

Divya Ramadugu
Kennedy High School
Cedar Rapids, IA
Nigeria, Climate Change

Increasing Rural Nigeria's Food Security by Bolstering Climate Resilience in Agriculture

Nigeria is often referred to as the "Giant of Africa" due to its diverse cultures and ethnic groups. The country's population exceeds 229 million, ranking it as the sixth largest in the world (Macrotrends). With a growth rate of 2.41%, the population is projected to soar to 401 million by 2050 (WorldCounts). The latest Global Food Security Index ranks Nigeria at 107 out of 113 countries worldwide and it also ranks Nigeria last (113rd) on the Affordability Index (GFSI 2022). Trends over the last few decades consistently indicate a rising percentage of the population experiencing food insecurity in Nigeria. The number of people facing acute hunger is expected to increase from 18.6 million in 2023 to 26.5 million in 2024 and an estimated 9 million children are at risk of acute malnutrition or wasting (FAO). In 2023, the primary factors for the worsening food insecurity in Nigeria were identified as climate change and internal conflicts by a UN Food and Agriculture Organization report. Additionally, Nigeria is ranked amongst the top 10 countries in the world most affected by climate change challenges like flooding, extreme temperatures, droughts, landslides and erosion (UNDRR). Urgent action is required to bolster Nigeria's agricultural resilience and address the underlying causes of food insecurity to prevent destabilization and ensure a sustainable future for its growing population.

Nigeria declared independence from British colonial rule in 1960 and established a republic consisting of 36 states in 1963 (ChathamHouse). However, the following three decades were marked by ethnic conflicts, military coups and civil wars. It wasn't until 1999 that a democratically elected president was inaugurated and a new constitution was put into effect. Nigeria's constitution is a federal system and its president is the executive head of the country. The legislature is made by the Senate and the House of Representatives.

Nigeria, located in the western part of Sub-Saharan Africa (Figure 1), shares borders with Niger to the north, Benin to the west and Chad and Cameroon to the east, while its southern coastline meets the Gulf of Guinea in the Atlantic Ocean (WorldAtlas). Its climate is predominantly tropical, characterized by alternating rainy and dry seasons. With over 70% of the population dependent on agriculture for their livelihood, the agricultural sector plays an important role in the country's economy and food security. Spanning across 75.4% of Nigeria's territory, the nation includes an extensive agricultural landmass totaling 174 million acres (WorldBank). Among the staple crops cultivated are cassava, maize, yam, beans, millet and rice, with Nigeria holding the title of the world's largest cassava producer and the third-largest cocoa exporter. The nation's fish production stands close to 1 million metric tons, with fishing serving as a crucial source of livelihood and a significant protein source. Contrasting starkly with the US, where the average farm spans 445 acres and farmers earn an average yearly income of \$95,418, Nigerian farms average a mere 2.4 acres, yielding an average annual income of \$500 (FAO).



Figure 1:
www.worldatlas.com

I contacted Dr. Tamunosisi Legg-Jack, a physician hailing from the southern state of Bayelsa in Nigeria, to acquire firsthand knowledge about the issue of food insecurity in the country. He highlighted the stark disparities between the northern and southern regions, including climate, development, religion, literacy and job opportunities. The 1970s oil industry boom led to a decline in the once-strong agricultural sector. In 2023, 53.54% of the population lived in urban areas, with 46.46% in rural areas (Macrotrends).

Notably, food insecurity is significantly higher in rural areas, particularly northern Nigeria where there is an 18% food insecurity rate in urban areas, compared to a staggering 52% in rural regions (IMF).

A Typical Nigerian Family:

A typical family in Nigeria consists of parents, children, grandparents and sometimes extended relatives (AFSUSA). The average family size is 5.06 members (NBS). Traditionally, the father serves as the primary financial provider and decision-maker following the social norms of a patrilineal society. Dr. Legg-Jack said the typical homes in cities resemble Western-style townhomes, condos, or bungalows, while rural dwellings are often made of mud, clay, or thatch. The Nigerian diet varies by region but typically includes a staple grain or starchy vegetable, such as rice or "swallows" (pounded grain or starchy vegetables formed into soft balls akin to mashed potatoes), accompanied by a soup or sauce made with vegetables and/or meat (Foods).

