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CIRCULARITY POTENTIALS OF THE OIL PALM PROCESSING ENTERPRISES AND EVALUATION OF ECONOMIC PARTICIPATION BY YOUTH IN OSUN STATE: A REVIEW

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Abstract: *The oil palm industry supports the economic development of several tropical countries, but in Osun State, Nigeria, it is controlled by older participants. This industry is, however, facing challenges concerning its environmental sustainability. This study examines the circular potential of palm oil processing enterprises while evaluating the economic participation of the youth in the industry. The paper compiles and analyzes the global case studies, particularly from Nigeria and Osun State, focusing on recovery of resources and waste recovery, including valorization, energy recovery, biofertilizer production, and inclusive business models. In addition, the review analyzes the scope and quality of youth engagement in the oil palm value chain. The findings presented pose both prospects and hurdles, including poor access and gaps in financing, insufficient policy and legislative frameworks, lack of technical training, and weak institutional support. Effective youth engagement, holistic adoption of the circular economy, and sustainable inclusive development in oil palm economies are all intertwined with these unresolved challenges.*

Keywords: *circular economy, youth, economic participation, sustainable development, and oil palm.*

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INTRODUCTION

The palm oil industry has seen rapid growth and is of great importance to the economy around the world, especially in tropical parts of Southeast Asia, West Africa, and Latin America (FAO, 2019). Countries like Indonesia and Malaysia are case studies in production concentration as they account for over 80% of palm oil production due to large scale farming, great weather conditions, and continuous investments in agricultural advancements (Goh & Asbi, 2019; FAO, 2019). However, this significant economic contribution has resulted in serious environmental consequences, including deforestation, loss of biodiversity, and pollution from palm oil mill effluent (POME) and other by-products (Wilcove et al., 2013; Gupta et al., 2019). In response to these pressing environmental challenges, there has been a notable shift toward integrating circular economy (CE) principles, which emphasize waste reduction, resource efficiency, and sustainable

practices throughout the entire value chain (UNEP, 2020; Ellen MacArthur Foundation, 2017). In Nigeria oil palm remains one of the most important agricultural products and the industry serves as a critical source of income for millions of smallholder farmers and underscores its significance for rural livelihoods and the national economic framework (Adekola et al., 2020; FAO, 2019). Nigeria, once one of the world leaders in palm oil production, has stagnated in recent years because of obsolete cultivation techniques, policy book deficits, and lack of investment in productivity enhancers (Adeniyi et al., 2017). In spite of these challenges, there is now a greater emphasis towards sector recovery, targeting the participation of the younger generation, and newer, more sustainable economic models of processing with dual economic and ecological scopes (Adekola et al., 2020; FAO, 2019). There is great potential in the application of circular economy concepts in oil palm enterprises in Nigeria, especially in the areas of waste-to-energy, bio-composting, and agroecology-based resource system integration (Oke et al., 2021; Bhuiyan et al., 2020). Nevertheless, many resource-constrained smallholder farmers who want to adopt these circular models are not sufficiently supported institutionally to scale these circular economy opportunities encountered by oil palm smallholders in the region. The state is recognized for its extensive oil palm plantations, but it is marked by fragmented landholdings, reliance on manual processing methods, and underutilized waste streams, all of which can hinder productivity and sustainability (Ogbebor et al., 2020).

The oil palm industry is crucial for economic activity in many tropics, providing incomes, employment, and livelihoods for millions. However, in Osun State, there are growing problems concerning the environmental sustainability of the operations within the oil palm sector. Moreover, the oil palm value chain's participation is largely dominated by the elderly, which is problematic for the sector's sustainability and the participation of younger people. This demographic skew hampers the creativity and adoption of new, ecologically responsible, and efficient oil palm cultivation methods. In addition, agriculture is not the only area in which the region has so much potential. Agricultural land is also very fertile, and factors concerning economic participation for younger people (NBS 2021) remain dire. The value chain of local oil palm industries is still very informal and small, which leads to a severe lack of finances, proper training, modern circular technologies, and other means which could help the farmers (Adebayo et al., 2018).

