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RESEARCH ARTICLE

Enhancing Agricultural Productivity with Rural Electrification in Africa

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ABSTRACT

This paper investigates whether rural electrification in sub-Saharan Africa enhances returns to agricultural investment. It is posited that investments enhancing agricultural productivity can yield significant returns, as these technologies rely on modern inputs, and African labour markets exhibit minimal distortions (Amuakwa-Mensah & Surry, 2022). By creating rural opportunities, rural electrification can mitigate urban migration pressures, decelerate urbanisation, and reduce risks to public order and political stability (Kyriakarakos et al., 2020). Despite the high potential benefits, including increased agricultural productivity, reduced urban migration, and improved living standards, the mere elimination of infrastructure failures might not suffice if low investment returns persist. The lack of rural infrastructure, particularly electrification, significantly hampers agricultural productivity in sub-Saharan Africa (SSA). Studies such as Osiolo (2021) document the strong relationship between rural electrification and rural development, highlighting the impact on investment behaviour, knowledge diffusion, and utilisation of modern agricultural technologies. Furthermore, the 'electricity gap,' described by Falchetta (2021), underscores the weak correlation between electrification and economic development in SSA, contributing to low aggregate productivity and growth. Integrating electricity into rural areas can revolutionise farming, enhance efficiency, and increase yields, thus supporting food security and economic development. This paper demonstrates that rural electrification is crucial for transforming traditional farming into a more efficient, sustainable enterprise, significantly boosting crop yields, resilience to climate change, and agricultural sustainability, promoting economic development and food security in Africa.

Keywords: *Agricultural Productivity; Rural Electrification; Agricultural Investment*

Introduction

In this paper, we urgently address whether rural electrification in sub-Saharan Africa enhances the returns to agricultural investment. Investments to enhance agricultural productivity can yield high returns, partly because the technologies heavily rely on modern inputs, and African labour markets exhibit few relevant distortions (Amuakwa-Mensah & Surry, 2022). Creating opportunities in rural areas can play a significant role in reducing urban migration pressures, slowing urbanisation, and mitigating risks to public order and political stability (Kyriakarakos et al., 2020). The potential benefits of rural electrification are substantial, including increased agricultural productivity, reduced urban migration, and improved living standards. However, eliminating infrastructure failures alone might not lead to meaningful progress if low investment returns persist, even with improved agricultural productivity and efficient power supply. A significant reason for low agricultural productivity in Sub-Saharan Africa (SSA) is the lack of rural infrastructure, particularly electrification. Numerous studies document the strong relationship between rural electrification and rural development in SSA. For example, Osiolo (2021) demonstrates that the lack of electrification in rural areas significantly affects investment behaviour, knowledge diffusion, and the utilisation of modern agricultural technologies. Building on studies like Kyriakarakos et al. (2020) and Amuakwa-Mensah and Surry (2022), Falchetta (2021) highlights that the weak relationship between electrification and economic development or rural wealth (often termed the 'electricity gap') is a critical factor in the observed low aggregate productivity and growth in African countries. Addressing this 'electricity gap' is not just important; it's urgent for the future of African agriculture.

