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From Dust to Harvest: Rebuilding Agriculture in Climate-Vulnerable Burkina Faso

Imagine waking up at 5:00 AM, the air already dry, and beginning a long walk several kilometers across dusty terrain to collect water. The rest of the village is awake too, completing the same task. With every kilometer, there is a quiet calculation: how much water can be carried back, and whether it will be enough. Each step marks uncertainty and hope: whether the crops planted months before will survive the upcoming weeks without rain. For many families in Burkina Faso, this is not an occasional hardship but a component of daily reality, as there is no rain for five to eight months in a year. In a region where agriculture depends entirely on rainfall, a single failed rainy season can determine whether families have enough food for the year. As climate change increases drought and rainfall variability, farmers face growing difficulty producing reliable harvests.

Background

Burkina Faso, a landlocked country in Western Africa's Sahel region, has a population of approximately 24.4 million people spread across a land area of 105,878 square miles, resulting in a population density of about 233 people per square mile. Roughly 67% of Burkinabè live in rural areas, while only 33% reside in urban centers [1]. Geographic isolation is a major challenge for rural communities, limiting their access to markets, healthcare, and education. Although Burkina Faso has millions of hectares of agricultural land, much of it is vulnerable to drought and soil degradation because the country lies in the semi-arid Sahel region, where rainfall is limited and unpredictable. Approximately 3.5 million people (20% of the total population) in Burkina Faso faced severe food insecurity in 2024 due to climate shocks, conflict, and rising food prices. Burkina Faso has about 9 million hectares of arable land, but less than half of it is cultivated, and agriculture is mostly rain-fed, making it vulnerable to drought and climate change [2].

Political instability has worsened the country's challenges. In 2022, Burkina Faso experienced a military coup when Captain Ibrahim Traoré overthrew the previous transitional president, Paul-Henri Sandaogo Damiba, citing failures to address growing jihadist violence. Ongoing conflict has displaced more than two million people across the country. Many displaced families have been forced to leave their farmland and livestock behind, increasing pressure on food systems and humanitarian aid networks [3]. As a result, strengthening agricultural productivity is not only an environmental priority but also a humanitarian one, as providing a reliable food source is critical for supporting displaced communities and stabilizing the nation during periods of conflict.

Burkina Faso's has a hot, semi-arid climate, long dry season and short rainy season, unpredictable rainfall, and dry land vulnerable to desertification. Major crops in meals include sorghum, maize, groundnuts, cowpeas, and sesame, and the major export crop is cotton, or "white gold". Most farms are smallholder farms under two hectares (five acres, or four to five American football fields), and traditional farming

methods are utilized. The average household size is approximately five to six people, and larger extended families often live together [4]. To cook, most families use wood or charcoal fires with large pots over open fires. Common jobs include smallholder farming, livestock herding, trading in markets, artisan work, and mining (particularly gold), and the average annual income (GDP per capita) is about $900-$1000 per year [1]. Although primary school enrollment is improving (72% in 2023), many children don't complete secondary school (only 30.93% do) because of school fees and inaccessibility with distance, which also affects healthcare access. Families rely on wells or community pumps for water, simple pit latrines instead of toilets, and less than 25% of the population has electricity [3].

Challenge

Burkina Faso is considered one of the most climate-vulnerable countries in the world, with about 80% of the population dependent on agriculture that relies on rainfall. Rainfall has become more unpredictable, and droughts and floods are becoming more frequent. Rising temperatures allow the atmosphere to hold more moisture, leading to fewer but heavier rainfall events and higher evaporation rates, with storms becoming three times more intense than in the 1980s. Currently, about 40% of the population lives in areas highly exposed to climate risks. Overall, trends are worsening: average temperatures are projected to increase by 2-3 degrees Celsius by the end of the century, rainfall variability increasing about 10-20% and crop yields declining 10-20% by 2050 [9].

Land degradation further exacerbates these problems. About 34% of land in Burkina Faso is degraded due to soil erosion, overgrazing, and desertification. In addition, roughly 90% of household energy comes from firewood or charcoal, contributing to deforestation and further environmental degradation [5]. These pressures are worsened by rapid population growth of about 2.2–2.3% annually, which increases demand for food, farmland, and natural resources. In 2024, an estimated 3.5 million people, about 20% of the population, faced severe food insecurity due to climate shocks, conflict, and rising food prices [9]. Because most agriculture depends on rainfall, effective solutions must focus on capturing water, restoring soil fertility, and helping crops survive under drought conditions.

