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Sierra Leone: Using Solar-powered Irrigation Pumps to Eliminate the Overreliance on Rainfed Agriculture

Introduction

A small country on the edge of Western Africa has struggled with food insecurity for years. It endured the destructive grip of an eleven-year civil war, the violent attacks of Ebola hemorrhagic fever, and relentless seasonal flooding caused by a prolonged, heavy rainy season. Like the rest of the world, it survived the devastating impact of COVID-19, which left many countries economically paralyzed. Unfortunately, Sierra Leone has been scarred by these consecutive catastrophic events, significantly impacting its agriculture and food security. Due to limited resources, they rely on rain-fed agriculture, making them vulnerable to unpredictable weather patterns (Feed Salone Strategy 13). This problem has mainly led to increased crop loss and declining soil fertility (Sierra Leone: World Food Programme, par. 3).

Problem Statement

Agricultural productivity in many developing countries remains heavily dependent on rain-fed farming systems, which are increasingly unreliable due to climate variability, prolonged droughts, and erratic rainfall patterns. This dependence exacerbates food insecurity, particularly in regions where subsistence farming forms the backbone of local economies. Insufficient and unpredictable rainfall leads to low crop yields, seasonal food shortages, and heightened vulnerability of rural households to poverty and malnutrition.

Despite the availability of vast solar energy resources in many of these regions, solar-powered irrigation technologies remain underutilized. Barriers such as high initial capital investment, lack of technical expertise, limited institutional support, and inadequate access to financing constrain their adoption. Consequently, farmers continue to view rain-fed agriculture as the only viable option, perpetuating cycles of low productivity and food instability.

The problem, therefore, lies in the systemic overreliance on rain-fed agriculture despite accessible renewable energy alternatives. Addressing this issue requires examining how solar irrigation can be effectively implemented to improve water access, enhance agricultural resilience, and ensure sustainable food production in developing contexts.

Sierra Leone, with its many natural, external, internal, and socio-economic challenges over the past three decades, is no different. To understand these challenges, this paper adopts a four-pronged approach that

catalogs the Socioeconomic and Domestic Aspects, Agricultural Volatility, Current Problems with Irrigation in Sierra Leone, Proposed Solutions, and a Conclusion.

Socioeconomic and Domestic Aspects

To understand the magnitude of the problem of food insecurity in Sierra Leone, one must examine the domestic landscape and socioeconomic factors. The country's population is approximately 8,950,902, with about 44.4% living in urban areas, leaving the majority in rural regions (Action Against Hunger, 2025). The average household has six members, which is challenging in a nation struggling with hunger and traditionally supported by the male breadwinner. However, in recent years, the female population has grown to 52% of the total population (World Food Program, n.d.). Women and children are left to manage their families' survival. This is evident in the rise of women's participation in both formal and informal economies, with around 70% of women comprising the agricultural labor force, playing a crucial role in natural resource management (UN Women, 2017, par. 1).

Despite the government's best efforts and investments in agriculture as a priority growth sector, there has been a significant decline in subsistence farming that sustains livelihoods. Many people are abandoning farming and agriculture in search of more stable jobs. This shift is driven by severe climate shocks, low profitability, poor infrastructure (98% rely on rudimentary tools), and a lack of financing (Ministry of Agriculture and Food Security, par. 3), which leaves the sector vulnerable and reduces food production in rural communities. Poor economic performance and resultant desperation have led to an increase in child labor, with youth forced to give up educational opportunities to support their families. "I used to like mathematics," said a boy who left school at just 12 years old and is now forced to catch fish at the beach to earn very little money for his family to survive. (Beaubien, 2021, par. 1).

Additionally, Sierra Leone is ranked 185th out of 193 countries on the 2025 Human Development Index (World Food Program, Par. 1), highlighting the significant challenges the country faces compared to others. For the past four decades, it has struggled to provide citizens with stable electricity, a situation that worsened after the 11-year civil war (1991-2002). With limited access to electricity, only about 30% of the population is connected nationwide, and less than 5% in rural areas (International Trade Administration, par. 1). Due to these electrical limitations, both rural and urban residents lack the refrigeration necessary to properly store and preserve food for extended periods. In Freetown, the capital city, approximately 0.4 kg of food is wasted daily on average, with around 30% of food lost each year due to poor storage and handling, especially during the harsh, warm dry season (Sillah et al. 4). This infrastructure failure has further intensified the daily struggle for food security.