Although Nigeria is highly urbanized only 11% of the population has access to piped water. Most urban residents rely on private water vendors and shallow wells (UNICEF). Islam is the predominant religion at 50%, followed by Christianity at 48.1% (Pew Research). The overall literacy rate stands at 48.9%, with urban literacy notably higher at 67.2% compared to rural areas at 33.7%. Dr. Legg-Jack said cities tend to have better schools and electricity access, while rural areas face challenges with infrastructure, healthcare and food security. A majority of the rural population's livelihoods depend on the agricultural sector mainly at a subsistence level. Dr. Legg-Jack said food insecurity affects all walks of life in rural Nigeria and that there is no specific marginal population based on religion or color. In general, people in power tend to make policies that help their tribal group, which can affect small tribal communities' interests.

Major Barriers to Farmers and Food Security:

Inflation: According to Dr. Legg-Jack, the primary cause of current food insecurity is high inflation. Nigeria heavily depends on imports of essential food items like rice, wheat and poultry to supplement domestic production. He said economic challenges in recent years have resulted in a substantial depreciation of the currency, thereby escalating the cost of imported goods. As a result, the dependence on imports, which are priced in US dollars, has led to a sharp increase in food prices, causing the average Nigerian family to spend around 59% of its earnings towards food expenses by August 2023(Picodi).

Rainfed Agriculture: The majority of the farms in Nigeria operate without mechanization, relying solely on rainwater for cultivation. This dependency limits farming activities to the rainy season, leading to lean (or dry) periods between harvests and reduced food availability, as well as insufficient pasture for livestock. Moreover, the seasonal nature of rain-fed agriculture results in sporadic employment opportunities, leaving a significant rural population unemployed during off-seasons. Dr. Legg-Jack mentioned that a major barrier to mechanization and irrigation is the lack of access to credit for farmers.

Intense Rains, Flooding, Droughts and High Temperatures: Another reason Nigeria struggles to meet its domestic food needs is due to declining crop yields and quality caused by recent changes in weather patterns. Over the past decade, the country has experienced rising temperatures, erratic and intense rainfall, land degradation, increased crop pests, droughts and desertification. These shifting rainfall patterns make it challenging for farmers to plan planting and harvesting. Additionally, deforestation, unsustainable grazing practices and prolonged droughts contribute to desertification, with approximately 35% of previously cultivable land in the northern states now transformed into desert within a mere 50-year timeframe (IRIN).

Conflicts in the Northern States "Bread Basket": The northern region of Nigeria, often called the country's breadbasket, has witnessed a surge in food insecurity due to conflicts between herdsmen and

local farmers. Dr. Legg-Jack said the primary cause of conflict is the shortage of fodder and water for the cattle in the dry season. These conflicts have increasingly taken on religious undertones, with over 90% of herders being Muslim and most farmers in the region being Christians. The communal violence has resulted in the displacement of more than 1 million farmers from northern states (CrisisGroup).

Post-Harvest Wastage: Food wastage presents a significant barrier to food security in Nigeria, impacting both farmer incomes and the environment. Approximately 40% of harvested food is lost to spoilage with perishable crops like fruits and vegetables experiencing particularly high wastage rates (ScienceDirect). 20-30% of grains and 30-50% of roots and tubers also suffer losses due to post-harvest damage. The main reasons for this wastage include inadequate processing facilities, inefficient transport systems and a lack of cold storage. Many farmers in North Eastern Nigeria rely on open-air storage which leaves crops vulnerable to humidity, pests and unpredictable weather conditions, further reducing market value and shelf life. Poor rural transportation infrastructure exacerbates the losses by delaying the timely delivery of perishable goods to markets.

Solutions:

Irrigation, Water harvesting and Dry season (Year around) planting: Supporting small-scale farmers in Nigeria, who produce over 90% of the country's food, by assisting them in irrigating their farms and harvesting rainwater can yield multiple benefits. Not only does it enable planting during the dry season and mitigate the effects of droughts and climate variability, but it also generates year-round employment opportunities in rural areas and enhances overall food production.

Over the years, the Nigerian government has implemented numerous large and medium-scale irrigation schemes, typically owned, operated and maintained solely by the government. Although some irrigation schemes performed well, many incurred heavy losses because of poor management, underutilization, infrastructural decay and abandonment (Environ Res. Tec.). Research indicates that farmer-led small-scale irrigation systems tend to be more successful than large government or community-led schemes (ScienceDirect). Small-scale farmers can employ various methods, such as digging wells, boreholes, building dams and tanks, to harvest water during the rainy season for irrigation in the dry season. They can irrigate their crops using a variety of equipment like drip kits, sprinklers and water pumps (threadle, solar or fuel-powered). The village-level councils can help dig and maintain shared wells, tanks and dams to store water during the rainy season. In rural areas where electricity is not reliable, solar-powered pumps can be installed to pump water from wells to surface level for safe use by villagers and livestock during the dry season. Village communities can also adopt water harvesting systems that increase ground and well water. For example, in India there is an ancient water harvesting system, called “Kattas”. These structures, commonly found in the southern state of Karnataka, help increase ground water. “Kattas” are temporary community dams built by villagers across streams and rivulets towards the end of rainy season, using locally available stones and wood (Deccan Herald) . These dams help to hold back heavy water flow, which allows it to seep into the ground slowly. This reduces run-off, as the water is able to gradually move into the neighboring wells, thereby increasing groundwater reserves. A similar system might be helpful in Nigeria to combat water scarcity during the dry season.