In this regard, Osun State is a prime candidate for exploring the opportunity for embedding circularity in the oil palm economies. Appreciating the prospects of this shift towards catalyzing youth economic engagement and rural development is important as it tends towards a more resilient sustainable agriculture sector which balances economic development and environmental protection (Adewale et al., 2021; Oke et al., 2021). With this in mind, this research aims to examine the value chain of oil palm in Osun State to understand actions taken, gaps, and preconditions to enable integration of circular economy. This review pursues three core objectives: to examine the level of awareness and involvement of youth in circular economy practices within Osun State's oil palm enterprises; to identify the institutional, financial, and policy-related barriers that limit youth participation; and, to propose actionable pathways that can strengthen youth-led circular innovations for sustainable development.

MAIN TEXT

Methodology

In this case, a narrative review approach was used to collect and document information from articles, reports, and case studies published from 2010 to 2025. Some of the references used in this research included articles from journals, institutional reports, and case studies. Information was collected based on very specific search phrases like "waste valorization" and "sustainable agro-industrial

development." Other databases included Google Scholar, ScienceDirect, and ResearchGate, along with institutional repositories like the FAO, UNEP, and the World Bank. 40 documents were used for this review based on geographic context, relevance, the diversity of research, and the thoroughness of the study. This review focuses on the circular economy and the empowerment of youths, structured along the four dimensions of greenhouse gas emissions reduction: technological, environmental, policy, and social inclusion.

Data Sources and Search Strategy

Relevant literatures were obtained from scholarly databases and institutional repositories such as ScienceDirect, Google Scholar, JSTOR, FAO, UNEP, and the World Bank. To capture Comprehensive and current literature on oil palm processing, the circular economy, along with the role of youth in economic development, the search window was limited to the period of 2010 to 2025. This study's literature search was structured using a combination of Boolean operators and specific keywords. Using the keywords "circular economy" AND "oil palm" yielded scholarly publications focused on circular economy practices in oil palm industry. The demographic component of the study, youth involvement, was examined with the phrases "youth participation" AND "agriculture." To place the study in its broader context of global development and geography, search combinations such as "sustainable development" AND "Nigeria" OR "Osun State" were used. Also, to find literature related to innovations in resource recovery, the search strings "waste-to-wealth" AND "oil palm processing" were used. The overlap of the informal economy with the concepts of the circular economy was captured through the search "informal sector" AND "circularity."

The mentioned databases were searched using the following terms, Scopus, Google Scholar, ScienceDirect, African Journals Online (AJOL), and SpringerLink. The search was performed from January to July of 2023, and the search was limited to the following types of publications: journals, policies, technical documents, and other non-conventional literature, but only if they were published between the years 2010 to 2023. priority was given to the studies conducted in a particular focused region which was the south of the sahara, more specifically, they were focused on Nigeria and the state of Osun.

Inclusion and Exclusion Criteria

Inclusion: In terms of CE, the relevant oil palm value chains, and the specific focus on youth participation within Nigeria and the broader African context, included are peer-reviewed journal articles, technical reports, relevant policy documents, and applicable case studies.

Exclusion: This category excluded documents published in languages other than English, youth economic engagement materials with no clear relation to CE, and texts lacking full document access.

Data Selection and Screening

From the 100-plus documents retrieved, the first 40 that were kept were the most relevant, credible, and data-rich. The duplicates removed using Zotero reference manager. Title and abstract screening was done manually. Eligible sources were subjected to full-text analysis.

Methods for Analysis of Data

The chosen documents went through thematic analysis. A qualitative content analysis technique was utilized in which prominent themes and sub-themes centered on circularity considerations, youth

participation, policy frameworks and enterprise models were identified. Findings were organized through manual coding and matrix charting.