Several strategies have already been implemented across the Sahel to address these challenges. Solutions that have been implemented include Zai pits (small holes filled with organic matter), stone bunds (placing stones along contours of land), Farmer-Managed Natural Regeneration, where farmers protect naturally growing trees instead of cutting them down, and the Great Green Wall (GGW) Initiative, a large African project aimed at planting trees and restoring degraded land across the Sahel. While the GGW struggles with low seedling survival (20%) and security challenges, FMNR has been highly effective because it relies on existing root systems rather than planting new seeds and zaï pits and stone bunds have increased crop yields by 50–100% in some areas [6]. Burkina Faso also possesses several strengths, including local farming knowledge, a growing youth population that can contribute to agricultural innovation, and support from international organizations (e.g, UN, World Bank, and NGOs). Many other Sahel nations face similar challenges due to climate change with food insecurity, including Mali, Niger, Chad, and Senegal, where similar strategies have been implemented. For instance, Niger has restored millions of hectares of farmland using natural regeneration. Yet, despite these efforts, such solutions remain futile against the accelerating extent of climate volatility, soil degradation, and population pressure. Increasingly

severe drought can still overwhelm a restored field if the crop itself cannot tolerate long periods without water [7].

The opposite is also true. A drought-tolerant seed cannot reach its potential if it is planted in crusted soil that loses water and nutrients. Burkina Faso therefore needs one coordinated solution that improves drought survival above ground while rebuilding water storage and biological activity below ground.

Proposed Solution: Crop-and-Soil Restoration Network

A promising solution is a Crop-and-Soil Restoration Network that pairs drought-resilient, gene-edited sorghum with farmer-led traditional microbial soil restoration techniques. Sorghum is one of the country's most important staple crops, typically grown during a 90–140-day growing season, but its yields are vulnerable to drought across the Sahel. Thus, this solution would not only include distributing improved sorghum seed, but we would also introduce the sorghum through community restoration hubs. Each hub would help farmers prepare damaged land using zaï pits, compost, native soil microbes, and water-capturing ridges before planting the improved sorghum. The seed and soil practices would be tested and implemented as one package.

This design focuses on sorghum because it is already a staple food in Burkina Faso and is adapted to the Sahel. It does not ask farmers to replace a familiar crop or depend on an entirely new farming system. Instead, it strengthens the crop they already grow and the traditional soil practices they already use.

Strengthening the crop

Climate change has already contributed to an estimated $730 million to $2.17 billion in sorghum production losses across West Africa, highlighting the need for more resilient varieties [8]. Researchers have identified a sorghum gene called *SbBRI1* that helps regulate plant growth and drought response. Using CRISPR, a tool that makes precise changes to DNA, scientists could reduce the activity of this gene. This change could increase the plant's production of protective compounds called flavonoids. These compounds help plant cells withstand water stress, allowing sorghum to retain water, continue photosynthesis, and wilt more slowly during drought [9]. Under controlled drought testing, these plants can sustain grain production and may increase yields by roughly 20% from typical levels of 0.85–1.5 tons per hectare to potentially 1.8 tons or more [10].

However, the goal would not be to maximize the genetic change. Completely disrupting *SbBRI1* may make plants shorter and reduce stalk material used for animal feed or fuel. Researchers would therefore screen several edits to find one that improves drought tolerance without sacrificing too much plant growth. Promising lines would first be tested in greenhouses and then in contained field trials under Sahelian conditions. Farmers should help evaluate not only grain yield, but also cooking quality, taste, stalk use, seed saving, and performance in local soils.

With sorghum import prices fluctuating between $0.05 and $0.22 per kg, increasing domestic reliance reduces the need for costly imports during times of drought. Other orthologs of SbBRI1 that can be studied for climate-resilient plants are AtBRI1, OsBRI1, SiBRI1, and BdBRI1, which are found in rice and millet. Compared to other nations, regulatory approval in Burkina Faso would be quicker, as the

nation was the first to grow certain genetically modified crops at scale, showing increased support for these biotechnology-focused solutions [11].

Yet CRISPR is only the crop component of the proposal. Even a plant that uses water efficiently still needs soil capable of absorbing rainfall and supporting its roots. For that reason, the edited sorghum would not be distributed as a stand-alone technology and would be coupled with soil restoration.

