

Research Article

RENEWABLE ENERGY AND SUSTAINABLE AGRICULTURE DEVELOPMENT IN NIGERIA: OPPORTUNITIES, CHALLENGES, AND PROSPECTS

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ABSTRACT

Renewable energy and sustainable agriculture development are pivotal for Nigeria's socioeconomic progress and environmental sustainability. Despite the nation's abundant renewable energy resources, including solar, wind, biomass, and hydro, various challenges impede their optimal utilization. This paper delves into the opportunities, challenges, and prospects associated with renewable energy and sustainable agriculture development in Nigeria. It underscores the necessity for comprehensive policy frameworks, robust regulatory mechanisms, and extensive public awareness campaigns to foster the adoption of renewable energy technologies and promote sustainable agricultural practices. Furthermore, the paper examines the critical role of government support, social and cultural factors, and the detrimental impact of insecurity on sustainable development initiatives. Recommendations for future research emphasize the exploration of the economic implications of clean energy adoption, the evaluation of policy frameworks, waste-to-energy initiatives, rural energy preferences, and the correlation between human capital development and renewable energy uptake. Through concerted efforts and strategic interventions, Nigeria can leverage its renewable energy potential and advance sustainable agriculture practices to realize its developmental goals while preserving its natural resources for future generations.

Keywords: Renewable energy; Sustainable agriculture; Waste-to-energy; Policy framework; Food security.

INTRODUCTION

Renewable energy and sustainable agriculture development in Nigeria are crucial components for the country's growth and environmental conservation. Nigeria, a country rich in renewable energy resources such as solar, wind, biomass, and hydro (Oyedepo, 2012), has been exploring the viability of these resources to enhance its energy sector (Oyedepo, 2012). The potential for renewable energy in Nigeria has been well researched over the years (John *et al.*, 2022), with studies highlighting the need for a comprehensive Renewable Energy Master Plan (REMP) to harness these resources effectively (Chinekeet *et al.*, 2022). However, challenges such as poor budgetary allocation, lack of policy direction, and inadequate manpower have hindered the growth of renewable energy in the country (Mbamalu and Okoro, 2021).

The integration of renewable energy into Nigeria's energy mix is crucial for sustainable development and economic growth (Akpojedje, 2022). Studies have shown that renewable energy consumption can enhance economic growth in Nigeria (Umejiet *et al.*, 2023), emphasizing the importance of transitioning towards sustainable energy sources. The development of standards for renewable energy technologies is also essential to regulate the influx of such technologies into the country (Emodi *et al.*, 2014), ensuring quality and efficiency in their deployment.

In the context of sustainable agriculture development, the conversion of organic wastes to electricity has been proposed as a means to promote a sustainable power sector and environmental development in Nigeria (Olujobiet *et al.*, 2021). Additionally, exploring renewable energy options, such as solar photovoltaic systems, in rural communities can address energy needs and contribute to sustainable

agricultural practices (Okwanyaet *et al.*, 2020). The potential for renewable energy to drive sustainable industrial development in Nigeria has also been highlighted (Asemota and Olokoyo, 2022), indicating the broader impact of renewable energy on various sectors of the economy.

To overcome the challenges and maximize the prospects of renewable energy and sustainable agriculture development in Nigeria, there is a need for supportive policies and regulatory frameworks (Daudu and Idehen, 2021). Establishing a renewable energy agency to enforce renewable energy laws and promote renewable energy utilization can accelerate the country's transition towards sustainable energy practices (Daudu and Idehen, 2021). Furthermore, public awareness campaigns on the benefits of renewable energy and its role in achieving energy security and environmental sustainability are crucial for driving adoption and investment in renewable energy technologies (Ayodele and Alege, 2021).

RENEWABLE ENERGY TECHNOLOGIES AND CHALLENGES

Renewable energy technologies offer a promising solution for Nigeria's energy future, given the country's abundant resources such as solar, wind, biomass, and hydro (Aba *et al.*, 2019). These technologies provide a sustainable alternative to traditional fossil fuels and have the potential to address Nigeria's energy challenges (Amulah, 2022). Specifically, wind energy has been identified as a viable renewable energy source to help meet the country's energy needs (Babawarunet *et al.*, 2023).

Despite the potential benefits of renewable energy technologies, Nigeria faces various challenges in their implementation. These challenges include weak institutional frameworks, poor policy implementation, inadequate financing, and a lack of awareness about the benefits of renewable energy (Edeme and Chibuzo, 2018).

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Additionally, issues such as non-adoption, non-implementation, and inconsistency in renewable energy policies across different government administrations hinder the development of these technologies (Williams *et al.*, 2019).

Moreover, the absence of national standards and quality control units for renewable energy technologies presents a significant obstacle to their adoption in Nigerian households (Chinekeet *et al.*, 2022). Regulatory challenges surrounding renewable electricity in Nigeria also impede the widespread deployment of renewable energy systems (Arowolo and Douglas, 2022). Furthermore, Nigeria's heavy reliance on fossil fuels for energy and economic sustenance remains a major challenge (Adejo and Osinibi, 2016).