Tools employed:
Zotero: Assists in collecting and organizing references and checking for duplicates
Microsoft Excel: Assists in data extraction and data thematic coding matrix creation.

Assured quality
The credibility of sources was ensured by prioritizing published peer-reviewed journals and using recognized international institutions. Agreement within the interpretation of data was maintained through cross-verifying with literature through theme triangulation.

2. Circular Economy in Oil Palm Processing Enterprises in Osun State

In Osun State, the integration of circular economy (CE) concepts in palm oil milling is still rudimentary, particularly in regard to smallholder farmers who dominate the industry (Okoye et al., 2019; Oke et al., 2021). The circular economy is concerned with waste minimization and the efficient use of resources through the reuse and recycling of materials as well as their regeneration (Ellen MacArthur Foundation, 2017). With regard to oil palm enterprises, CE is an approach where each stage of the production hierarchy from the growing, processing, and selling is done with consideration of minimizing negative impacts on the environment and adding value economically. This approach focuses on the utilization of by-products palm oil mill effluents, empty fruit bunches, and even palm kernel shells, instead of treating them as waste. For instance, empty fruit bunches can be transformed into organic fertilizer or bioenergy while palm kernel shells are used as biomass fuel. The adoption of CE by oil palm businesses facilitates the establishment of closed-loop systems that help conserve natural resources, protect the environment from pollution, and provide additional employment especially to the youths and rural population. In the oil palm industry, CE promotes sustainable development by achieving environmental, economic, and inclusive social integration.
In Osun State, waste streams such as palm oil mill effluent (POME), empty fruit bunches (EFB), palm kernel shells (PKS), and mesocarp fiber are often discarded indiscriminately due to a lack of awareness, poor infrastructure, and insufficient technical expertise for value-added conversion (Sulaiman & Abdul, 2022; Tappi et al., 2021). Most oil palm mills in the state operate outdated processing systems that lead to energy losses and underutilization of nutrient-rich residues that could enhance farm productivity or power rural communities (Okoye et al., 2019).

2.1. Bioenergy and Methane Capture

Bioenergy innovations, such as the capture of methane from POME, are virtually non-existent in Osun State due to a convergence of financial, infrastructural, and policy limitations (Oke et al., 2021). Palm Oil Mill Effluent (POME) is one of the most significant waste streams generated during palm oil processing. On average, the processing of one tonne of fresh fruit bunches (FFB) produces between 0.5 and 0.75 tonnes of POME, while the production of one tonne of crude palm oil can generate up to 2.5 tonnes of POME (Ahmad et al., 2013; Olarewaju et al., 2020). In Nigeria, small- to medium-scale mills dominate, yet many operate without effluent management systems. Although no centralized data exists for Osun State, extrapolations based on local production suggest that thousands of tonnes of untreated POME are discharged annually into the environment.
One of the major valorization opportunities for POME lies in anaerobic digestion, which produces biogas (methane). A recent study in Imo State, Nigeria, estimated the biochemical methane potential (BMP) of POME at 22.8 L CH_4 /m³ during the wet season and 75.5 L CH_4 /m³ in the dry season

(Onukwuli et al., 2021). However, such technologies are virtually absent in Osun State due to a convergence of technical, financial, and policy limitations (Oke et al., 2021).

Beyond anaerobic digestion, other valorization pathways include composting into biofertilizer, microalgae cultivation for biomass, and membrane filtration for water recovery. Yet, these innovations remain underexplored or completely lacking in the region. Composting, while more feasible, is limited by a lack of farmer education and structured waste collection (Igbokwe et al., 2019). Microalgae cultivation and membrane technologies require sophisticated infrastructure, which small-scale processors in Osun often cannot afford.