A 2017 case study in Morocco's Sais area and a 2020 UN Environment Programme study in Kenya found that local retailers can play a key role in the implementation of small-scale irrigation systems. Both studies found that a strong network of local retailers, irrigation systems technology suppliers, government or developmental organizations, commercial banks, or microloan institutions can form a supply chain to help small-scale farmers implement irrigation systems. The irrigation technology suppliers and local retailers have great incentive to promote and implement their irrigation equipment. Government agencies like the Agriculture Development Project, the State Irrigation Department, the National Fadama Development Project and international development organizations like USAID, International Fund for

Agricultural Development (IFAD) can collaborate with local retailers, suppliers and help build such sustainable end-to-end networks to implement farmer-led irrigation systems. These institutions can provide necessary support and incentives to financial institutions to encourage loans to small farmers. They can work with local retailers and technology suppliers to help educate the small-scale farmers on various water harvesting and irrigation technologies available and affordable to them. The local retailers can help implement systems that best suit the farmers' needs.

Education on Climate Smart Agricultural Practices to Increase Yields: International organizations like International Fertilizer Development Center (IFDC) and national non-profit organizations like Leventis Foundation Nigeria, that promote sustainable farming practices can help create programs to educate farmers about sustainable and modern practices to mitigate climate change impacts like drought, floods, desertification and soil deterioration on crop yields. In 2021 Agricultural Research Council of Nigeria has initiated radio and television programs to educate farmers. They can expand such education programs to include climate smart agricultural measures farmers can take up.

- ***Use of Climate Resistant Inputs:*** Climate-smart seeds can mitigate the impact of extreme weather events, transforming rural livelihoods from subsistence to surplus production. Educating farmers on seed selection and fertilizers tailored to local climate risks, such as drought in the north and floods in the south, can minimize crop losses and boost yields. For instance, Drought Tolerant Maize for Africa (DTMA) seeds have demonstrated resilience to drought, high yields and fortified protein content in select African countries, reducing yield risks. Collaborations between government and research institutes like the International Rice Research Institute, Pan-African Bean Research Alliance, International Maize and Wheat Improvement Center, etc., could develop and promote resilient seed varieties tailored to Nigeria's changing weather patterns and enhance yields. The Growth Enhancement Support Scheme that was initiated by the Nigerian government to provide seed subsidies to small farmers can help to subsidize climate resistant inputs to facilitate widespread adoption among farmers.
- ***Adaptability to weather forecasts:*** Timely and reliable weather forecasts can help the farmers to plan and prepare ahead for the changing weather patterns. In 2022 Nuru International has launched a pilot program to deliver weather forecasts and advising alerts to participating farmers on mobile phones. The messages included information on agricultural practices and time-specific advice for farmers on planting, fertilizer application and harvesting. Approximately 2,000 farmers in Nigeria participated in the program and found information to be accurate and beneficial in planning farm activities. Nuru Nigeria with the help of government agencies can expand this program to more farmers in Nigeria.
- ***Vertical Sack Farming & Hydroponics:*** Nigerian urban population has been growing at 2.8 to 3% rate and is expected to double in the next two decades (Annals of African Medicine). In urban areas land availability is scarce and they do not have power supply issues as much as in rural areas. They can utilize innovative growing methods like Vertical and Hydroponics farming to increase urban food availability and reduce impact of supply chain disruptions. Vertical sack farming involves growing crops on top or sides of soil in large sacks of soil. Hydroponics involves growing plants in nutrient-rich water with no soil. For example, Soupah Kitchen & Grocery Technology Company, based in Ibadan, Nigeria, uses hydroponics to grow lettuce, kale, leafy green and herbs on urban rooftops (AFDB). It successfully cultivates around 1,600 kg of vegetables within a 26-day cycle. Adaptation of such resource smart technologies in urban regions that are highly prone to droughts, floods and unpredictable weather patterns can decrease the impact of extreme weather, increase resource efficiency and help produce year-round.

