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Ethiopia, Solar powered Irrigation

Ethiopia's Solar Irrigation: Beyond The Technology

Thomas Jefferson once said "cultivators of the earth are the most valuable citizens. They are the most vigorous, the most independent, the most virtuous, & they are tied to their country & wedded to its liberty & interests by the most lasting bands." More than 11,000 miles from the United States lies a country where this truth is lived everyday: Ethiopia. There, people dedicate their lives to cultivating the earth, not for convenience, but for survival. What takes us only a trip to the grocery store demands in Ethiopia endless labor, perseverance, and sacrifice. Farmers there face obstacles that range from war, drought, and famine to unreliable and insufficient infrastructure. Yet they remain bound to their land and their communities, proving Jefferson's words still resonate across the world.

Context

Ethiopia, located in the Horn of Africa, is home to about 130 million people, making it the second most populous country on the continent (World Bank). It's a predominantly rural and young nation, with nearly 77% of people living in densely populated highland areas. The country's economy heavily depends on agriculture, and most families practice subsistence farming—growing just enough food for themselves, with little or no surplus to sell (Bliss, 2016).

Despite Ethiopia's vast agricultural potential, around 16 million people still face food insecurity (World Food Program USA, n.d.). This is due to a mix of climate challenges, political instability, and lack of infrastructure. At the forefront of these challenges are droughts. Ethiopia is among the countries most susceptible to climatic shocks—mainly drought and flooding—because of erratic rainfall patterns (UN Office for the Coordination of Humanitarian Affairs, 2024). This has been an ongoing crisis from 2020-2023 and the effects continue today, harshly impacting

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the livelihoods of nearly 1.7 million people in regions such as Tigray, Afar, Oromia, and Amhara

Famine in northern Ethiopia (2020–present), n.d.).

Droughts affect people, land, and livestock alike. For families and their animals, limited water access forces many to migrate across dangerous, undeveloped infrastructure, while countless livestock perish along the way. On the land, drought leads to soil degradation—the wearing down of topsoil that reduces fertility, stripping away the nutrients needed to support plant growth. The convergence of these effects is devastating for Ethiopia's smallholder farmers, who rely on rainfall not only to sustain their farms, but also to feed their families.

In the northern part of Ethiopia, the Tigray region has been especially hard hit by both environmental and political crises. Within Tigray, the Alamata Woreda (district), located in the southern part of the region, relies heavily on agriculture, particularly crop and livestock farming. The main crops grown include cereals such as teff, sorghum, and barley, along with pulses, oilseeds, and vegetables (Hagos, 2017).

Because rainfall in northern Ethiopia is scarce and unevenly distributed, groundwater serves as the primary source of irrigation to support smallholder farmers. Alamata is one of the 16 drought-prone woredas in Tigray and experiences a bimodal rainfall pattern, making farming especially vulnerable to climatic shocks (International Water Management Institute, 2006). In addition to drought, the district has endured the disastrous impacts of the two-year conflict between the Tigray People's Liberation Front and the Ethiopian government, which displaced nearly three million people and destroyed healthcare facilities. According to the Tigray Bureau of Water and Energy, prior to the outbreak of war, approximately 60% of urban residents and 55% of rural inhabitants in the region had access to potable water. However, a study conducted between late 2021 and early 2022 revealed that the conflict reduced water supply coverage by more than half—dropping to 28% in rural areas and 25% in urban areas (Shishaye et al., 2023).

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Findings

The challenges facing the Alamata Woreda illustrate the wider crisis of food insecurity in Ethiopia. Farmers remain the backbone of the economy, yet their ability to provide for their families is hindered by drought and political instability. One of the main strategies used to address Ethiopia's food security crisis is irrigation. Irrigation is the artificial application of water to crops through pipes, canals, or sprinklers, rather than relying on rainfall alone (National Geographic).

Ethiopia has deployed a combination of small-scale irrigation (SSI) and large-scale irrigation systems to alleviate poverty, stabilize agricultural production, mitigate the effects of rainfall variability, and create employment opportunities for millions of youth and women (International Water Management Institute). The government has also introduced targeted programs such as the Participatory Small-Scale Irrigation Development Programme (PASIDP-II), a seven-year initiative (2017–2024) financed by the International Fund for Agricultural Development (IFAD), the Adaptation for Smallholder Agriculture Programme (ASAP), the Government of Ethiopia (GOE), and local beneficiaries. This program has constructed irrigation schemes for smallholder farmers in drought-prone areas (International Fund for Agricultural Development).

