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Chad: Incorporation of Lentils in a Malnourished Diet

The Central African country of Chad is ethnically diverse, with a colorful culture, and over 200 different groups within its population. After gaining independence, unfortunately, they have stumbled into poverty and malnourishment. Chad has come to rely on foreign aid and food assistance to subsidize daily nutrients. Frequent droughts and other disasters prevent a surplus of crops from being successfully grown, and Chadians barely consume enough calories to make it through the day. Nonetheless, its people persevere, working to sustain their families. The addition of lentils, a nutritiously beneficial legume, can integrate more subsistence into the Chadian diet as they not only have enough protein and calories to sustain the average person, but encourage self-sufficiency in the nation.

Chad is a landlocked country in north-central Africa with a population of 15.5 million people. Out of the total population, 23% occupy urban areas, and 77% rural villages (“Urban Population”). Of those families, 50% follow Islam, 25% are Protestant, and 20% are Roman Catholic. The average household consists of 5.8 people living in a circular hut made of adobe and straw (“Data Center: International Indicators.”). Chad has three distinct climate regions. The northern region of the country is home to the hot and dry Sahara desert along with grassy plains in the south. The midsection of Chad is referenced as the Sahelian zone, a semi-arid transition from the hot and dry desert to the tropical and subtropical regions of the savanna. Lake Chad, what remains of the second largest wetland in Africa, is situated on the western side of the country; a majority of crops are grown seasonally around Lake Chad in the southwestern region (Connah 21). Significant crops include millet, sorghum, peanuts, and tubers; although these crops are unsuitable to desert conditions (“General Profile”).

Trading of goods is a considerable lifeline to the people. However, the goods produced by crops are difficult to transport to the northwestern part of the country. Chad is best known for its export of oil, which generates the majority of Chad’s export income. They also export cattle overland to neighboring Nigeria, as well as distribute cotton, and gum arabic (the main ingredient to many types of glue) internationally. As a large exporter of oil and gum arabic, Chad could regain its vibrant culture through a substantial increase of the growth of lentils.

In recent years, the Boko Haram insurgency, an extremist Islamic terrorist group in Nigeria, has been disrupting the trade in the northern part of the country. The Chadian government is working to end the political unrest (Bukarti). Chad has had an arduous government history, leading to frequent socioeconomic and political struggles. After gaining independence from France in 1960, the government placed a ban on political parties to suppress dissenting opinions, leading to almost 40 years of civil war. Ultimately in 1990, the incumbent president, Idriss Deby, took control over the country amidst wavering

political support; Deby created a pseudo-democracy in which the people's liberties were limited. Boko Haram has stressed liberties further (Jones and Grove). Frequent political uncertainty has threatened not only trade but also livelihoods and food security throughout the country's history.

Political uncertainty, paired with harsh and unpredictable growing conditions, has created a significant Chadian dietary gap. Chad's climate is often at a precipice of harsh weather conditions such as frequent droughts and natural disasters resulting in poor crop growth. The extreme Saharan temperatures command the northern region of the country, producing unsuitable land for growing food-producing crops. Located in the central area of Chad, the Sahel can be quite dry but is still able to produce a limited number of crops that can be grown and harvested throughout the year. The southern zone of the country is where a majority of farmland can be found. Chadian farmers rely on subsistence agricultural farming, and grow crops exclusively for themselves and their families, due to little surplus of crops. Additionally, the focus on the cultivation of non-edible crops, such as cotton, reduces the amount of food being produced.

The unfavorable agricultural environment has led to decades of unreliable access to sufficient nutrients in Chad. Statistics reveal that 43% of children under the age of 5 suffer from stunted growth, 3.7 million people are considered to be food insecure, and 5.6 million are malnourished (World Food Programme and Food and Agriculture Organization). Despite technological advancements and international aid, these numbers, unfortunately, have not improved. Malnutrition is the epicenter of health concerns; it results in substantial susceptibility to numerous parasites and diseases that are common in Central Africa, as well as cognitive and physical impairment in children ("Understanding the True Cost of Malnutrition.").

It is widely acknowledged that the lack of nutritious food leads to a detrimental state of health; in fact, this directly impedes a country's development at astonishing rates. A 2016 study by Cost of Hunger revealed that Chad's malnutrition misfortune could cost a gross domestic profit of nearly a 10% deficit (qtd. in World Food Programme). Statistically, malnourished children underperform in school and contribute to fewer job opportunities resulting in undernourished adults that are less likely to enter the workforce and lend to their economy. Malnutrition affects not only the economy but quality of life.