- ***Sustainable Soil Fertility Management:*** Climate change is reshaping soil water and nutrient dynamics, posing new challenges for farmers in predicting and managing soil nutrient requirements (Environmental Reviews). This uncertainty results in diminished crop yields and heightened input costs. While synthetic fertilizers offer short-term yield boosts, they contribute to increased greenhouse gas emissions, nutrient imbalances, soil degradation and water pollution. Conversely, studies reveal that organic fertilizers rejuvenate soil and enhance long-term productivity (ScienceDirect). Adaptation of techniques like crop rotations, diversification, permanent soil cover by mulching or crop residues, precision nutrient application and water conservation can mitigate nutrient loss, decrease pest attacks and promote soil health.
- ***Increase Flood Readiness:*** Implementation and maintenance of a proper drainage system on farmlands is critical to decreasing the impact of intense rains and floods. Trees and vegetation act as natural barriers, slowing floodwater and preventing erosion (Journal of Civil Engineering Researchers). Adjacent grass strips or vegetation alongside watercourses and ditches could provide additional physical barriers, restricting stormwater flow. Regular maintenance of drainage ditches facilitates efficient water removal from farmland and slows water flow into rivers and streams. With future rainfall patterns expected to change, retaining water in ditches and promoting infiltration can help alleviate drought risks. Connecting ditches to small ponds and water storage lagoons can also enhance water management capabilities (Ecological Engineering).

Decrease Post-Harvest Wastage: Post-harvest losses not only have economic implications but it also has a great environmental impact. The land, water and energy used to produce the food are also wasted along with the food. Investment in the reduction of post-harvest loss has high returns as the expense is modest when compared to the replacement cost of producing the crop.

- ***Education on post-harvest handling:*** Educating farmers in proper harvesting, handling and packaging techniques is crucial to reducing harvest losses. Using appropriate containers and protective materials can prevent physical damage and contamination during transportation and storage. Harvesting at adequate crop maturity and moisture content and drying to maintain crop quality is crucial to minimize storage losses. Government organizations like Nigerian Stored Products Research Institute (NSPRI) can help in creating education programs for farmers on optimal post-harvest handling. Anchor Borrowers Programme, a government program that currently helps small farmers with inputs, can help by subsidizing quality seed varieties that have a high post-harvest shelf-life.
- ***Farmer Cooperatives & Contract Farming:*** Small-scale farmers can form cooperatives to share the costs of mechanized tools for harvesting and post-harvest cold storage facilities. They can collectively negotiate contracts with corporations so the farmers have a price guarantee for their produce and shared cooperative costs. The corporations have the incentive to bring undamaged produce to the market so they can help in investments for proper storage and transportation. The use of off-grid solar-powered cold storage devices can help buffer against electricity shortages in rural areas.
- ***Microloans:*** Government banks like Bank of Agriculture and private banks can offer microloans to individuals or small businesses in rural areas to produce value-added agricultural products. For instance, Yemisi Iranloye founded Psaltry International in rural Nigeria in 2005, specializing in food-grade starch, high-quality cassava flour and cassava-based sorbitol production, sourcing cassava locally (Annual SocioEconomic Summit). The company's revenue reached \$12 million within a decade. Small-scale industries in rural areas like this will help reduce post-harvest transportation distances and increase farmer profit margins by ensuring steady buyers for agricultural outputs. Additionally, these companies can assist farmers with inputs and product delivery, fostering employment opportunities and rural economic development.

- **Rural transportation development:** The government needs to plan, develop and maintain transportation networks to connect rural areas to commercial markets. Improving road networks can facilitate quick and efficient transportation of crops to markets efficiently.

Conclusion:

In conclusion, climate change poses a significant challenge to global food security, Nigeria is particularly vulnerable because of its geographical positioning. The country already struggles with a large food-insecure population, especially in rural areas. In 2022, an estimated 88.4 million people lived in extreme poverty in Nigeria, which accounts for 12.9% of the world population living in extreme poverty (Statista). Ethnic conflicts in northern states where most of the agricultural produce comes from is further exacerbating the situation. Furthermore, climate change-induced events like droughts, floods and desertification have intensified in recent years, leading to declining agricultural yields. To address these challenges, the Nigerian government, along with non-profit organizations and farmers, must collectively work to strengthen the agricultural sector. This effort is crucial not only for combating high food inflation but also for achieving self-sufficiency amidst projected high population growth. Enhanced food security can also contribute to increased youth employment and bolster overall national security.

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