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Malnutrition **Aflatoxins + Maize: The Combo That Nearly Destroyed Kenya**

When taking a glimpse at the various social and environmental issues that the Eastern-African region has endured, one of the largest issues that has been overlooked is the outbreak of Aflatoxins in 2004. Aflatoxins, a type of Mycotoxin, are an invisible poisonous substance formed from various molds and fungi found in warm, moist environments (JSTOR, 2005). In addition to being a dangerous substance, Aflatoxins can cause various diseases, hinting as to why the 2004 outbreak of this deadly toxin in Kenya was incredibly appalling. Furthermore, agricultural practices are not improving, and as a result, 1⁄4 of crops grown have been contaminated with Aflatoxins. This forces most Kenyans to feast on a limited amount of food and waste a significant amount of crops. Something must be done in order to withdraw Kenyans from all these hardships. Therefore, by educating Kenyan farmers with information on sustainable and healthy irrigation practices, spreading awareness to various countries, and providing Kenyans with ideal storage techniques of grains, the etiology of the globally-known Aflatoxin will be eradicated, thereby saving lives.

Aflatoxins, as mentioned above, are molds and fungi found in various plants including peanuts, tree nuts, maize, and wheat. They are one of the most salient mycotoxins because of their unique ability to cause cancer in humans. The most well-known species of Aflatoxins are *Aspergillus flavus, Aspergillus Parasiticus, and Aspergillus Nomius* (Veterinary Toxicology, 2018). In order for these toxins to grow, a large amount of moisture in the atmosphere in addition to high temperatures are required, which are native to Kenya. Potential diseases caused by this toxin include: Liver and Kidney Cancers, acute Aflatoxicosis (*Environmental Poisons in Our Foods,* 1993), the potential to cause birth defects in early growing children, and immunosuppression (NCBI, 2017). Adding on, if the concentration of Aflatoxins is between 20 PPB - 100PPB, it is registered as safe. However, anything above that will cause many illnesses/death when consumed (FAO, 1985). As can be seen, Aflatoxins are potent in living organisms, and something needs to be done in Kenya to prevent their constant growth. In regards to the struggling nation, Kenya, with a population of approximately 49.7 million, is a country that is predominantly hot and humid. Average temperatures throughout the year along the coast range from 72 °F to as high as 90 °F, and the precipitation in this area ranges from 0.5in to as high as 11.7in. (World Climate Guide, 2019). Continuing, 70% of families in Kenya are mainly farmers, with the average farm size at just 6 acres (IntechOpen, 2019). This adds up to 48.55% of agricultural land in Kenya. Furthermore, Maize, being one of the most commonly grown crops in all of Kenya, is very prone to the contamination of Aflatoxins, which is what ultimately led to the outbreak in 2004.

This outbreak of Aflatoxins was one of the worst in Africa. Before this, the effect of Aflatoxins was not as prevalent because Maize, one of the most popular crops now in Kenya, was not introduced in Africa until the Portugeese had introduced it to the western-Africans in the 15th century (JSTOR, 1965). Eventually, the crop began to grow in western Africa and then spread to Kenya in the late 19th century (SourceWatch, 2012). After a few decades, maize began growing everywhere as farmers became very interested in this

new and healthy crop (SourceWatch 2012). Aflatoxins started to produce in large quantities, leading to the outbreak in 2004. Additionally, there has been more than three outbreaks of Aflatoxins since 1981 in Kenya caused by improper growth in Maize, however many farmers and citizens of Kenya had not realized at the time that these diseases and deaths were caused by their crops; they believed that it was caused by another disease, such as common rusting (Applied and Environmental Microbiology, 2010). The main reason for this is that Aflatoxins had not been categorized as a fungi in plants and was unknown to the Kenyans (Applied and Environmental Microbiology, 2010). Due to their invisibility in maize, Kenyans were unable to identify the toxin, which resulted in the death of 80 people and the admission of 180 Kenyans into local hospitals (BBC, 2019). At the time, the Kenya Bureau of Standards, a government organization that maintains the standards and practices of Kenyans, ordered a stop on the production of Maize for the protection of its citizens. After 2004, "There have been smaller recurring outbreaks and ongoing challenges with aflatoxin control and prevention." (CDC, 2013). The trends of this issue are not improving due to the lack of proper agricultural practices, as well as the various diseases that often remain in Kenyans due to the lack of proper healthcare.

It is important to realize that Aflatoxin outbreaks in this nation are still going on, and many families are being impacted as a result. Many families in Kenya after the outbreak became scared because they fear that what they commonly eat every single day has become something that could potentially injure their loved ones, especially young children. The spread from one child continues on into adulthood, making the child very weak and unable to perform and protect their families (BBC, 2019). In fact, Ugali, a traditional African dish that Kenyans enjoy, is made with Maize (Podium Runner 2015), which was also one of the leading factors of the nation-wide outbreak. It is pertinent to realize that the average family size dropped to 4 in 2017 from 5.3 (United Nations, 2017), the average wage is $1,129, and many Kenayans are unable to afford the healthcare provided by the nation.

