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Chad, Climate Change

Chad: Realities and Solutions to Climate Change.

Chad is a landlocked country in North-Central Africa. Although it is the fifth largest country on the continent, it has a very low population density. "Chad is one of the least developed countries in the world making the country very vulnerable to climate change." (Climate Change/Chad, n.d.). In addition to being underdeveloped, Chad is also one of the poorest countries in the world as its people suffer from extreme droughts, floods and plagues of locusts leading to food insecurity. Persistent drought has increased desertification in the northern part of the country, causing drastic declines in agricultural productivity. Beyond that, drought continues to threaten freshwater resources in the region surrounding Lake Chad. Climate studies project that the country will become increasingly hot and arid throughout the 21st century, meaning lower crop yields, less pastureland, and a harder life for the Chadian people. While the developed world continues to debate climate change risks and consider the necessary mitigating investments, Chad does not have that luxury. For this country, the realities of climate change are ever present and devastating.

How people in Chad live with the effects of climate change can bring new insight into why it is a problem that needs solutions. Most of the citizens of Chad are living as cultivators and pastoralists in dispersed hamlets, cattle camps, villages, and oases. With drought and famine common throughout the country, many leave their villages and their homes behind to find safety. The combination of climate crises and the relentless attacks carried out by armed groups in the Lake Chad Basin has resulted in a devastating impact on the region, forcing families to flee and leading to a severe rise in malnutrition rates.

The average Chadian home consists of six to eight people, with the primary caretaker being the mother. "The average life expectancy is short, only 53 years. Due to the country's poverty, about 6% of the population have access to electricity and only 8% have access to basic sanitation." (*Chad*, n.d.). Chad protects immigrants and allows humanitarian relief to 480,000 refugees and almost 300,000 internally displaced people. "Chadians are primarily dependent on basic primary health care and polyclinic aid, as well as traditional medicine, due to the underdeveloped and neglected state health-care system and the unavailability of private alternatives." (Education and Health, n.d.) The ratio of doctors to the population is low, with only one doctor serving every 38,000 people. "Although about 60 percent of children in Chad attend primary school, the literacy rate in the country is estimated to be only 20 percent, which is low compared to other countries in Africa. Only a small percentage of individuals choose to pursue further formal education, while many children are educated within their families and simultaneously take on responsibilities such as domestic chores and economic activities during their early teenage years." (*Chad. Culture of Chad*, n.d.) Due to the prolonged civil conflict, isolation, and neglect that has lasted for decades, the education system, especially Islamic education, has started to grow among the communities in the northern regions. There are still significant shortcomings in its quality. One positive aspect of the various ethnic cultures is that they each have their own unique traditions of oral literature. These traditions encompass a wide range of storytelling forms such as narratives, epics, and ritual drama.

The people of Chad are very dependent on agriculture, namely cotton production. In terms of exports and income, oil provides about 60% of the country's export revenues, but cotton, cattle, livestock, and gum arabic provide the bulk of Chad's non-oil export earnings. "About 40 percent of the gross domestic product is generated from agriculture, and approximately 18 percent from the livestock economy." (*Chad. Culture of Chad*, n.d.)

Most of Chad is occupied by the Sahara Desert and is acknowledged as one of the hottest countries.

Since the 1970s, Chad has already experienced an increase in mean annual temperature of 0.7°C. Temperature is rising in Chad faster than the global average and is projected to increase by 1.0-3.4°C by the 2060s. These changes threaten food security, due to the vulnerability of the agriculture, livestock, fisheries, and land use sectors to climate change. Chad is particularly affected by low yields and declining harvests, which are exacerbated by weak forecasting, preparedness, response and adaptation. (Climate Change/Chad, n.d.)