Due to unpredictable weather, irregular rain, droughts, and tensions between herdsman and farmers, the current food system is fractured, weak, and unsustainable. Problems in the food system lead to suboptimal health, economic staticity, and crowded living conditions. Currently, Chadians get 62% of the necessary protein intake; an insufficient amount of calories to get through the day (Food and Agriculture Organization). This deficit contributes to lower productivity and food output. Chad's agricultural industry employs 85% of the population, but as of 2016, only 40% of the land is cultivated, and the average farm size is small, approximately 1-2 hectares or 2.5 American football fields (Food and Agriculture Organization).

Gender inequality is another issue that perpetuates malnourishment. Chad ranks second-worst in terms of gender inequality, with a female literacy rate of 13%, compared to a rate of 41% for men (Villarreal). A study in Central Africa by the International Food Policy Research Institute showed a strong correlation between hunger and gender inequality, especially inequalities in education ("2009 Global

Hunger Index”). Societal norms also keep women from entering the workforce, specifically the farming industry (Villarreal). Women’s lack of access to agricultural resources such as land and job opportunities as well as knowledge of the industry can be detrimental to the already prevalent issue of hunger. Recent studies have shown that if women were given the same resources as men, 100 to 150 million people could be lifted out of hunger (Villarreal). Addressing the systemic gender inequality present in many rural communities is crucial to reducing malnutrition.

Numerous international organizations such as the World Food Programme have provided assistance to counter Chad’s food crisis; although rates of malnutrition remain high. The Chadian government partnered with the World Food Programme in 2017 to achieve “Vision 2030: The Chad We Want,” a framework of consecutive development plans to be implemented over the next decade. Strategies include offering monetary incentives and ready-to-eat meals as motivators to increase school attendance, creating centers for the treatment of diseases and malnutrition, and implementing interventions to provide nutritious food to rural villages. Nonetheless, these plans rest on one notion: reactive responses to disasters. They provide aid when an entity causes rates of malnutrition to increase, not as a preventative measure. Oftentimes, a crisis has already affected many people before aid arrives and the damage cannot be reversed. However, preventative measures such as education and providing citizens with the means to be independent and grow their own food are proactive and sustainable, and can reduce the negative effects of a natural disaster.

The International Center for Tropical Agriculture (CIAT) has developed a system called the Nutrition Early Warning System (NEWS) that proactively tracks issues such as undernourishment. NEWS will implement the use of machine learning technology to analyze weather patterns and other trends to detect a crisis before it occurs, then notify officials that aid will be needed and will provide ample time for measures to be prepared before a crisis transpires. In the event of a disaster with the appropriate measures taken to lessen the impact of an emergency, the country will once more be reliant on international aid to resolve the issue. The challenge of malnutrition must be curbed and approached in a manner that is proactive and autonomous.

One promising approach involves incorporating lentils into the existing Chadian diet. Lentils have been grown and harvested throughout Asia for over 10,000 years. A part of the legume family, lentils consist of a wide range of nutritional value. They are high in protein, fiber, and provide necessary carbohydrates and calories. A 2015 study highlighted the benefits of incorporating lentils into a cereal-based nutriment, similar to the current Chadian diet. The addition of lentils increased the intake of essential vitamins and minerals as well as combatted calorie deficiency (Migliozzi et al.). A 2018 trial implemented lentils in rural Bangladeshi diets. The results showed a great increase in overall wellbeing of the participants as well as a decrease in micronutrient deficiencies (Yunus). Introducing lentils into the Chadian diet can reduce malnutrition and decrease stunted growth in developing children and young adults.

Farmers are limited to a small variety of viable options that can be grown in the Central Sahelian region, due to unstable weather conditions and persistent droughts. However, Chad’s well-drained soil is ideal for

lentils, they flourish best with minimal water. Additionally, the soil's pH of 7.3 is well above lentils' threshold of 5.6 ("CHAD Series"). Lentils require a minimum of 12 inches of water to produce the highest yield, which is quite suited for Chad's annual rainfall of 13 inches in the Sahel region. Additionally, a study by Montana State University stated that the planting of legumes can reduce the need for fertilizer. In most cases, legumes do not require fertilizer to begin with, and can even 'add' nitrogen—a major component of chlorophyll—back into the soil. This process is called nitrogen fixation, where lentils convert molecular nitrogen in the air into nitrogenous compounds that are then released into soil (Abi-Ghanem). Oftentimes, nitrogen fertilizers are a large percentage of farmers' expenses, however, as lentils improve the nitrogen efficiency they also reduce the costs associated with fertilizer (Balasubramanian 19). Overall, lentils increase soil quality and reduce fertilizer costs.