Agricultural Volatility

According to the Feed Salone Strategy, the reliance on rainfed agriculture is intensified by the country's climate-related vulnerability (Feed Salone Strategy 13). During the rainy season (May to October) of 2024, approximately 1.6 million tons of cereal crops—such as rice, sorghum, millet, and maize—were produced (FAO, par. 4). Although various agricultural reports estimate that post-harvest losses range from 20% to 40% due to high humidity, heavy rainfall, and flooding, climate change in 2024 has further impacted the rainy season by delaying it by up to a month beyond the typical May to October period. This delay disrupted planting schedules and led to early germination in several cropping areas. Heavy rains

from August to November 2024 triggered flooding across multiple regions, leading to minor crop losses (GIEWS, par. 1). “The most common flooding experienced in Sierra Leone is pluvial flooding, this means extremely sudden and high volumes of rainfall that comes in a few hours or days, which causes water to back up on flood plains because of the country’s lack of urban planning” (World Bank 39).

Similarly, "drought and dry spells tend to go unnoticed because of the abundance of rainfall Sierra Leone experiences. These dry spells can sometimes occur at unfavorable times of the growing season or are extreme enough to impact crop production” (World Bank 40). Due to the lack of irrigation during the dry season, seedling mortality for horticultural crops increases. “The large amounts of river discharge variability and required investments into the mechanization of such projects limit the relative attractiveness of irrigation as a water supply source in agriculture in comparison to rain-fed" (World Bank 29). “The nation imports approximately between $196M to over $200M annually in foodstuffs” (OEC World.). Unfortunately, the food being imported can be grown naturally, but due to the lack of proper amenities to support the growing population, Sierra Leone is forced to surrender to the whims of the economy. According to Dr. Kpaka, “the country is currently between 65-75% rice self-sufficient, yet due to the poor processing infrastructure it must heavily import to meet the demand and close the gap” (Sutton, par. 8). Taking all of this into consideration, a big part of solving the global food crisis in Sierra Leone is developing a suitable irrigation system for both rainy and dry season.

Current Problems with Irrigation in Sierra Leone

Currently, Sierra Leone faces many challenges in expanding and maintaining its irrigation schemes. Two companies provide services. One uses pivot irrigation systems, while the other uses both pivot and drip systems to supply water to crops. Pivot irrigation is an automated, pressurized water irrigation method that, through rotating pipes across large fields (AGRIV par.1), while drip irrigation delivers water to crops directly at the root level using a network of tubes (Green Business Benchmark par.1). These systems have slightly improved water access to some farming communities.

However, irrigation is employed in less than 2% of arable farmland in Sierra Leone (FAO), which indicates that they are still facing some major challenges. There is a high cost of installation and maintenance of irrigation infrastructure, especially given the current economic status of the country. Moreover, pivot irrigation methods are more suitable for large, circular fields, which are not always available to remote rural areas, and their high application rate can exceed the slow infiltration capacity of Sierra Leone’s clay-based soils. Although drip irrigation is normally more energy-efficient, Sierra Leone’s current system relies on generators for power. During the dry season, farmers lack sufficient water supply, pressure, or storage to sustain efficient crop production. This causes many rural communities to continue to rely on rain-fed agriculture, leaving productivity vulnerable to climate variability.

Proposed Solutions

The most proficient method to address these challenges is to strengthen the already existing irrigation systems using small, independent solar-powered irrigation pumps. Rather than replacing the current methods, solar technology can serve as a more reliable energy source than generators. Solar-powered pumps use sunlight as an energy source to draw water from wells, rivers, or boreholes and transport it to

elevated storage tanks (Healing Waters, n.d.). This can supply drip irrigation systems using gravity. This new approach can reduce dependence on fuel, unreliable electricity, and large centralized systems.

