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Mycotoxins in Senegal: The Problem that Grew Without Detection

Mycotoxins are secondary metabolites that are the result of certain fungi. There are five types of mycotoxins Deoxynivalenol/Nivalenol, Zearalenone, Ochratoxin, Fumonisin, Aflatoxins; each type has other categories inside depending on what crop is affected by the mycotoxin. (Agriculture and Consumer Protection, 2015) Mycotoxins have recently been discovered as a natural concern for any area that has inappropriate conditions for the crops. African nations, specifically Senegal, are therefore one of the areas most notable for mycotoxin presence due to the lack of sanitation and the climate change, higher humidity.

Senegal is a nation on the west coast and sub-Saharan areas of Africa. The country has a population of 15.41 million; in which 55.4% of the population is rural and 44.7% is urban. This developing country has a semi-presidential and democratic republic government. Senegal's capital of Dakar is known for having 60% of the country's peanut production which would lead one to expect that this country should progressively become an economic success in the field of agricultural exports. However, due to climate barriers, and especially health barriers among the Senegalese, this is not the case. (Our Africa Company, 2017)

Senegal has the area of 75,951 mi² of which there are three notable regions with distinctly different climates and geographies; the Coastal region, the Sahel region, and the Southern region. The Coastal region consists of cooler temperatures than the other two regions. The Coastal region typically has the temperature of 18-26 Celsius in the winter and 31 degrees Celsius in the summer. Lastly, the Coastal region has the average rain precipitation of 550 mm from August to October. The Sahel region is located across Africa, known as the Sahel belt. The nights are usually cool with 14 degrees Celsius due to the land breezes, while the day has an average of 40 degrees Celsius. The Sahel region has the least amount of rain precipitation in Senegal with 400mm making it perfect for pastoral nomads, people who practice animal agriculture by moving to different areas for their animals to graze on. Finally, the Southern region is the hottest, humid region with an all year 30 degrees Celsius average temperature. The Southern region rain precipitation is the highest at 1500 mm. This region has sandy soils making the Southern region the best area to practice traditional agriculture for crops such as peanuts. (Nations Encyclopedia Company, 2012)

Eleven percent of Senegal's land is cultivated by crops such as millet, peanuts, rice, sugarcane, maize, beans, sweet potato, and cotton. (Nations Encyclopedia Company, 2012) Notable crops such as peanuts and cotton are the main export items for the nation as the other listed crops are not originally from Senegal. Senegal locally processes peanut products like oils and sells the products to neighboring nations.

(Nations Encyclopedia Company, 2012) Senegal's second greatest export crop is cotton as it is used for textile fibers. The average farming land per farmer in Senegal is 1.5-2.4 hectares, while in the United States each farmer has around 434 acres. Clearly, this is due to the huge geographical differences in the sizes of both nations, and what areas of land are particularly fertile. (Nations Encyclopedia Company, 2012)

Most families in Senegal are involved in the area of agriculture due to it being the country's main source of income, therefore the population's main income. Other jobs in Senegal include working as a shopkeeper, domestic servant, secretary, typer, and more. Teenagers as young as 14 are often the ones to work in the main cities due to their need for an income after having to drop out of school. The average income for the city jobs is around 4,942.86 dollars, while the average income in the United States is around 50,000 dollars. The distinction is not only due to the country's slow progression economic wise, however also due to the large lack of education among children in Senegal.

Along with education for the majority of the country follows a lack of healthcare due to the country not being able to afford the expenses of hospital equipment, medicine, and more. Therefore, the Senegalese are exposed to more diseases which are known for being parasitic, intestinal, venereal, and respiratory diseases. Poor sanitation also contributes to the diseases in Senegal. (Advameg, 2018) A lack of sanitation, or growing conditions, is what mainly causes the presence of fungi, followed by mycotoxins, in Senegal's agricultural crops for food. Mycotoxins are poisonous to humans and can cause diseases. For example, *Aspergillus flavus* is a fungus that's mycotoxins are found in peanuts, meaning it is prevalent in Senegal due to peanuts being the main crop produced, which causes angioinvasion, or cancer in blood vessels. (D. W. Denning, 2007) The lack of sanitation is led by the need for fundamental materials such as toilets, clean water, and more.

Food is limited for the most part as seen by the country's population of 46.7% being in poverty. Typically, if food is accessible or gathered by oneself, a meal in Senegal includes cooked rice with spicy sauce and vegetables. Food can come from family farms and fishing, however, a portion also results from imports. With food constantly in an on-the-edge position of being taken away 17% of the population is concerned with being able to provide for their families. Depending on what class one is in Senegal they will use from a common stove to even a fire. The average family in Senegal has nine children to feed. Not only do the Senegalese have starvation to worry about, but also their failure of crops, robbery, flooding, and disease. (Advameg, 2018)