Even more interesting is the downtrend of agricultural practices currently going on in Kenya. In the rural areas of the nation, food and agriculture take up a majority of the jobs available for the youth. However, many children residing in rural Kenya have started to migrate to urban areas due to the increased number of employment opportunities, as well as the increased wage received from urban jobs. Perhaps more astounding is that the youth are twice as likely to be unemployed in an urban environment, yet they still reject rural job opportunities (RTI International). Simply put, the youth are trying to seek educational/job opportunities, and moving to urban areas such as Nairobi will enable them to do so. Kenyans, namely children, are more concerned for money over anything else. This migration practice has led to a downfall in the agricultural economies of Kenya, revealing why rural Kenyans are unable to afford additional support for the growth of their crops. As a result of this decline, Keyan farmers in rural areas suffer a larger impact from Aflatoxins compared to urban areas. With the decline in the main source of income for subsistence farmers in Kenya, Aflatoxins have not been a priority for them; instead, farmers are more concerned about the quantity of crops they are able to produce over a given time. Meanwhile, in urban areas, as Maize is not commonly grown in these areas, the risk of Aflatoxins is much lower. This delta between the health and financial conditions of rural and urban Kenya is the main reason why many Kenyans choose to migrate to urban areas, and why Aflatoxins are more prominent in rural Kenya. However, despite these dilemmas, moving to urban areas has led the overall economy to grow by more

than 25% (BBC, 2014), and access to healthcare is more effortless in an urban environment.

Despite this, the conditions for these rural and urban Kenyans are poor, and in order to prevent the growth of Aflatoxins and save the lives of these victims, a viable solution is required. The current solutions available against Aflatoxins involve genetically-modifying the organisms grown in order to make it more chemically resistant to various diseases. Furthermore, there are technologies available that could *theoretically* eliminate the Aflatoxin-infected area of the DNA of the crop, such as using extensive gene-therapy, which involves technologies including the Viral Vector (ScienceDirect, 2012). This means that the Kenyan government may have to invest a large sum of money into technologies like this, or farmers may have to invest in these technologies, which is simply not possible for people to afford as the average salary is quite low. Therefore, a sustainable and easy-to-incorporate solution is warranted for the benefit of the Kenyan people.

One of the biggest problems in Kenyan agriculture is that farmers lack the ability to grow their crops in a healthy, sustainable way so that the crop can live a long, healthy life. Therefore, an education program in Kenya can be created in which Kenyan farmers will be educated in order to comprehend how to grow their crops and to reduce the large amount of Aflatoxins present in Maize crops. This educational program will consist of a large number of irrigation experts who will interact with Kenyan farmers and teach them proper farming habits so that their crops may grow Aflatoxin-free.

During their time of being educated, Kenyan farmers will be provided with a large variety of important points in order to grow their crops in the best manner possible. Examples of what the Kenyans will be taught are to first, grow plants using a good pest-management system and provide the care needed, as many different insects can attack the crop and spread the various diseases. Secondly, it is important that after crop season is over, Kenyans should get into the habit of cleaning up the remains of old crops (Gardener's Supply Company, 2017). This is because remains of old crops, such as the remains of corn and maize plants, can lead to many pests and toxins such as Aflatoxins potentially entering the next plant. Furthermore, farmers need to remove infected and diseased plants. This is especially important for a developing country like Kenya because most farmers will save the infected plants so they can still be consumed, as farmers think that they are losing money and food by simply putting it to waste. Continuing, Kenyans will be taught that crops need to be rotated every season or on a scheduled basis. This is because different types of diseases can start to form in a certain location, and if a plant is grown in that affected area, the disease can easily form, allowing the crops to be contaminated much faster. Lastly, Kenyans must be informed that they should store corn/maize in a dry area after they have fully grown (Gardener's Supply Company, 2017). This is because Aflatoxins are more likely to grow in moist environments. Therefore, if they are kept wet or in humid conditions after growth, Aflatoxins are more likely to produce in this area.

These are just examples of what Kenyans need to do in order to protect and lower the Aflatoxins entering

these crops. The proposed solution of educating the farmers can definitely meet all the needs for the entire population of Kenya as they begin learning proper irrigation habits and continue to spread the best practices amongst the country, thereby making more and more Kenyans safer and smarter farmers. Furthermore, this solution will be incredibly impactful, as the WHO states that countries with fully developed agricultural practices are exposed to less than 1 kg. a day of Aflatoxins compared to the over 100 kg. in sub-saharan Africa (World Health Organization, 2019). As there are many different irrigation experts across the entire world, various non-profit organizations could fund these skilled groups of experts to spread the knowledge. Irrigation experts could go to Kenya for live demonstrations of various methodologies to Kenya's farmers. The greatest benefit of this solution is that the government of Kenya will not need to create a separate budget for technologies that could *potentially* prevent the spread of Aflatoxins. Instead, Kenyans are gaining important knowledge that will continue to cutivate safe crops for a lifetime.

