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Colombia, Malnutrition

### **Biofortification: Feeding the Future**

Two billion people across the world are suffering from a problem that often goes completely unnoticed: micronutrient malnutrition (Van Der Straeten). Even those who consume large enough quantities of food can suffer from micronutrient malnutrition. While people may have access to enough food by quantity, they are still food insecure if the food being consumed lacks essential nutrients. It is imperative that people are provided with not only enough food, but also with the correct food choices. This has become a global issue, but a large focus needs to be placed on people living in Colombia.

Home to over 48 million people, Colombia is located in Latin America (Kline). There are vastly different geographical features throughout the entire country. The coastline primarily borders the Pacific Ocean, but parts of the country border the Caribbean Sea and even the Atlantic Ocean. Because of the diverse geography, Colombia is best classified into four major regions: “the Andean Highlands (consisting of three mountain ranges and valley lowlands), the Caribbean Lowlands, the Pacific Lowlands and the Llanos, and tropical rainforest on the south of Colombia” (“Colombia”). In addition to the major regions listed, Colombia also has islands located in the Atlantic and Pacific Oceans. The various geographical features make Colombia a beautiful country with endless opportunities.

While Colombia’s geography is stunning, the country has many underlying issues. It has one of the highest rates of internally displaced people (IDP) in the world with 7.8 million people displaced. These displacements are a result of more than a half century of conflict. Fortunately, a peace agreement was signed in 2016; this will help to reduce the amount of people displaced in coming years; less people will be fleeing their homes due to violence. However, the conflict and IDP rates are a problem with lasting impacts. Although there is generally adequate quality housing in urban Colombia, the rural portions of the country have significantly higher poverty rates and lower quality housing. The housing crisis is aggravated further for the large population of displaced people who are confined to extremely poor quality housing. In fact, about 30% of Colombians find themselves without adequate housing (Orenstein). Some of these people live in slums which are houses that are insufficient and crowded. They are often located on pieces of land that the families do not own, and they lack access to many basic necessities (“Housing”). Many inhabitants of slums are IDPs since it is the only type of housing they can find and afford.

Another issue that plagues Colombians is wealth distribution. The distribution heavily favors the richest three people in the country; these three individuals account for about 10% of the country’s Growth Domestic Product (GDP) (“Poverty”). This makes Colombia the seventh most unequal country in the world in terms of income (“Housing”). Since the wealth is disproportionately spread amongst the citizens of Colombia, the country lacks a middle class, and the working class does not receive enough support. The economy in Colombia, composed mostly of private enterprise, also has a major agricultural base along with several smaller industries that provide additional revenue. Coffee is the largest legal export from the country, and Colombia ranks as one of the highest producers of coffee in the world (Kline). Because of the diverse geographical regions of Colombia, many other crops are grown. Bananas and plantains are both important fruit crops. Sugarcane is also grown across the country but is more often used domestically and not exported. In the most

rural areas of Colombia, the mountains, the most common crop grown is maize. Other major crops include rice, sorghum, kidney beans and cassava (Kline).

Although violence has subsided in Colombia, it was replaced by a new challenge: climate change. Farmers across many important agricultural regions have battled droughts, and coal mining has contaminated water basins in several areas of the country. The deforestation of the Catatumbo Barí National Natural Park in Colombia also contributes to the intensity at which climate change impacts the country (Mora). Areas affected by deforestation are sometimes used for cattle, but more often than not they are taken down to make room for drug production. The most common crop produced in the deforested areas is coca, a major ingredient needed for cocaine. While growing coca is illegal in Colombia, and those caught could face deadly consequences, some farmers find the high profit margin worth the risk. The coca crop is sold for much higher prices than other legal crops in the country (Mora). While the money made by coca farmers may seem tempting, it is illegal and worsening climate change for the country. In addition, measures are being taken in an attempt to stop the production and exportation of coca.

Like other countries worldwide, Colombia has many people living in poverty. When analyzing the country as a whole, 34% of the population lives in poverty (“Housing”). This problem is intensified as a result of long term conflict. Almost  $\frac{2}{3}$  of the displaced population lives in poverty, and most of them are living in informal settlements with crippling infrastructure (“Why”). This makes it much more difficult for people to get adequate food, so as a result, many experience food insecurity. So, despite Colombia being more developed than some other countries in Latin America, its people still struggle with food insecurity. Looking at the entire population, about 41% of people are food insecure, but in rural areas, the problem is much more prevalent with almost 60% of people food insecure (“Why”). Even worse, upwards of 90% of those displaced within the country are food insecure. This unrelenting problem kills up to 40,000 people every year in Colombia alone (Guadiana).

Much of the land in Colombia is uncultivated as a result of remarkably rugged terrain across many portions of the country. Some soil is unsuitable for farming as a result of the terrain, but other parts are overworked or dry from lengthy droughts. While large farms are equipped with technology to improve the quality of farming, many rural farmers do not have the same access to advances in farming. Most farms, about seven out of ten, are small, family-owned farms (“A Tech”). These people rely on labor-intensive practices to grow crops. To help improve conditions for rural farmers, there are current studies being completed analyzing the weather patterns of Colombia to help produce data that better represents the country's farming capabilities.

While Colombia is dealing with an overabundance of issues, the widespread issue needing the quickest sustainable solution is micronutrient malnutrition. Those with micronutrient deficiencies may consume enough food but lack proficient amounts of vitamins and minerals. Most commonly absent from people's diets include vitamin A, iron, and zinc. These deficiencies can present many risk factors in all populations. People with an iron deficiency commonly have anemia which causes people to feel weak and tired. For pregnant women, lacking these vital nutrients can result in birth defects in their infants, low birth rates, and delayed development. If the infant lacks nutrients for an extended period of time, they are likely to have stunted growths. During some of the most crucial times of development, from birth to age one, 25% of Colombian infants are iron deficient (Angarita). As for children under the age of five in Colombia, one in four have a vitamin A deficiency (Funes). All of these support the idea that getting small children well nourished early is crucial for proper development. While the issue of malnutrition is often connected with those who are underweight, the problem is also present in those who are obese as well. In fact, it is observed that more than half of the population in Colombia is overweight or obese (Parra). For those who are

obese, micronutrient deficiencies may be disguised, but they pose the risks of increased mortality rates and shorter life spans.