Despite these efforts, Ethiopia has yet to realize its full potential. While the country has more than 11 million hectares of irrigable land, only about 10% is currently in use (International Water Management Institute). In the Alamata region, most farmers continue to rely on low-productivity seasonal spate irrigation and rain-fed farming practices. Spate irrigation, a traditional method used in the Raya Valley, supplements rainfall by diverting floodwaters to

fields, but its effectiveness remains limited in the face of worsening drought and conflict Steenbergen et al., n.d.) Moreover, the development and management of SSI in Ethiopia face serious challenges. High demand, combined with inefficiencies in scheme design, planning, construction, operation, management, and financing, limits irrigation's ability to provide reliable, long-term solutions to the country's agricultural crisis.

Harnessing the Sun for agriculture.

While the challenges of traditional irrigation are significant, they open the door to new opportunities. Solar power irrigation offers a sustainable and practical path forward, one that can empower farmers, reduce costs, and provide communities with greater resilience against drought and conflict. Solar irrigation uses the sun's energy to power a pump which supplies water to crops to help growth (Future Pump, 2021). These systems provide reliable and affordable energy, especially in rural areas, where the cost of diesel fuel is high or access to the electricity grid is unreliable. Solar-powered irrigation can be particularly successful to overcome the frequently occurring energy shortages causing disruption of supply needed for lifting and distributing irrigation water (Food and Agriculture Organization of United Nations).

Solar water pumps provide a reliable and consistent water supply for irrigation. They are designed to operate efficiently under various weather conditions, ensuring that crops receive adequate water even during power outages or fuel shortages. Consistent and efficient irrigation facilitated by solar water pumps directly impacts crop yields and quality. With a steady water supply, crops can grow more uniformly and healthily, resulting in higher productivity. Farmers can better manage their water resources, optimizing the irrigation process to meet the specific needs of their crops. (SunCulture, 2024).

Solution

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Government Commitment

Any effort to introduce small-scale solar irrigation must begin with the Ethiopian government's role in securing food security. The Ethiopian government has been very proactive in their fight for food security. Along with the Participatory Small Scale Irrigation Development Programme (PASIDP-II), The government is working side by side with The World Food Programme in providing lifesaving food assistance to vulnerable people in drought and conflict-affected areas (World Food Program, 2024). The government can also encourage private sectors to bring their business to Ethiopia by offering subsidies such as tax exemptions. In May of 2019, the Ministry of finance approved the exemption of import duties on mechanization, irrigation and animal feed technologies (Addis Standard, 2019).

Mobilizing External Support and Funding

Once a foundation of government commitment is established, the next step is to seek support from development partners and private companies. Organizations such as SunCulture offer solar surface pumps to small-holder farmers in Kenya. Grekkon Limited has experience in Kenya, providing equipment and training to smallholder farmers on selecting efficient irrigation systems (Grekkon Limited, n.d.). I propose that the Ethiopian government invites similar companies to expand their services to Ethiopia.

Models for Small Scale Irrigation

1. **Farmer-Owned model (Individual Solar Pumps)**

- **Pay-As-You-Go Financing:** This follows the SunCulture model which allows farmers purchase solar pumps with an upfront deposit, and gradually pays off the full cost.
    i. Within this model includes a free setup
    ii. Factors that influence cost includes: product type and farm size
- **Financial risk management:**
    i. Index Based Agricultural Microfinance: This model links loan payments to environmental triggers such as rainfall, or vegetation index data. If a drought or weather event occurs, the system automatically triggers a payout, or loan forgiveness, protecting both the farmer and the lender. This can be integrated directly with the pay-as-you-go system, with the insurance premium being a small part of the monthly payment.
    ii. BASIX India is a company that offers micro- credit, micro-savings, and micro-insurance to rural and small holder farmers. BASIX works in 20,000 villages and 106 district states in India (Wikipedia, 2025)

2. **Government Funded Cooperative Model** (Community Shared systems)
    - **Community Ownership:** The government funds and builds community level irrigation systems that are managed by the **Water Users Association** (WUA).
    - **Water Users Association** are usually a group of elected individuals responsible for the day-to-day operation and maintenance of the solar irrigation systems. Their roles are:
        i. To censure fair distribution of water.
        ii. To resolve user disputes, addressing grievances.
        iii. To collect water fees to fund repairs and maintenance

- **Checks and Balances:** The WUA will be responsible for creating regular reports that include financial data such fees collected, debts, and unpaid fees, along with information on infrastructure maintenance, crop yields, production trends, and water quality. To ensure accountability and alignment with both technical expertise and community needs, a liaison from the Ethiopian Ministry of Agriculture or anyone familiar with both the culture and tech of the irrigation system will serve as a middleman between the WUA, the government, and external partners like NGOs or companies. This liaison, who has a strong understanding of local culture and social dynamics, will work closely with the WUA to verify and consolidate their reports before submitting them to the government. By combining local knowledge with outside technical oversight, this system ensures that water management is transparent, culturally appropriate, and effectively monitored, while giving the government accurate data to guide support and policy decisions.