The drying of Lake Chad is the largest example of environmental degradation in the country. “Lake Chad is a source of freshwater for over 30 million people and covers an area of 17,000 km squared over four countries, when measured at its highest point at the end of rainy season.” (Centre, U. W. H, n.d.) Thirty million people not only depend on the freshwater from Lake Chad to drink but for their livelihoods. It sustains fishing, irrigation, and economic activities in Chad, Cameroon, Nigeria, and Niger. However, as the lake continues to shrink, communities struggle and compete for the limited resources the lake still offers. In many communities, men must look for work in larger cities during the dry season when the lake is unable to support them. Internal migrations are on the rise, and people are looking for work outside of the country in places like Europe. Women and children who are left behind are forced to fill the gap and innovate to ensure food security. Despite the droughts the citizens of Chad must overcome, floods are still a common natural disaster in Chad and are expected to increase because of climate change. Not only is Lake Chad crucial for the life of the inhabitants of Chad, but also hundreds of bird species and diverse ecosystems. It is recognized as a wet zone of international importance. Drought, in addition to overuse, has caused acceleration of the drying up of Lake Chad. The size of Lake Chad has shrunk by 90% between the 1960’s and the 1990’s. Forecasts by NASA have indicated that it could completely disappear in two decades at the current rate of water use and silting of upstream rivers. As a result, the Lake Chad Basin region is facing one of the world’s greatest humanitarian crises. Many people who lived in the lake region are forced out of their homes and now face substandard living conditions, including shelter, hygiene, and clean water. Many have also lost their source of income, farming and fishing.

The effects of climate change on food security in Chad include desertification, floods, and the exhaustion of freshwater resources. All these factors have had a negative impact on agricultural production in Chad. Margot van der Velden, the World Food Programme Regional Director for Western Africa, states, “The Sahel and Lake Chad Basin regions are grappling with an unprecedented food security and nutrition crisis that jeopardizes their vast potential. We must act swiftly to prevent conflict, climate change impacts and economic challenges from disrupting humanitarian efforts, and from increasing safety risks.” (Conflict, climate, hunger, n.d.) Chad is recognized as one of the hottest and driest countries. The temperature in Chad is rising, and the food availability is decreasing. The extreme heat and unpredictable rainfall disrupt traditional farming practices. Rising temperatures in Chad not only lead to crop failures, but an increase in insect infestations. Other climate-caused agriculture limitations include soil degradation and desertification. Food insecurity is not just a term for the citizens of Chad, it is a harsh, ever-present reality. “1.8 million people in Chad are starving, with children under five most at risk with 414,000 being severely malnourished between October 2022 and September 2023. Around 270,000 pregnant and lactating women were also expected to experience acute malnutrition.” (Chad: Food Security Crisis, n.d.)

The past year has marked the fifth consecutive year of severe food insecurity in Chad. This is exacerbated by the massive influx of refugees and declining agricultural production due to climate change, and an immediate admixture of emergency aid is needed. Long term solutions are also needed to support livelihoods and climate resilience, including community-based interventions, protecting the environment, improving water use, and protecting against floods.

In 2017, Chad adopted two important strategies: The National Environmental Policy and the National Climate Change Strategy. The National Environmental Policy objective was:

contribute to sustainable development through the rational management of natural resources by following specific objectives: i) effectively combat all factors of environmental degradation (e.g. climate change, desertification and all forms of ecological pollution and natural disasters), ii) promote the conservation and rational use of national biological heritage and iii) guarantee access for all to natural resources, including land, genetic resources and related knowledge. (Chad: First National Climate Change, 2022)

The National Climate Change Strategy aim is to build a more climate-resilient economy. The overall objective is the bringing together of all stakeholders addressing climate change. The National Climate Strategy identifies five strategic pillars:

Pillar 1: Strengthen the resilience of agro-sylvopastoral, fishery and urban systems

Pillar 2: Promote climate change mitigation actions

Pillar 3: Prevent and manage extreme climate phenomena and risks

Pillar 4: Build the capacity of actors and institutions to combat climate change

Pillar 5: Strengthen the instruments and capacities to mobilize climate financing ((Chad: First National Climate Change, 2022)

In 2021, Chad further outlined its commitment to the above strategies and priorities by implementing the National Adaptation Programme of Action (NAP) to build capacity toward climate change adaptation. However, due to Chad's extreme heat and flooding, accelerated migration of peoples from other countries, and the COVID 19 pandemic, Chad has struggled implementing all these new strategies.