The dual burden that Colombia is facing calls for a solution that will help to reduce micronutrient malnutrition in all populations. One promising solution is the use of biofortified plants. This option is both cost-effective and sustainable for the foreseeable future. Biofortification is the key solution to reduce the micronutrient malnutrition issues across developing countries. It increases specific micronutrients in crops before and during growing. There are many ways that crops can be biofortified, including both GMO and non-GMO methods. One of the most common ways to develop biofortified crops uses plant breeding which does not genetically modify crops and is widely accepted among farmers. Some biofortified seeds also produce crops that, once harvested, will not lose vitamin/mineral densities, a process that otherwise occurs as a result of exposure to light and oxygen among other sources. Creating a biofortified seed takes extensive research and testing, and many factors influence the decision of whether or not a particular seed is suitable to enter the market. The most important factors are developing a low-cost and high-yielding seed, ensuring that the nutritional value has increased significantly, and integrating the seed into the diets of the target population (Van Der Straeten). In the case of Colombia, the highest priority populations are pregnant women and small infants living in poverty; however, almost all people in Colombia would benefit from the highly nutritious biofortified crops. To best fit the diet of rural Colombians, there are two leading crops that have the greatest potential to deliver life-changing impacts: biofortified cassava and kidney beans. The cassava is best to be biofortified with vitamin A and has potential for biofortification with other micronutrients. The beans are best biofortified with iron.

Cassava has the capability to provide many benefits, and it is one of the more sustainable crops for the future despite the changing conditions caused by climate change. Currently, cassava has been biofortified with vitamin-A in some Latin American and African countries. This vitamin is crucial in maintaining healthy eyesight and effective immune system responses (“New”). While the vitamin A biofortified cassava already provides considerable health benefits, there is also ongoing research to develop a cassava variety that is biofortified with zinc and iron. The research is still ongoing and has proved many initial challenges during testing phases, but using genetic engineering to increase levels of these two micronutrients offers an optimistic outcome. The researchers are working to overexpress certain genes related to zinc and iron to produce a crop that has significantly higher levels of these nutrients (Naryanan). If this were to prove successful these cassava varieties would be great additions to Colombians’ diets.

In a 2017 study published in *The Journal of Nutrition*, biofortified iron beans were studied with women in Rwanda in a double-blind experiment; in this type of experiment neither the subjects (Rwandan woman) nor the researchers are aware of which bean the subject is consuming. The experiment provided the women with beans twice a day over a period of 128 days. The women receiving treatment ate biofortified beans and those receiving the placebo ate regular beans. The results of the study presented strong evidence to support that consuming iron-biofortified beans provided both physical and cognitive health benefits. As expected, it was found that the women’s iron levels increased. Levels of ferritin, a protein that stores iron, increased in the participants given biofortified beans which resulted in improved memory and quicker reaction times. One of the key focuses of the study was to observe the changes in cognitive health, and it was concluded that consuming biofortified iron beans does, in fact, improve cognitive health (Murray-Kolb). Improving these can increase work efficiency and lengthen attention spans.

The complicated process to engineer a biofortified crop may seem daunting, but it is instead a promising, cost-effective way to decrease instances of malnutrition. The most costly parts of

biofortification are the research and testing phases. Luckily, this research is often done in labs and does not force seed consumers to pay for costs. At markets, where seeds are commonly sold, the seeds are sold at a price that is affordable for all farmers, and the price difference between regular and biofortified seeds becomes negligible (“Frequently”). Also, cassava and bean crops can be replanted each year by saving seeds/roots from the crops the previous year. This is an option for all farmers to save even more money, but many farmers prefer to buy seeds every year because it is easier and tends to produce higher yields of crops.

After knowing that the solution is cost-effective, the next big hurdle to overcome is how the seeds will be distributed and how farmers will be educated about the seeds they have. Luckily, biofortified seeds have been distributed in other countries, specifically Rwanda. There, a few different methods of distribution were found to be successful. The first method was to go to small markets and distribute the seeds to farmers in smaller packages. The other two methods, payback and seed swap, were found to be the most effective ways to distribute seeds (Vaiknoras). The payback method gave farmers seeds with a promise that they would return an agreed upon portion of their crops back to the organization providing them with seeds. The most common method of distribution is the seed swap method. This method simply had farmers swap the local seed they were using with the seeds that are biofortified.

The solution of biofortification is extremely sustainable. Once the initial seeds are distributed to farmers in Colombia, the farmers would not need to change anything about their farming practices to maintain the plants. The seeds, once biofortified, will always be biofortified even when seeds are saved for a future year. In addition to this, the engineered seeds will not lose the nutrients they are enhanced with over time (Goldstein). Consumers of the biofortified crops will eat the same amount of food, but will intake more nutrients. The beans and cassava are staple crops, so these are already in people's diets.

Biofortified crops are a key solution to feeding the 9 billion people that will inhabit the planet in the near future. They are a simple, cost-effective, and sustainable solution to help solve micronutrient malnutrition. If implemented to farmers across Colombia, consumers' physical and mental health will improve vastly. Biofortified seeds will continue to improve over time, as they already have since first being introduced to farmers. As technology, science, and knowledge progress globally, so will the quality of these biofortified seeds.

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