Sorghum, the primary crop cultivated in the Sahel, is grown and harvested seasonally from November to February. Lentils can be planted during the dry off-season, from March to June. The Sahel consists of 1.9 million acres of farmland available during the off-season of sorghum. To cultivate the entirety of this land, 760 billion seeds, or 47,500 tons of seed, are needed, with an estimated expense of \$21.5 million. With an approximate yield of 1,250lb/acre (Lentil), up to 1.2 million tons of lentils could potentially be produced. This would be effectively sufficient to allow for 14.8 million people, over 95% of the country's population, to eat a daily serving of lentils for over a year. However, this estimate does not take into consideration the differences in serving sizes for children, young adults, and adults.

Chadian cuisine currently consists of another type of legume: peanuts. Chadian's familiarity with peanuts will assist with the acceptance of lentils into their diet without causing digestive issues. Millet and sorghum are usually made into breads, or rolled into balls then dipped in a variety of sauces, or brewed into beer ("Customs and Cuisine"). Chadians could add a lentil sauce to aiyash, a common meal of fried millet balls consumed in different stews, or potentially replace peanut butter paste in the vegetable stew daraba. Overall, lentils have the potential to be widely accepted throughout the country as there are no existing religious restrictions and there are several ways of supplementing them into the Chadian lifestyle.

The implementation of lentils in Chad parallels the incorporation of mungbean, another legume, in Asia to combat protein deficiency in the late 1990s to early 2000s. After decades of research and development of the crop, trials were conducted in six countries to optimize the mungbean crop (Shanmugasundaram 388). In 2002, the UK's Department of International Development (DFID) approved a project whose purpose was to diversify diets, increase nutritional security in South Asia, and promote the consumption of mungbean. Other efforts included the distribution of practice guides in local languages and demonstrations on how to cook mungbean (Shanmugasundaram 388). Organizations around Asia then planted mungbean in their respective countries. As the success of the crop grew, other regions then incorporated mungbean (Shanmugasundaram 390). The addition of this legume had many economic and nutritional benefits in Asia, and could serve as a guide for the addition of lentils in Chad.

The World Food Programme, from various donors, has set a budget of \$1.3 billion to assist Chad. Over \$220 million have been set aside to ensure access to nutritious foods year around. A portion of the funds can be used to supply lentils to Chad in hopes of encouraging independence and reducing the need for

aid. The United States may also partner in supporting the implementation of lentils. In 2015, the U.S. was the single largest donor of foreign aid. Chad is the second largest exporter of gum arabic, a plant that is used as a thickening agent or emulsifier in everything from paints and glues to medicines and confections (Ahmed). The scope of gum arabic's applications makes it a great commodity. Also, the northwest region of the U.S. is one of the major producers of lentils. It would be beneficial to both countries for the U.S. to send the initial seeds and agricultural experts to Chad in return for gum arabic. After planting, lentils can be harvested within 3 months, and due to their resilient nature, do not require foreign aid or attention after the initial exchange (Pavek et al.). A trade deal between the two nations could offer an incentive for the U.S. to fund the import of lentils to Chad.

To ensure full access to nutrition, financiers may set parameters or conditions for the sale of crop types. For example, donors could set limits on high margins, so that lentils are affordable and accessible for all Chadians and restrict the quantity of bulk lentils for export; these measures would ensure adequate food quantities and nutrients for Chadians.

Chad has reported high rates of malnutrition for decades; statistics show 1 in 5 children are affected by stunted growth, along with several other common maladies. However, studies indicate that these rates can be greatly reduced simply by adding lentils into their current diet. Presently, the partnership with the World Food Programme and the CIAT's NEWS system rely on foreign aid. Lentils are a high protein addition to a diet containing many essential vitamins and minerals. They would not only do well in the dry Sahel region but also would improve nitrogen content in the soil. They can be grown and harvested in the opposing season of sorghum, not impacting the current crops, and can yield enough to feed over 95% of the country. This solution provides a self-sufficient and autonomous production methodology to combat malnutrition, omitting the reliance on foreign aid.

Over 15 million people call Chad their home despite the poverty and insecurity that comes with it. With the addition of lentils into the Chadian diet, we can improve the lives of 15 million people by giving them access to nutritious food and the means to support themselves.

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