To overcome these obstacles and fully leverage the potential of renewable energy technologies in Nigeria, responsive and effective policies promoting their adoption are essential (Adeyanju *et al.*, 2020). Establishing renewable energy units in technological universities and research institutions to conduct research and development in renewable energy technology is also recommended to enhance their benefits and foster a technical culture in Nigeria (Ajao *et al.*, 2021).

SUSTAINABLE AGRICULTURAL PRACTICES

Sustainable agricultural practices can be adapted to the unique context of Nigeria by leveraging the benefits they offer while addressing the challenges specific to the region. In Nigeria, sustainable agricultural practices have been shown to enhance food security by improving access to high-quality and affordable nutrition (Garba, 2023). These practices, which are environmentally sensitive, can lead to improved agricultural productivity in Nigeria (Bello *et al.*, 2012). Despite the potential benefits, there are challenges to adopting sustainable agriculture in Nigeria, such as the high level of ignorance among farmers about these practices (Ojadi, 2024).

The adoption of Conservation Agriculture (CA) practices in Nigeria has been identified as a viable option to increase food production and achieve sustainable food security (Olalekan and Ayodeji, 2017). Agricultural policies implemented in Nigeria, like the E-wallet programme and Fadama, have already shown promising results in increasing production and improving livelihoods, especially in rural areas (JI *et al.*, 2022). However, challenges remain, as some experts have highlighted barriers to promoting and adopting CA principles in Nigeria (Eheazu, 2023). To enhance sustainable agriculture in Nigeria, there is a need to focus on educating farmers, particularly in regions like South-East Nigeria, to improve their adoption of sustainable practices and ensure food security while conserving resources (Mgbada *et al.*, 2016). Factors influencing the adoption of sustainable agriculture among smallholder farmers in Nigeria include age, education, and family size (Oyewole and Sennuga, 2020). Additionally, the impacts of climate variability on sustainable agriculture in Nigeria, particularly in states like Imo, underscore the importance of considering climate factors in agricultural practices (Ajireet *et al.*, 2021).

In Nigeria, where rain-fed agriculture is predominant, climate change poses significant challenges to agricultural sustainability, affecting crops like rice (Diagi *et al.*, 2021). Mitigating the effects of climate change-induced extreme events on agriculture requires intensified research efforts and adaptation strategies (Durodola, 2019). Furthermore, addressing issues like soil erosion control and sustainable land management is crucial for ensuring agricultural sustainability in regions like Oyo State (Oyewoet *et al.*, 2019).

Government support, both in terms of financing and policies, plays a vital role in promoting sustainable agriculture in Nigeria. Adequate credit provision to the agricultural sector is essential for transitioning farmers from subsistence to commercial farming sustainably. However, there are concerns about the level of government expenditure on agriculture in Nigeria, highlighting the need for concrete steps to drive sustainable agricultural development (Dul and Evbuomwan, 2017).

GOVERNMENT POLICY AND REGULATION

The Nigerian government has been actively involved in policies aimed at boosting the agricultural sector, often in collaboration with international agencies like the World Bank and African Development Bank (Okafor and Chikalipah, 2021). These policies are essential for diversifying the country's revenue base, which is a significant challenge for sustainable growth (Asaleyee *et al.*, 2020). Environmental regulation is also vital in promoting sustainable behaviors among farmers, which is crucial for Agricultural Green Production (AGP) (Li *et al.*, 2022). In the context of Nigeria, incorporating renewable energy planning and investment is recommended for sustainable development, as it promotes research, market development, and regulation of renewable energy resources (Ajao *et al.*, 2021). Additionally, government policies are needed to promote responsible and sustainable agricultural production (Sanders *et al.*, 2022). The government's role in ensuring food security through sustainable agriculture is highlighted, aiming to achieve "Zero Hunger," one of the Sustainable Development Goals (Garba, 2023).

Furthermore, appropriate policy combinations are necessary to attract capital towards expanding agricultural productivity and increasing agricultural exports for economic development in Nigeria ("Impact of Agricultural Trade Policies on the Exportation of Agricultural Commodities in Nigeria", 2021). Evaluating agricultural policies and programs is crucial for future farming intensification in Nigeria, aiming to achieve food self-sufficiency, create employment, and drive rapid economic growth (Amuda, 2023). Legislative frameworks provided by the government are essential for sustainable development in rural areas, insulating programs and policies from inconsistency (Okunola, 2016).

SOCIAL AND CULTURAL FACTORS

Social and cultural factors are pivotal in the implementation of sustainable agricultural practices in Nigeria. These factors wield significant influence over the success or failure of initiatives aimed at promoting sustainable agriculture in the country. The literature highlights several key factors that illuminate the complexities involved in ensuring the adoption and success of sustainable agricultural practices in Nigeria. One critical social factor identified is the impact of climate change on agricultural sustainability (Diagi *et al.*, 2021). Nigeria, akin to many African nations, faces high vulnerability to climate change effects, evidenced by extreme events like flooding, droughts, and shifts in weather patterns. These challenges pose substantial threats to the sustainability of agricultural practices, particularly in Nigeria's predominantly rain-fed agricultural system. The timing of rains dictates cultural practices among farmers, underscoring the intricate relationship between climate patterns and agricultural activities.