Mycotoxins are a new concern for countries worldwide and the main countries that export agricultural crops such as Senegal are exposed to fungi and therefore mycotoxin production; 25% of produced crops are mycotoxin contaminated. As of now the worst case of mycotoxin-poisoning was in 2004 in Africa with the aflatoxin mycotoxin in corn. (Institute for Crop Science and Resource Conservation, 2008) There are two types of toxic responses from humans when exposed to mycotoxins, acute and chronic. An example of acute toxicity are gangrenous or convulsive effects from the mycotoxin ergot alkaloids, from the fungus *Claviceps purpurea*. An example of chronic toxicity are mycotoxins resulting in cancer. (Milićević, Dragan

R., 2010) Not only are mycotoxins life-threatening on their own, but also when they combine with diseases such as malaria, and AID/HIV which are extremely common in Senegal. Due to the lack of economic growth in Senegal and therefore the lack of investment for conditions in agricultural farms the problem keeps on increasing rapidly. This would also result in mycotoxin poisoning in different areas of the world as Senegal depends on agricultural exports to fund itself. Fungi are caused by pre-harvesting, unsanitary conditions were present when harvesting; moisture levels being high during harvesting, unsanitary transportation and processing, and insect damage; this allows for mycotoxins to be produced. The rapid growth is the result of increasing climate change, and the lack of money in African nations such as Senegal. (Institute for Crop Science and Resource Conservation, 2008)

All of Senegal experiences the effects of mycotoxins due to the nation's dependency on agriculture crops such as maize and peanuts. The country's economy is so weak that even the considerably 'richer' areas can't afford better agriculture conditions for food. Although all of Senegal is affected by mycotoxins there are rare examples of mycotoxins affecting certain populations. For example, infants have been discovered recently as being the common victims of the fungus *Stachybotrys chartarum*'s mycotoxins resulting in idiopathic pulmonary hemosiderosis, or alveolar capillary bleeding and hemosiderosis in the lungs. The environment does not directly respond to the mycotoxins; only the animals that are affected are those involved in animal agriculture and those who consume animal and crop agriculture. However, critical environmental factors such as the troposphere now hold fungi expose to air, the exposure is especially present in humid areas as it is the ideal growing condition for fungi. (Milićević, Dragan R., 2010)

The best solution that Senegal can do with assistance would be to practice grain drying. Grain drying in different forms has been seen in European countries, the United States, Argentina, and others. Grain drying allows for a water activity of or below 0.7 which implicates a comfortable moisture for the crops without the disruption of fungi appearing. The most affordable drying is sun drying, however with sun exposure comes humidity exposure depending on what region the crops are located. There are also two main types of mechanical dryers, cross-flow dryers, and mixed-flow dryers. Mixed-flow dryers work as columns; they are self-cleaning and notably require 20%-30% less energy than cross-flow dryers. Cross-flow dryers function the same as mixed-flow dryers except they are more effective. (Encon2.3, 2012) Drying can reduce from 17-30% of a crop's moisture which when overly exposed to results in mycotoxins. For example, maize, when dried, loses about 15.5% of its moisture, therefore, reducing the crop's chance of developing aflatoxins. (Hamilton, 2000) Another clear example of grain drying being effective is with a 2002 report in which groundnut kernels that had 6.6% of moisture and were contaminated by mycotoxins in a short amount of time became mycotoxin free. (Axtell and Bush, 1991) The total expense would depend upon how many would be placed through Senegalese farms and what type of resources the dryer would use whether it be fuel, electrical power, and more. Companies such as 'The Global Fund' would invest in dryers for Senegal. As of now 'The Global Fund' has already helped Senegal with investing 300 million American dollars in helping the prevention of diseases and providing healthcare. (The Global Fund, 2017) However, mycotoxins are affecting families in Senegal at a much faster rate causing, for example, different forms of cancer which would result in even more of a hold back in Senegal's potential as a growing nation.

Another solution would be creating more sanitary conditions in Senegal. Providing overall sanitation would be providing the Senegalese with needs such as toilets, clean farms, clean shops, etc. Sanitation in farms includes keeping the crops up to date, meaning no rotting crops would be allowed to be kept in the same areas as the new harvest. Crops would also avoid fungi if conditions were cleaner due to the spread of fungi through human farmers. (Bankole and Adebajo, 2002) Therefore placing sanitation as a solution would not only help prevent the expansion of mycotoxins but would also benefit the well-being of the people. However, the only problem with this potential solution would be the expenses would much higher than those of dryers. Nevertheless, companies such as 'The Global Fund' would still be able to support Senegal by providing the country with money to produce more sanitary conditions. Additionally, UN programs such as SDG6 and 2030 Agenda are working now to grant proper sanitation to countries such as Senegal. (Ndiaye, 2017) The Senegalese would have to simply go along with the plan which would not be a problem due to their need for clean conditions. Along with providing clean conditions to prevent mycotoxins diseases such as AIDS/HIV would be reduced in Senegal.

Finally, Senegal is one the most notable countries with the mycotoxin fear due to the climate change, more humidity, and the lack of overall sanitation causing their presence. Mycotoxins are toxins that are the result of fungi in crops. Mycotoxins are a major threat to developing nations such as Senegal as they oftentimes result in death, or starvation to avoid mycotoxin poisoning. With the provided possible solutions Senegal would be able to not only stabilize its crops' health, therefore human health, but the nation's economy would boast due to the lack of spending from diseases that prevent from mycotoxins.

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