Climate Smart Agriculture (CSA) technologies and practices are essential components of the (NAP) plan. CSA provides an opportunity to strengthen food security while securing climate adaptation and mitigation. CSA practices consider objectives in water management, soil management, crop management, and livestock and fodder management. With support from the World Bank, Chad has installed sixty-four solar-powered synoptic stations for real-time capture and transmission of weather information. Stakeholders from across the country have been trained in issuing weather forecasts, including television broadcasts. Also, gauges have been installed to support tracking and alerts about flood risks. Additionally, this program is supporting communities in the use of climate information, enabling them to adapt and to take early action.

Chad is among eleven African countries supporting the Great Green Wall project whose focus is mobilizing communities to plant as many trees as possible to counter the advance of the Saharan desert. The African Union (AU) launched the Great Green Wall (GGW) project in 2007 with support from the United Nations and World Bank. Using proven methods of natural regeneration enclosed areas protect trees and other vegetation from grazing animals and woodcutters. Once established, the shady plots provide good conditions for agroforestry opportunities, growing crops, or keeping bees.

A successful project sponsored by the Swiss Agency for Development and Cooperation supports water management using water-spreading weirs in Chad. Weirs help to store water from rainfall, slowing the percolation of the water and thereby allowing groundwater reservoirs to develop. The Swiss Agency has supported 150 water-spreading weirs built by local companies in eastern Chad. This has allowed close to 5,000 acres to be irrigated for vegetable growing. This has stabilized the food supply and herders can also water their animals at the weirs. Village communities collectively build, use, and maintain the weirs.

Other countries, with similar problems and concerns, have adopted strategies and technologies to increase food abundance and prevent further damage from climate change. Learning from other more developed countries could help Chad decrease its food scarcity and benefit all its inhabitants.

In Tanzania, the ACCELERATE Project initiated by the Tanzania Agricultural Research Institute (TARI) addresses the challenges of climate change and low crop productivity focusing on promoting climate-

resilient seed varieties for essential crops, including groundnut, sorghum, and beans. The seeds have been developed in collaboration with local and international agricultural research organizations empowering farmers to achieve better yields and improved food security across Tanzania. Crops like ground nuts (peanuts) are climate friendly as they require less water to grow compared to other nuts, enrich the soil with nitrogen, have a smaller carbon footprint, and can thrive in drier conditions.

The Climate-Smart Village (CSV) Research for Development (R4D) project sponsored by the CGIAR Research Group, has been extremely successful in sponsoring six villages in East Africa. The project provides new knowledge and skills and builds the capacity of local farmers to change farming practices while adopting new crop and livestock interventions. The comprehensive interventions include better access and delivery of improved seed varieties, improved breeds of small ruminants, access to improved year-round potato varieties, and the introduction of disease resistant root crops such as cassava, and sweet potatoes.

In Ghana, the company FutureWater is supporting Ghanaian farmers by developing climate smart irrigation technologies. This smart irrigation service is able to translate various weather parameters and data crop specific irrigation advice in volumes, but also in minutes for small-scale farmers. Satellite based irrigation advice provides how many minutes a farmer should irrigate a specific crop aligned with local weather data and real-time data made for small scale. Sensing data from ground networks of weather stations is linked to drip irrigation systems. The tool changes the current traditional practices, eliminating overwatering and improving food production.

The Food and Agriculture Organization of the United Nations (FAO) is working to help African farmers mitigate the effects of climate change by sharing sustainable and efficient nutrient, water and soil management practices. The initial program started in Nigeria and has now spread among other African countries focusing on improving cassava production. “Due to climate change, water scarcity and declining soil fertility, cassava yields are being adversely affected across the continent, causing many people to face food shortages and malnutrition.” (IAEA. (2023) With applied training farmers have been able to double and even triple their cassava yields.