Moreover, the engagement of youth in agriculture has been acknowledged as a factor that can influence rural households' income and agricultural sustainability (Fasakin *et al.*, 2022). Encouraging youth participation in agriculture, such as through initiatives like the Youth-In-Agriculture Programme (YIAP), can yield positive outcomes

for sustainable agricultural practices. Involving the younger generation in farming not only contributes to economic growth but also ensures the continuity of agricultural practices, which is crucial for long-term sustainability.

Additionally, social and political factors can impact specific crops like wheat production in Nigeria (Dambazauet *et al.*, 2021). Understanding these factors is vital for devising targeted solutions to enhance crop production and bolster sustainability. Social and political dynamics can mold agricultural policies, resource access, and market opportunities, all of which are pivotal for the successful implementation of sustainable agricultural practices. Furthermore, the role of education in advancing sustainable development in agriculture is indispensable (Oluyomiet *et al.*, 2021). Educational reforms can wield a significant impact on sustainable development across economic, social, and environmental dimensions. Strengthening educational opportunities and fostering awareness about sustainable agricultural practices can lead to more informed decision-making among farmers and stakeholders, ultimately fostering the adoption of sustainable practices.

IMPACT OF INSECURITY

In Nigeria, insecurity significantly impacts the implementation of sustainable agricultural practices, crucial for ensuring food security in the country. The presence of insecurity, including conflicts, violence, and terrorism, poses challenges that hinder progress towards sustainable agriculture and food security (Orumaet *et al.*, 2021; Akanle, 2021). Insecurity not only disrupts farming activities but also creates an environment unfavorable for agricultural development and investment, making the sector unattractive to both local and foreign investors (Aba and Baiyeri, 2021; Ojadi, 2024). This situation is exacerbated by the fact that conflict and violence make it difficult to achieve sustainable food production in Nigeria. The implications of insecurity on sustainable agricultural practices extend to the broader context of food security in Nigeria. Studies have shown that insecurity contributes to food insecurity in the country (Ojadi, 2024). The rising insecurity issues, such as Boko Haram activities and kidnapping cases, have led to hunger becoming one of Nigeria's most pressing problems (Ojadi, 2024). Furthermore, the effects of insecurity on agriculture have been more severe in low and middle-income countries like Nigeria, where restrictive measures to contain the spread of infections have disrupted the agricultural workforce and jeopardized food security.

RECOMMENDATIONS FOR FUTURE RESEARCH

To advance research on Renewable Energy and Sustainable Agriculture Development in Nigeria, several key areas warrant attention. Firstly, exploring the economic implications of clean energy adoption in Nigeria is crucial. Maji (2015) discusses the relationship between clean energy and economic growth in Nigeria, highlighting the need to investigate energy policies and legal frameworks to support renewable energy development. Understanding the economic benefits and challenges associated with renewable energy adoption can provide valuable insights for policymakers and stakeholders.

Secondly, the role of policy frameworks in promoting sustainable electricity supply through renewable energy sources is essential. Oyewoet *et al.*, (2018) emphasize the significance of the National Renewable Energy and Efficiency Policy (NREEEP) in guiding energy efficiency and renewable energy development in Nigeria. Analyzing the effectiveness of existing policies and identifying areas for improvement can guide future policy formulation to enhance sustainable energy practices.

Moreover, the conversion of organic waste to electricity presents a promising avenue for sustainable power generation in Nigeria. Olujobiet *et al.*, (2021) highlight the importance of waste-to-energy initiatives in reducing greenhouse gas emissions and promoting investments in renewable energy sources. Further research on the legal and regulatory aspects of waste-to-energy projects can facilitate their implementation and scalability.

Additionally, evaluating renewable energy preferences among rural communities is crucial for designing targeted energy policies. Okwanyaet *et al.*, (2020) suggest creating a conducive policy environment to make renewable energy accessible and affordable to rural populations in Nigeria. Understanding community preferences and addressing barriers to renewable energy adoption can inform strategies for expanding clean energy access in rural areas. Furthermore, assessing the impact of human capital on renewable energy penetration is vital for sustainable energy transitions. Adepoju *et al.*, (2022) discuss the development of a renewable energy master plan by the Energy Commission of Nigeria to enhance clean energy deployment. Investigating the link between human capital development and renewable energy uptake can guide capacity-building initiatives in the renewable energy sector.

CONCLUSION

In conclusion, Nigeria's pursuit of renewable energy and sustainable agriculture development is multifaceted, encompassing opportunities, challenges, and prospects. By leveraging its abundant renewable energy resources, enacting effective policies, and increasing public awareness, Nigeria can achieve sustainable development, economic growth, and environmental conservation.

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