Infrastructure and after-sales support

The success of these models hinges on more than just the pump. A consistent problem in the previously tried irrigation system that resulted in its failure is that government, NGO, and private sector companies alike failed to include the people in the project and left them to fend for themselves once the system was established. That is why this model necessitates a local training hub and repair hub. This can be set up by either private companies or the government and will be available to both individual users and cooperatives. It will function to train the WUA first as they are in control of the maintenance and repair and then any others who are interested. This will provide them with valuable skills for long term employment and local capacity to

address common issues like pump malfunctions, tap replacement, and solar panel cleaning. It can eventually expand into a business to employ locals.

Conclusion

Ethiopia's struggle with food security, drought, and political conflict shows the urgent need for innovative and sustainable solutions. These solutions must go beyond technical fixes and be designed with the people and their culture in mind. While traditional irrigation remains limited, solar irrigation offers a promising alternative that empowers farmers and provides reliance against future challenges. Through a mix of government commitment, external partnerships, and locally managed systems Ethiopia can thrive as agriculture not out of necessity but out genuine Love for what its people can create.

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Bibliography

World Bank. *Population, total – Ethiopia*. World Bank, n.d., https://data.worldbank.org/indicator/SP.POP.TOTL?locations=ET.

Wikipedia contributors. "Alamata." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Alamata#Economy.

Bliss, John. "Ethiopian Highlands." *Maine Organic Farmers and Gardeners Association*, Summer 2016, https://www.mofga.org/resources/international/ethiopian-highlands/.

World Food Program USA. "Ethiopia." *World Food Program USA*, n.d., https://www.wfpusa.org/place/ethiopia/.

Wikipedia contributors. "Famine in northern Ethiopia (2020–present)." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Famine_in_northern_Ethiopia_(2020%E2%80%93present).

Steenbergen, F., et al. *Spate Irrigation*. SSWM, n.d., https://sswm.info/sites/default/files/reference_attachments/STEENBERGEN%20et%20al%20ny%20Spate%20Irrigation.pdf.

ScienceDirect. "Article Title." *ScienceDirect*, n.d., https://www.sciencedirect.com/science/article/abs/pii/S147470651100235X. *(You may need to replace "Article Title" with the actual title from the article.)*

United Nations Office for the Coordination of Humanitarian Affairs (OCHA). "Ethiopia Situation Report 10 – Jan 2024." *OCHA*, n.d., https://www.unocha.org/publications/report/ethiopia/ethiopia-situation-report-10-jan-2024.

Wikipedia contributors. "Check dam." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Check_dam.

Wikipedia contributors. "Rainwater Harvesting in the Sahel." *Wikipedia*, Wikimedia Foundation, n.d., https://en.wikipedia.org/wiki/Rainwater_harvesting_in_the_Sahel#Obstacles_to_implementa

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tion.

Global Green Growth Institute (GGGI). "GGGI – Ethiopia's Largest Pilot SPIS Project Goes Operational." GGGI, n.d., https://gggi.org/gggi-ethiopias-largest-pilot-spis-project-goes-operational/.

PASIDP-MOA. "PASIDP-II." PASIDP, n.d., https://pasidp-moa.gov.et/#:~:text=PASIDP%2DII,holder%20farmers%20will%20be%20changed.

International Water Management Institute (IWMI). "Navigating the Future of Irrigation in Ethiopia: Public-Private Partnerships for Small-Scale Irrigation Development and Management." IWMI, n.d., https://www.iwmi.org/blogs/navigating-the-future-of-irrigation-in-ethiopia-public-private-partnerships-for-small-scale-irrigation-development-and-management/.

National Geographic Education. "Irrigation." *National Geographic*, n.d., https://education.nationalgeographic.org/resource/irrigation/.

International Fund for Agricultural Development (IFAD). "Our Vision." IFAD, n.d., https://www.ifad.org/en/our-vision.

SSWM. "Spate Irrigation." *SSWM University Course*, n.d., https://sswm.info/sswm-university-course/module-4-sustainable-water-supply/further-resources-water-use/spate-irrigation.

Food and Agriculture Organization (FAO). "Solar-Powered Irrigation." FAO, n.d., https://www.fao.org/land-water/overview/onehealth/solar/en/.