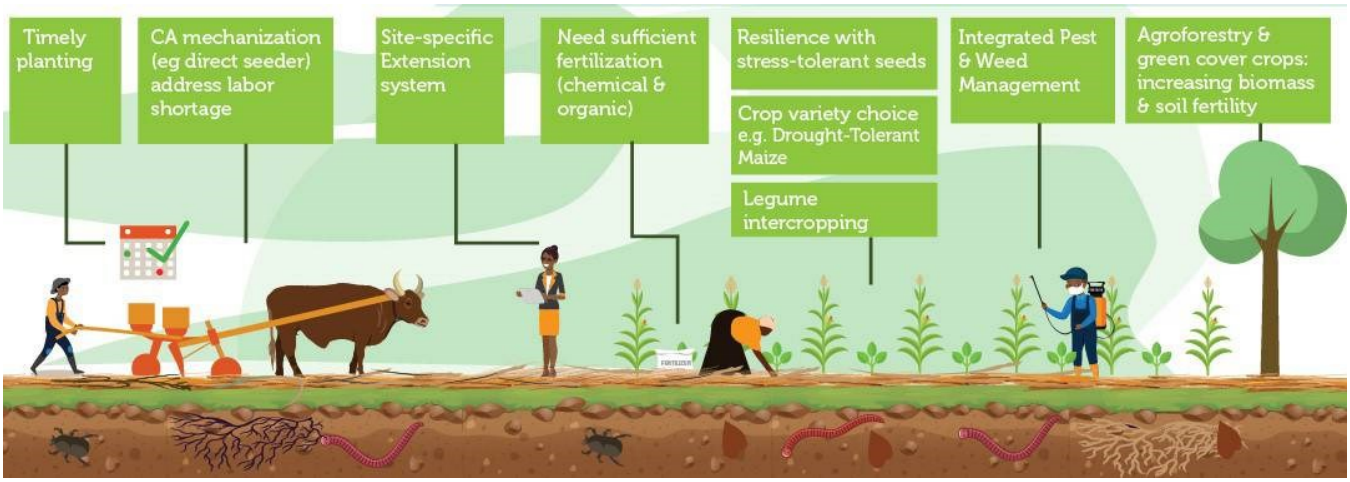

Figure 1: Integrating electricity into rural areas can revolutionise farming, improve efficiency, and increase yields, thus supporting food security and economic development.

Rural electrification is pivotal for enhancing agricultural productivity in Africa, where agriculture is a key economic sector. Integrating electricity into rural areas can revolutionise farming, improve efficiency, and increase yields, thus supporting food security and economic development. Electrification enables using electric-powered machinery for timely planting, reducing labour and ensuring optimal crop growth. It supports site-specific extension systems through ICT, providing farmers real-time advice on weather, pests, and best practices. Electrification also facilitates the production and distribution of fertilisers, with electric machinery manufacturing organic fertilisers and electric vehicles ensuring timely delivery. Automated irrigation systems powered by electricity optimise fertilisation applications, enhancing efficiency. Furthermore, electricity is essential for developing stress-tolerant seeds, with research institutions requiring stable power for experiments and cold storage facilities preserving seed quality. Integrated Pest and Weed Management (IPWM) benefits from electric-powered sprayers and drones, allowing precise application of chemicals and early detection of infestations through advanced monitoring systems. Electrification supports agroforestry and green cover crops by powering nursery operations and irrigation systems, improving soil health and overall productivity. Hence, rural electrification can transform traditional farming into a more efficient, sustainable enterprise, significantly boosting crop yields, resilience to climate change, and agricultural sustainability, promoting economic development and food security in Africa. Addressing the 'electricity gap' is crucial for unlocking the full potential of agricultural investments, ultimately fostering a more prosperous and stable rural economy.

Background and Rationale

This study will make a pivotal addition to the following areas: 1) filling the general void of quantitative studies on rural electricity consumption and rural business and their implications for rural development (Valickova & Elms, 2021); 2) quantifying the direct community-level impacts and their mechanisms using detailed surveys in one or two African countries (Sarkodie & Adams, 2020); 3) contributing to understanding the general lack of productivity effects of electrification in the literature (Blimpo et al., 2020). Rural activities are the most suitable entry points for mapping opportunities to facilitate productive end-uses of electricity among people with low incomes. While the voluminous sectoral studies focusing on individual rural activities using electricity have provided critical examples and insights, detailed assessments of policy implications are rare because they are generally fragmented and not informed by a systematic, quantitative examination of the general benefits, the constraints, and trade-offs (Daggash & Mac Dowell, 2021). Sub-Saharan Africa (SSA) has the world's lowest per capita electricity access. Implemented at a slower pace than population growth and demand growth, the poor access to electricity in developing countries is commonly viewed as a vicious cycle characterised by stagnated economic growth, low profitability of investment in the power sector, and the inability of low-income customers to pay for power consumed. However, many rural communities in developing countries are generating and using electricity or other energy sources in ways that enable them to increase their agricultural productivity, engage in rural businesses, and enhance living standards. Little is known about these practices and the incentives promoting them.