Rebuilding the soil

Much of Burkina Faso's farmland includes areas known locally as "zippellé," barren, crusted soils where years of erosion, drought, and overgrazing have destroyed biological life for plant growth. Restoring these soils requires rebuilding the biological communities, microbial soil restoration networks (MSRN), that help retain water and cycle nutrients. Moreover, traditional soil remediation (excavation and disposal) can cost over $50 per cubic yard, while biological methods like phytoremediation (using plants and their associated microbes) can be 50% to 98% cheaper [13].

Before planting this genomically-edited sorghum, participating farmers would prepare small demonstration plots during the dry season. They would dig zaï pits and construct half-moon-shaped earthen ridges to slow runoff and concentrate rainfall around plant roots [10]. Each pit would be filled with compost or manure, which adds nutrients and provides food for soil organisms.

The program would then introduce locally sourced communities of beneficial microbes. Healthy nearby soils, compost, and carefully produced local microbial inoculants can contain bacteria and fungi that help cycle nutrients, improve soil structure, and support plant roots. Mycorrhizal fungi are especially useful because their threadlike networks extend beyond the roots and help sorghum obtain water and nutrients. This would prioritize microbes collected within Burkina Faso instead of importing a universal commercial mixture, since organisms adapted to local heat, soil, and rainfall are more likely to survive.

Afterward, sorghum can be planted symbiotically because it forms strong relationships with arbuscular mycorrhizal fungi, thereby expanding underground fungal networks for water and nutrient absorption. Agroforestry species such as *Acacia* or *Piliostigma reticulatum* can also be integrated; these deep-rooted trees act as "hydraulic lifters," pulling water from deeper soil layers and making it available to the surrounding microbial community during drought. To ensure the system becomes self-sustaining, farmers would practice network stabilization techniques, including assisted natural regeneration of native plants, mulching, and leaving crop residues on the soil surface. These practices protect soil from extreme heat while providing a continuous carbon source for microbes, preventing what researchers call "microbial starvation."

Long-term scaling would allow the program to expand. Scientists could track changes in microbial diversity through DNA analysis such as 16S rRNA sequencing, measuring how bacterial and fungal communities recover over time [10]. Farms of initial success could be expanded using regreening strategies that assimilate microbial restoration into national climate-smart agriculture initiatives. The overall impact would be stronger soil structure, increased water retention, and improved crop survival during dry years, allowing farmers to maintain yields even when rainfall declines. However, microbial restoration is not a quick fix; microbial communities respond differently depending on soil type and

farming practices, meaning monitoring and local participation are critical. Therefore, this process would rely on partnerships among agricultural research institutes, local farmers, and international organizations. By combining soil microbiology with traditional restorative practices, the MSRN could transform degraded land into productive farmland and strengthen food security in Burkina Faso.

Reccomendation

Burkina Faso should pilot the Crop-and-Soil Restoration Network in a small number of drought-prone communities. Burkina Faso's agricultural system is dominated by smallholder farms, which operate with limited financial resources and access to technology. Because of this, solutions that rely on local materials and existing farming practices are more likely to be adopted quickly. This recommendation is narrower than pursuing gene-edited crops, microbial restoration, and irrigation as independent projects because it invests in one system targeting one goal: helping sorghum produce a reliable harvest by both improving its drought tolerance and the surrounding soil's ability to reinforce it.

The program should begin on a limited scale before expanding. Researchers could compare plots using traditional sorghum, traditional sorghum with soil restoration, and CRISPR-edited sorghum with soil restoration. They should measure crop yield, cost, and farmer acceptance across multiple growing seasons. The edited crop should be introduced only after biosafety review and field testing, with clear protections for seed affordability and farmers' ability to save seed. If the combined plots consistently produce more reliable harvests without creating unreasonable costs, the network could gradually expand to other drought-prone regions. This pilot-based approach would allow Burkina Faso to evaluate the effectiveness of the entire system before committing resources to larger implementation.

Conclusion

Climate change poses a serious threat to food security in Burkina Faso. Rising temperatures, unpredictable rainfall, and soil degradation make harvests less reliable, while conflict and displacement place additional pressure on farming communities. The Crop-and-Soil Restoration Network would address these connected challenges by pairing CRISPR-edited, drought-resilient sorghum with microbial soil restoration and familiar land-management practices. The edited crop could better withstand periods of limited rainfall, and the restored soil could improve water retention and provide the nutrients needed for crop growth. Implemented through a dozen farms before being scaled, this approach would combine scientific innovation with local knowledge and allow communities to evaluate its tradeoffs before adoption. Over time, it could help stabilize harvests, strengthen rural livelihoods, and make Burkina Faso's agricultural system more resilient to a changing climate for generations to come.

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