conditions for Kenyan family health. An example of such a program would be PATH (Kenya Ministry). PATH works together with the Kenyan government to teach health professionals proper techniques for medical procedures and medical waste disposal. These techniques help to protect both patient and practitioner from possible injuries and helps to prevent the spread of disease through unhealthy medical practices. Another program, PSI/Kenya, has been responsible for many workshops that seek to improve aspects of HIV/AIDS, reproductive health, malaria and child survival in a Kenyan's life (PSI). These workshops teach families topics such as the importance of family planning to the dangers of malaria towards young children. All of the above organizations work together to largely improve the outdated agricultural practices within Kenya, and to improve the daily life and health of the Kenyan people.

If any of these programs were to be expanded, governments and corporations would play a major role in their funding. Community members would be responsible for the organization of program workshops, and for alerting other community members of the workshop to increase local participation. An organization called Kiva uses the internet to allow anyone in the world to make loans to entrepreneurs in developing countries like Kenya (Kiva). Kiva is completely non-profit and all of the money loaned supports the particular entrepreneur and is paid back to the lender in increments of time. If more Kenyan citizens were to take advantage of this opportunity, and other similar opportunities, it would help aid some of the burden in funding these large scale programs.

In conclusion, many of Kenya's rural families suffer tragically from food insecurity. Typical rural families contain a set of parents and their children that all work on the family farm so that they have food to eat. Food insecurities stem from the harsh Kenyan environment, tampered by relentless droughts. They also emerge from poor agricultural practices such as outdated soil tillage farming methods. Disease and limited health care also impede the productivity of small rural farmers throughout Kenya. Sickneses such as HIV/AIDS, pneumonia and fevers spasmodically infect the people of Kenya, and often claim many lives due to poor medical practices or inability to reach a medical facility quickly enough. Other obstacles that farmers face are water scarcity, due to the adamant droughts, and pests such as stemborers that unremittingly damage food crops. These problems are slowly but surely being improved through a

wide number of programs, both through the government and local communities. These programs are used to educate rural farmers on more effective farming and biotechnology practices. These practices often include techniques like Push-Pull farming and “no-till” farming. The community and government programs also help to educate Kenyans on reproductive health, a major contribution to the awareness of HIV/AIDS. The programs also help to educate Kenyan citizens on proper nutrition and disease prevention. Food insecurity within Kenya can be tempered through the education of Kenyan people towards self sufficiency, through the techniques of modern sustainable agricultural practices.

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