Scope and Objectives

The paper is organised as follows. The introduction provides background on the welfare situation, economic constraints, and rural development strategies in Africa. The following section reviews the literature on rural electrification, particularly in Africa. Section three describes the methodological approach and data sources. Results are presented in section four, along with a discussion of effects on socio-economic outcomes at the household level. The main conclusions are provided in the last section. Rural electrification promotes economic development (Lee et al., 2020). Cost and reliability of electricity supply are strong predictors of rural industrialisation and electrification rates worldwide. On-farm benefits of rural electrification are supported by empirical evidence (Wassie & Adaramola, 2021). Enhancing rural electric supply is crucial to improve rural income and reduce poverty. Strategies targeting rural growth are the most effective for poverty reduction in Africa (Lee et al., 2020).

Current State of Agriculture in Africa

Low productivity in African agriculture has been primarily attributed to the low use of modern agricultural technologies and inputs (MOLEMA, 2022). Lack of irrigation, low-quality seed and fertiliser, inadequate use of machinery in planting, cultivation, and harvesting, poor maintenance of infrastructure that connects farms with urban markets, and weak institutional supports, such as poor extension service, lack of connections to input and output markets, limit local agricultural production and productivity (Rotberg, 2020). Furthermore, the low rural education and human capital levels contribute to low agricultural productivity. With almost 100% access to primary education and 80% to rural schools in Sub-Saharan Africa, the literacy rate and secondary enrollment in rural areas are still very low (Mutula, 2021). Only 60% of Africans are literate, living in rural Africa, which hosts 70% of the 240 million illiterate African adults. Only 36 out of 100 children in rural Africa enrol in secondary education. As a consequence, the vast majority of African rural adults are left largely unexposed to potential knowledge spillovers. Excluding this large rural segment from broader market interactivity and knowledge diffusion, public investment in rural electric access will fail to convey many of the leading social and productive gains (Tremaine, 2023).

Improving the productivity of agriculture is a mechanism for stimulating further growth in agricultural yields, raising rural incomes, creating jobs in rural areas, and enhancing food security. Agriculture is critical to socio-economic development in Africa. For most African countries, agriculture accounts for approximately 30-70% of the labour force, is the primary source of food supplies, and accounts for the majority of revenue from exports. Despite these facts, the current state of African agriculture is rather dire. Agricultural productivity and rural income are often very low. However, an increasing domestic and international demand for farm products creates favourable economic opportunities in this sector. The critical question is whether these opportunities can be harnessed and brought to

fruition, providing welcome relief in the short term, enabling the pertinent agricultural practices and institutions to take root and flourish in the medium term, and knowledge progress based upon successful experience over the long term.

Challenges and Opportunities

To achieve development objectives in developing countries, it is essential to extend access to energy sources beyond what is currently available, particularly in rural areas, which house the most significant proportion of the world's poor people (Omole et al., 2024). Rural electrification thus constitutes a central ingredient of modern poverty reduction strategies crucial to achieving the Millennium Development Goals (MDGs). Providing off-grid electricity for livelihood purposes in rural areas remains essential to reducing poverty (Akbas et al., 2022). Rural electrification is also at the core of efforts to achieve sustainable development and avoid environmental costs often associated with alternative energy sources used for cooking and heating (Ahmed & Gasparatos, 2020). Given the scale of investments needed to extend modern energy services to households, the preeminent development challenge is how to target investments for maximum impact in providing access to people experiencing poverty. Energy poverty can be a significant impediment to development. It is a paradox that many countries and individuals with the lowest income per capita have the highest infrastructure costs. This is mainly because of the cost of providing infrastructure in low-density rural areas and delivering "off-grid" energy services. Thus, despite often having good development prospects, low-income countries usually are extremely energy-poor.