In addition, a crucial advantage is the low cost of locally made storage systems. Elevated tanks can be built using durable and low-cost materials such as clay bricks, that are properly waterproofed with cement which makes them easier to repair in rural communities. By combining solar-powered pumps with gravity fed drip irrigation systems, farmers can have stable crop production and reduce energy costs. This combination of resources can also address the problem of reliance on heavy rainfall by providing a reliable water source. The system can also connect to available sources like wells and rivers, then use the solar-powered pumps to lift water from those sources and store it in tanks for later use. Also, the improved water management system can help regulate excess water during heavy rainfall. To protect local resources, active water metering protocols will be put in place to strictly limit overuse and consumption rates.

To fund this solar-powered irrigation pump plan, the government of Sierra Leone would combine local and international money in a step-by-step approach. First and foremost, the government would launch a pilot project using its own internal budget and small grants from international donors to prove that the project works and is a practical solution. Next, once the pilot becomes successful, the government of Sierra Leone would transition to a large-scale funding from organizations such as African Development Bank (AfDB) and the World Bank. This is a realistic approach, as the AfDB is currently funding major agricultural infrastructure in Sierra Leone to increase crop yields (African Development Bank Group, par.1). Under this umbrella, the government can secure low interest, long-term loans to partner with private companies for maintenance, buy equipment in bulk and offer financial safety to local banks as they invest in rural agricultural communities.

The implementation should begin in the town of Kambia. “Kambia also commonly known as Kambia Town is the capital and the largest town of Kambia District in the Northwest Province of Sierra Leone” (Wikipedia). It is located near an extensive mangrove ecosystem. Choosing Kambia for this project perfectly matches the Feed Salone strategy, which aims to mitigate expensive vegetable importation by boosting onion farming (Feed Salone Strategy, 8). Kambia’s lowlands are perfect for growing dry season onions. But muddy mangroves can present a slight water challenge. To prevent the irrigation system from experiencing blockages, a two-chamber filtration system will also be built directly into the project. Muddy swamp water will pass through a chamber filled with coarse gravel and sand to trap sediment which ensures that only clean water will enter the elevated storage tanks.

In addition, to ensure the solar powered irrigation infrastructure is both durable and environmentally safe, the project will establish a localized training system on Kambia’s youth. The training system directly targets the “Empowering Women and Youth” strategic pillar of Sierra Leones’s national Feed Salone initiative (Feed Salone Strategy, 11). Based on the historic 2010 Barefoot Women Solar Engineers project (a national initiative where semi-literate rural Sierra Leonean women mastered solar engineering using color-coded charts and hands on training at India’s Barefoot college), this curriculum will intentionally bypass text centered manuals to overcome education barriers in rural farming areas (UNIDO, Par.1). Instead, local youth will undergo a multiple month, immersive program centered on “learning by doing.” The final phase transition will be from observation to independent problem solving, testing youths with

real world system issues alongside on-site ecologists. According to officials at the Ministry of Agriculture and Food Security who frequently visit Agri-sites, having these ecologists is a proven daily practice. Trained youth and farmers will directly manage and maintain the system long term, ensuring continued operations and independence after the initial funding concludes.

Conclusion

The dependence on rain-fed agriculture remains a large barrier to stable food production in Sierra Leone. Although the current irrigation methods have provided some support, they do not alleviate the financial, technical, and economic instabilities faced by rural communities. Adopting solar-powered irrigation can significantly reduce the problems associated with unpredictable rainfall, severe climate shocks, lack of infrastructure, and prolonged dry seasons. Importantly, this irrigation directly boosts food security by allowing farmers to grow crops two to three times a year instead of focusing on rains, which will inevitably double food yields. This constant water supply can eliminate seasonal food shortages, therefore keeping market prices stable even during the harshest dry months. Investing in affordable, locally maintainable irrigation infrastructure will be crucial for building a strong and resilient farming system to help ensure better food security in Sierra Leone

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