While the previous solution is great in benefitting the Kenyans, one of the largest ways that many global issues are solved is when the people are aware and the issue is known all throughout the world. Therefore, it will be beneficial not only for the Kenyans but also for the other nations who have to endure the challenges Aflatoxins spur, if we as global citizens collaborate to spread awareness and extinct this deadly toxin. Together we can make this issue on top of the United Nations' priority list and announce this as a globally recognized issue. What this will allow is that many scientists will be able to realize that Aflatoxins is a pertinent issue, and many countries will be able to start helping too. As the United Nations is arguably one of the world's most important organizations, this issue will do nothing but spread to country after country. This will result in humans taking charge in order to help those in need. For instance, by donating to various scientific organizations and donating to countries like Kenya, everyone in the world can begin to produce a difference, one that can be created by spreading awareness on this largely known toxin. One of the greatest benefits of this issue is that we as a human race are working together for the better, meaning that Kenyans and nations in need will not need to fund anything themselves. By announcing this as a global issue, we as a human race will soon begin realizing how pertinent of an issue this is and we can work together to make this issue a thing of the past.

Adding on, with the potential to raise awareness throughout the world, as mentioned before, raising money could be a *result* of this solution. Therefore, in order to eliminate one of the biggest causes of Aflatoxins, moisture, ordinary people and other national governments throughout the world can begin donating deaerated/dehumidified-equipped silos to Kenya. A Silo is a storage-bin in which farmers will put their grains post-harvest in order to maintain their heat (NAPA). However with dehumidifiers and deaerators inside, Silos in Kenya will have the ability to remove all the moisture inside the grains, as well as all of the surrounding air, thereby removing the risk of Aflatoxin production (Veterinary Toxicology, 2018). Using silos can increase productivity for farmers and make it much easier for farmers to maintain their crops (CIMMYT, 2012). Yes, Kenyans already have adapted Silos, however they are mainly available for the middle-upper class, and those who truly desire it are forced to share with another farmer. Adding on, current silos, as mentioned above, are only meant to maintain heat, so by adding these dehumidifiers and deaerators, these new silos will serve the purpose of these Kenyans. Therefore, the money generated from raising awareness can be invested in the purchase of dehumidifying-silos, thereby making Aflatoxins essentially removed from this nation.

Currently, solutions involving raising awareness and informing the people are quite lackluster. The WHO has stated that it has worked with other nations in order to create regulations on agricultural practices. They have also suggested inspecting each contaminated food, purchasing reputable brands of Nuts, Corn, and Maize, and eating a variety of diets (World Health Organization, 2018). However, without citizens understanding the information, there is really no point in what the WHO has currently been doing. Furthermore, many examples are prevalent in today's world that show how awareness has made an impact on various diseases/social issues. For instance, as the coronavirus began impacting hundreds of lives in China, many media outlets began making reports on this virus, and people became more aware of the issue. Therefore, many governments have now started to take action by placing the ill in quarantine and promoting scientists to come up with a solution to this deadly virus (NY Times, 2020). Even though the solution may appear as simple, it truly will make a grand impact on these poor Kenyans and enable us to start helping one family at a time. We can start to meet the needs of each and every Kenyan and more as this solution begins to take action. This solution is quite sustainable as it does not involve wasting any resources, similar to the solution listed previously. Furthermore, as humans begin to assist each other in finding solutions and aiding those in need, the ultimate goal of removing Aflatoxins can easily be achieved.

Ultimately, Kenya is a country that is in desperate need of assistance. With an average wage of just $1,129, it is almost impossible for Kenyans to take time away from their farming lives to come up with a solution to prevent the growth of Aflatoxins. It is important to understand that this fungi is almost invisible and causes a variety of diseases, namely Liver Cancer. We need to start taking action now so that we can make Aflatoxins a simple toxin, not a plague. Yes, the solutions listed above will involve quite a bit of work and effort, however we as privileged global-citizens need to start acting up and start helping out other citizens who are dying for causes that can be fixed. Adding on, in 1989, here in the United States (specifically in Kansas City), there was an Aflatoxins outbreak in which many people were found ill. However, unlike Kenya, the FDA was quick to arrive and managed to solve the issue quite swiftly (NY Times, 1989). Why hasn't the same thing happened in Kenya? All Kenya was used for in the outbreak was to conduct studies on Aflatoxins - not benefit the people in any long-term way. Therefore, with the provided solutions above, not only will we be able to save the lives of crops, we can save the lives of humans and ultimately help the Kenyans in a sustainable manner.

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