Role of Rural Electrification in Agriculture

Providing rural dwellers in developing countries with greater access to electricity could significantly contribute to their economic development comprehensively, with a critical emphasis on agricultural growth (Asghar et al., 2022). However, it is essential to acknowledge inadequate research on the vital role of rural electrification in enhancing agricultural productivity, particularly within developing countries (Tiwari et al., 2021). This paper seeks to alleviate this gap by concentrating on multiple African countries and their specific contexts. The findings put forth in this paper suggest that rural electrification has the potential to serve as a critically important policy instrument in realising elevated levels of agricultural productivity (Murshed & Ozturk, 2023). Furthermore, it may also effectively uplift the welfare of impoverished communities at large (Babajide, 2020). It is imperative to recognise that the continuous provision of adequate quantities of nutritious food and raw materials to meet the ever-increasing global population necessitates rapid enhancements in agricultural productivity. Regrettably, the growth rate in this aspect has been sluggish, especially within numerous impoverished African nations, as well as rural regions within those countries. One of the contributing factors to this underwhelming growth performance could be the lack of adoption or limited implementation of information technology (IT)-related agro-technologies, which have proven to be instrumental in driving productivity gains within the United States and other regions worldwide. Electricity access is a prerequisite for effectively utilising and implementing these technologically advanced agricultural practices. Nonetheless, it is essential to highlight that an astounding 1.2 billion individuals worldwide still lack access to electricity, with an alarming two-fifths of them residing within the African continent.

Enhancing Agricultural Productivity with Rural Electrification in Africa

Rural electrification is crucial to Africa's agricultural development and economic growth. Drawing inspiration from successful electrification initiatives like those shown in the figure above, Africa can leverage similar programs to boost farm productivity and improve rural livelihoods. These initiatives demonstrate the potential of targeted government programs to extend electricity access to rural areas, which can be instrumental in transforming agriculture and promoting sustainable development.

Impact on Agricultural Productivity

i. *Improved Irrigation:* Electrification enables using electric pumps for irrigation, ensuring a reliable crop water supply, which can significantly increase yields.
ii. *Enhanced Processing and Storage:* Electric access allows refrigeration and other preservation technologies, reducing post-harvest losses and maintaining produce quality.
iii. *Extended Working Hours:* Lighting and electric tools enable farmers to work beyond daylight, improving efficiency and productivity.
iv. *Access to Information:* Electrification facilitates information and communication technologies (ICT), providing farmers timely information on weather, markets, and best practices.

Rural electrification is pivotal for transforming agriculture in Africa. By implementing strategic initiatives inspired by successful programs, African nations can enhance agricultural productivity, improve rural livelihoods, and drive sustainable economic growth.

Benefits and Impacts

On the macro level, the joint positive impact of the increased rural and industrial demand for electricity is expected to foster more rapid growth in the service industries (Gorjian et al., 2022). This growth in demand will not only lead to new jobs and economic opportunities but also encourage investment in infrastructure and technology advancements (Rahman et al., 2022). Investment in the expansion of the transmission system advances growth by creating and sustaining economic activity in the rural communities during the construction phase. This, in turn, will attract more businesses and industries to these areas, leading to further economic development. Regions that gain access to electrical services should also experience faster growth of local branch economies in areas such as trade and services. With reliable and affordable electricity, rural communities can engage in productive activities within their local economies and through connections to broader markets (Elahi et al., 2022). This will enable them to participate more actively in regional and global trade, opening up new possibilities for growth and development.

The macro-simulation model indicates that if the rate of electrification in rural areas is increased, it gives rise to higher economic growth, increased agricultural trade, faster growth in manufactured goods exports, and decreased poverty in rural areas (Raihan & Tuspekova, 2022). Providing electricity to rural communities improves their living standards, productivity, and efficiency. This, in turn, leads to increased agricultural production and exports, strengthening the rural economy and reducing poverty levels. Rural electrification is expected to not only lead to a direct impact on the rural community where it is extended but also to have indirect effects on regions along the lines. Improved access to electricity will attract businesses and industries to these areas, resulting in job creation and increased income levels. This will also ripple effect on surrounding regions as the increased economic activity spreads through supply chains and trade networks. As a result, the entire region will experience a boost in economic growth and development. Expanding rural electrification brings energy access to rural communities and has far-reaching positive economic impacts. It stimulates growth in the service industries, attracts investments, promotes trade and services, and alleviates poverty. By providing electricity to rural areas, we improve the quality of life for individuals and communities and foster sustainable and inclusive economic development for the entire region.