While Chad has taken some steps to prevent future environmental degradation and food insecurity, they would benefit from implementing the technology and strategies that have already been proven successful by other countries. However, in order to improve the quality of life and quantity of food as well as combat the effects of climate change, the global community needs to continue to explore new, creative technologies and untested solutions.

An important tool to be considered in improving food security, particularly in struggling agricultural regions like Chad, is the use of plant growth-promoting microbes (PGPM). PGPM provides protection against pathogens and stimulates plant growth. Researchers have found that instead of using chemical fertilizers, biological microorganisms including bacteria and fungi can be used as a more stable solution to environmental stressors and depleted soils. Specifically, *Trichoderma harzianum* and *Arbuscular mycorrhizae* are two fungi that could be used in Chad as a solution to help plants flourish under the current extreme environmental conditions. *Trichoderma* is proven to help accelerate flowering, enhance growth, promote seed establishment, and protect against pathogens. *Mycorrhizae* has numerous benefits and allows plants to deal with environmental stressors. *Mycorrhizae* helps plants find and modify nutrients in the soil and increases access to nutrients as it helps to create resources. *Trichoderma* has already been proven successful in improving drought tolerance as well as the growth and vigor of rice.

To advance these findings, colleagues and I undertook two research projects using both plant growth promoting bacteria and fungi. Using *Trichoderma harzianum* and *Arbuscular mycorrhizae* as a priming seed soak, the benefits of natural herbicide and fertilizer can be observed. For this study, we began by

soaking a mixed variety of native wildflowers in a Trichoderma and a Mycorrhizae solution for 24 hours. We used three equal 225 sq. ft. plots to study Trichoderma-soaked seeds and Mycorrhizae-soaked seeds versus a control group. Under drought conditions, similar to the ones in Chad, a cover crop of wildflowers in eight weeks saw a 240% gain in biomass. “In eight weeks, the sample biomass of the Mycorrhiza site outperformed the control by 240%, and the sample biomass of the Trichoderma site outperformed the control by 365%.” (Tomlinson, M., & Dennis, R., 2024) Under similar drought conditions, an ornamental crop of chrysanthemums saw in five weeks a 50% gain in biomass (Hibble, A., & Seaton, K., 2024). Chad’s main agricultural export, cotton, is a plant that shares many characteristics with the flowering plants used for this study. The conclusion can be drawn that the priming seed soak of these two fungi would be an excellent solution to implement in Chad.

Biopriming seeds and using PGPM is considered one of the most cost-effective integrated nutrient management supplements. Chemical fertilizers only cover where they are applied, while certain fungi, like *Trichoderma harzianum*, grow along the surface of the roots, meaning farmers would not have to reapply fertilizer multiple times through the growing season and input costs would lower. Not only is PGPM a cost-effective solution to improve food availability in Chad, but it would also help improve the soil health and water quality. In contrast, chemical fertilizers harm other organisms in the soil and strips the soil of nutrients which can lead to the edibility of the crops being affected. Using bio-fertilizer and priming seeds is a sustainable, and climate smart solution that would benefit agriculture, without the extreme costs or start up efforts of things like solar panels, micro irrigation, or other climate smart agriculture technologies.

One of the most exciting facets of this solution is the ability to apply PGPM on a very large or a very small scale. The cost barrier is extremely low, and individual citizens can apply this practice to personal plots, as our experiment demonstrates. The benefits could be observed almost immediately with minimal labor efforts. Conversely, this solution could be applied on a large scale with economic benefits for the entire country.

Chad must focus on providing extension education training and financial incentives to small scale farmers to switch to climate smart agricultural methods, such as PGPM. Climate change and food insecurity are enormous issues that can only be addressed by starting small and being committed to implementing micro changes first at the community level and then on a national level. Supported by global investment partners and community initiative, improved food security and climate resilience can be sustained in Chad.

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