As private firms and workers, both employed and unemployed, in the rural non-electrified areas face financial and other barriers that inhibit their ability to move to areas with greater access to electrical services, they are expected to gain from extending electricity transmission lines to their areas. "Once installed, electricity positively impacts agricultural productivity by saving labour, increasing output, and improving the quality of agricultural products." The transmission line brings electricity not only to the community but also to economic activities occurring along the route, which enhances growth.

Case Studies and Best Practices

1. Successful Rural Projects Enhancing Agricultural Output

Numerous rural projects have successfully enhanced agricultural output through innovative irrigation design, construction, and management practices. Among the extensive literature on irrigation systems, it is evident that many projects have failed to deliver even average-quality service, while a select few have performed exceptionally well. Successful projects generally share several key characteristics: Demand-Driven Design: Projects responding to precise farmer demands are more successful. Understanding and incorporating the specific needs of farmers ensures that the infrastructure meets actual requirements, leading to better utilisation and satisfaction.

a. ***Farmer Engagement:*** Full engagement of water users in the design and implementation process is crucial. Farmer participation, often called the "endogenous" component, ensures that the solutions are practical and culturally acceptable, leading to greater infrastructure ownership and maintenance.
b. ***Efficient Management:*** Successful projects allow for efficient management at or below the Level of Management (LoM). This decentralisation often involves local communities or farmer associations taking on management roles, which can lead to more responsive and effective operation and maintenance of the systems.
c. ***Electric Power Supply:*** Integrating reliable electricity into irrigation projects enhances efficiency and effectiveness. Electrically powered pumps and control systems can significantly improve water distribution, reduce labour, and increase irrigation precision, thus enhancing agricultural productivity.

2. Critical Elements of Successful Power Supply Efforts

Providing reliable power to agricultural consumers is critical for the success of rural electrification projects. Several key elements have been identified in studies investigating productive service delivery by the utility sector and non-electric power applications:

a. *Decentralisation:* Encouraging decentralisation in managing small-scale irrigation systems can lead to more efficient and responsive service delivery. Local management often results in better maintenance and quicker issue resolution.
b. *Endogenous Participation:* Farmers' and local communities' involvement in the design, construction, and operation of power and irrigation projects ensures that the systems are tailored to their needs and capabilities, leading to higher adoption rates and better performance.
c. *Performance Evaluation:* Successful power provision should be assessed based on achieving development-related objectives at the lowest overall system costs. Performance evaluation indices facilitate transparency, dialogue, and consistent appraisal of different approaches despite no universal agreement on the specific goals.

3. Best Practices in Rural Electrification and Irrigation

a. *Community-Based Management:* Projects like Participatory Irrigation Management (PIM) initiatives in countries such as India and Nepal have demonstrated the effectiveness of involving local communities in managing irrigation systems. These projects have improved water use efficiency, crop yields, and farmer incomes (Kanda & Lutta, 2022).
b. *Public-Private Partnerships:* In Kenya, the government and private sector partnerships in developing the Mwea Irrigation Scheme have been successful. The introduction of solar-powered irrigation systems and the active involvement of farmers in the management have led to increased agricultural productivity and sustainability (Durga et al., 2024).
c. *Renewable Energy Integration:* Projects integrating renewable energy sources, such as Benin's Solar Electric Light Fund (SELF) initiatives, have shown that solar-powered irrigation can be cost-effective and sustainable. These projects have improved crop yields, reduced reliance on fossil fuels, and provided a reliable power source for rural farmers (Birhanu et al., 2023).
d. *Capacity Building:* Training and capacity-building programs are essential for the success of rural electrification and irrigation projects. For example, Egypt's Training and Visit (T&V) system has effectively trained farmers

to use modern irrigation techniques and maintain electric-powered equipment, improving agricultural practices and productivity (Lefore et al., 2021).

The success of rural electrification and irrigation projects in enhancing agricultural productivity in Africa hinges on several critical factors. Demand-driven design, farmer engagement, efficient management, and reliable power supply are essential (Anena & Mwesigwa, 2021). Decentralisation and endogenous participation play pivotal roles in ensuring the sustainability and effectiveness of these projects. Best practices, such as community-based management, public-private partnerships, renewable energy integration, and capacity building, provide valuable insights for future initiatives. By focusing on these critical elements and best practices, rural electrification projects can significantly contribute to the socio-economic development of African communities.

Successful Projects in Africa

The restart of the Rusumo hydroelectric plant was essential for restoring Rwanda's water supply and partially rehabilitating the crucial railway link to Tanzania (Iweh et al., 2021). Instead of investing in transmission infrastructure, Rwanda built a mini-grid extending 70 kilometres. Despite achieving its goal of operating the turbine in 1990, erosion severely impacted the mini-grid extension, leading to its abandonment (He et al., 2021). Once the hydroelectric plant began generating power, electricity demand surged, achieving an 80% load factor. The World Bank resumed significant work in this sector, providing funding through Coopération Électrique. After completing the load management project in Kigali, CEB became the central partner for implementing the Enersis project, aligning with the deconsolidation strategy despite not receiving funding from Coopération Électrique (Proedrou, 2021). CEB facilitated meetings with key stakeholders to explore integrating renewable energy sources into the existing grid. These collaborations led to a comprehensive plan to modernise and expand the Rusumo hydroelectric plant and incorporate sustainable energy solutions throughout Rwanda (Azeem et al., 2021). This approach garnered significant support and investment from international development agencies, including the World Bank, the African Development Bank, and the United Nations Development Programme.

Recognising the importance of inclusivity and gender equality, the Rwandan government partnered with local women's cooperatives to provide training and employment opportunities in the renewable energy sector. This empowerment contributed to the socio-economic development of rural communities. With a renewed focus on renewable energy, Rwanda emerged as a leader in sustainable development, demonstrating its commitment to combating climate change and reducing carbon emissions (Farrok et al., 2020). Through continuous investment in clean energy infrastructure and innovative policies, Rwanda became a model for how sustainability can drive economic growth and improve citizens' lives. Inspired by Rwanda's success, neighbouring countries embarked on renewable energy journeys, fostering regional cooperation and shared prosperity. These efforts laid the foundation for a sustainable and interconnected Africa, shown in Table 1, where clean and affordable energy became a reality for all.

Table 1: Successful Renewable Energy Projects in Africa

Project Name	*Location*	*Description*	*Outcomes*	*References*
Rusumo Hydroelectric Plant	Rwanda	I restarted to restore the water supply and partially rehabilitate the railway link to Tanzania.	Increased electricity demand, 80% load factor, World Bank funding, integration of renewable energy sources.	Iweh et al., 2021; He et al., 2021; Proedrou, 2021; Azeem et al., 2021; Farrok et al., 2020
Mwea Irrigation Scheme	Kenya	Public-private partnership for solar-powered irrigation systems and farmer involvement.	We have increased agricultural productivity and sustainability.	Andersson & Liedman, (2022).
Solar Electric Light Fund (SELF) Initiatives	Benin	Integrating solar-powered irrigation improves crop yields and reduces reliance on fossil fuels.	Improved agricultural yields, reduced fossil fuel dependency, and reliable power source for rural farmers.	Birhanu et al., 2023
Training and Visit (T&V) System	Egypt	Training farmers on modern irrigation techniques and maintenance of electric-powered equipment.	It improved agricultural practices and productivity.	Before et al., 2021
Participatory Irrigation Management (PIM)	India and Nepal	Involvement of local communities in irrigation management.	Improved water use efficiency, crop yields, and farmer incomes.	Kanda & Lutta, (2022).
Enersis Project	Rwanda	Integration of renewable energy sources into grid infrastructure.	Development of a comprehensive plan for modernising energy solutions with significant international support.	Azeem et al., 2021

These projects highlight the diverse approaches to enhancing rural electrification and agricultural productivity through community involvement, public-private partnerships, renewable energy integration, and capacity building. They serve as exemplary models for driving socio-economic development across Africa through sustainable energy initiatives.

Cost-recovery and Inclusivity Strategies

The estimates confirm that greater agricultural productivity in solar home system-connected villages creates value that offsets the cost of off-grid solar home systems (Zebra et al., 2021). However, these cost savings are not guaranteed. Our household experimental results are silent on whether households are forced to rely on off-grid energy sources due to issues of land tenure security and credit constraints (Andersson & Liedman, 2022). However, our experimental results that connect relatively inefficient traditional energy sources and greater poverty levels suggest that forcing households to switch to off-grid sources is incorrect because this would force many households below any poverty line.

So far, we have established statistical patterns that demonstrate a connection between rural electrification and agricultural productivity among beneficiaries of off-grid solar home systems (Syed & Morrison, 2021). In the next section, we provide policy implications of our findings by addressing cost-recovery and inclusivity strategies for off-grid solar home systems and feasibility issues. Lastly, we discuss the potential of off-grid electrification to trigger more

substantial economic and social changes in sub-Saharan Africa that contribute to the modernisation of rural economies. We provide the roadmap of our policy recommendations in Table 2.

Table 2: Policy Recommendations for Off-grid Solar Home Systems

Policy Area	*Recommendations*	*References*
Cost-Recovery Strategies	Implement tiered pricing models to ensure affordability and sustainability.	Zebra et al., 2021
	Develop financing schemes to mitigate initial setup costs for low-income households.	Andersson & Liedman, 2022
	Introduce government subsidies and incentives to encourage the adoption of solar home systems.	Syed & Morrison, (2021).
Inclusivity Strategies	Ensure community involvement in planning and implementation to address specific local needs.	Zebra et al., 2021
	Provide education and training programs to improve technical skills and knowledge about solar energy systems.	Andersson & Liedman, 2022
	Establish credit facilities and microfinance options tailored for rural households.	Syed & Morrison, (2021).
Feasibility Issues	Assess and improve land tenure security to ensure long-term investment in solar infrastructure.	Zebra et al., 2021
	Strengthen institutional frameworks to support reliable maintenance and service networks.	Andersson & Liedman, 2022
	Foster public-private partnerships to leverage investment and technical expertise.	Syed & Morrison, (2021).
Economic and Social Impact	Promote the integration of solar systems with agricultural productivity tools to boost economic returns.	Zebra et al., 2021
	Encourage the adoption of solar-powered technologies to enhance the quality of life and economic opportunities.	Andersson & Liedman, 2022
	Monitor and evaluate the socio-economic impacts of off-grid solar home systems to refine and improve strategies.	Syed & Morrison, 2021

These recommendations aim to ensure that off-grid solar home systems are sustainable, cost-effective, inclusive, and impactful for socio-economic development in sub-Saharan Africa.

Conclusion

Rural electrification holds immense potential for enhancing agricultural productivity in sub-Saharan Africa, offering substantial returns on investment by modernising agricultural practices and technologies. The provision of electricity can revolutionise farming operations, facilitate timely planting, support the establishment of ICT-based extension systems, and optimise fertilisation and irrigation practices. Electrification is also essential for developing stress-tolerant seeds and implementing precise pest and weed management systems, further bolstering agricultural resilience and efficiency. By addressing the 'electricity gap,' rural electrification can unlock the full potential of agricultural investments, fostering a prosperous and stable rural economy. The benefits extend beyond increased agricultural productivity, including reduced urban migration, improved living standards, and overall economic development. Empirical evidence underscores the significant positive impact of rural electrification on socio-economic outcomes at the household level, demonstrating its pivotal role in achieving sustainable development goals. Therefore, strategic initiatives to enhance rural electrification are crucial for transforming agriculture in SSA,

promoting food security, and driving socio-economic growth. Integrating renewable energy sources and community-based management practices in electrification projects further enhances sustainability and inclusivity, ensuring long-term benefits for rural communities. By leveraging successful rural electrification models, sub-Saharan African nations can significantly improve agricultural productivity and contribute to broader economic and social development goals.

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