Table 1: Valorization Pathways for POME and Feasibility in Osun State

Valorization Pathway	**Product / Benefit**	**Technical Requirements**	**Feasibility in Osun State**
Anaerobic digestion for methane	Biogas (methane)	Digesters, gas capture infrastructure, skilled labor	**Low** – no existing digesters; capital- and training-intensive
Biofertilizer / composting	Soil nutrients, organic amendments	Treatment pits; pathogen control; application training	**Moderate** – lower cost, but needs awareness and support
Microalgae cultivation	Biomass for feed or biofuels	Photobioreactors, nutrient management	**Low** – high-tech requirement, limited local expertise
Membrane filtration / reuse	Clean water and reduced discharge	High-cost filtration units, maintenance	**Very low** – costly and technically intensive for smallholder settings

Sources:

- Anaerobic digestion figures: BMP estimates from Nigeria (Imo State) research nijest.com.
- Baseline POME yields: global and regional data avensonline.orgPMC.
- Valorization pathways drawn from broader literature on POME treatment and sustainable practices, including composting, biogas, algae systems, and membrane reuse technologies IntechOpenPMC.

The environmental cost of this gap is significant, as untreated POME is routinely discharged into rivers, contaminating water sources and threatening biodiversity (Tappi et al., 2021; UNEP, 2020). In contrast, similar contexts in Southeast Asia have piloted the installation of small-scale bio-digesters that convert effluent into methane, powering rural homes and mills (Saputra et al., 2020). Implementing such systems in Osun could improve energy access and reduce deforestation driven by wood fuel dependency. However, without pilot demonstrations, public subsidies, and technical assistance, uptake remains unlikely (World Bank, 2020).

2.2. Biomass Valorization

Biomass residues like EFB, PKS, and fronds accumulate in Osun's mills without structured end-use pathways (Okoye et al., 2019). These by-products are either burned openly—causing air pollution and greenhouse gas emissions—or left to decompose wastefully. Valorization options such as composting, pelletizing for fuel, and biochar production are technically feasible but institutionally unsupported (Martins et al., 2022). The formation of youth cooperatives specializing in biomass processing could provide sustainable income while reducing environmental burdens. Nevertheless, a

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lack of investment capital, skills training, and business incubation services stalls the commercial development of this sector (Adekola et al., 2020).

2.3. Agroecological Integration

Agroecological integration offers another pathway for circularity. Practices like using EFB as organic mulch, employing palm fronds as livestock feed, and intercropping palm with legumes or vegetables can regenerate soil health and diversify farm income (Adebayo & Obayelu, 2021; Tappi et al., 2021). In Osun, such practices remain largely untapped due to limited extension services and the predominance of monoculture systems. Integrating circular methods requires adaptive agronomic research, demonstration farms, and community-level training programs to shift mindsets and encourage adoption (FAO, 2019; Goh & Asbi, 2019).

2.4. Technological Capacity

The capacity gap in Osun's oil palm sector is significant. Most mills are equipped with rudimentary presses that offer low oil extraction efficiency and generate high waste volumes (Okoye et al., 2019). These conditions make it difficult to integrate secondary recovery systems like sedimentation tanks for POME or bioenergy units. Moreover, the digital divide in rural areas hinders farmers and processors from accessing information on best practices or funding opportunities (Sulaiman & Abdul, 2022; Agyeman & Mensah, 2022). Strengthening technical capacity will require partnerships between polytechnics, vocational centers, and agritech incubators to offer targeted skill-building in waste processing, renewable energy systems, and digital business tools (FAO, 2019).

2.5. Policy and Institutional Environment

Although Nigeria has introduced federal programs to support agribusiness, green growth, and youth employment, specific national policy frameworks on circular bioeconomy remain fragmented and weakly enforced at sub-national levels. For instance, the National Bioeconomy Framework (NBF) developed by the Federal Ministry of Science, Technology and Innovation (FMSTI) in 2022 outlines goals for integrating biotechnology, waste valorization, and renewable energy in agriculture and industry. Similarly, the National Renewable Energy and Energy Efficiency Policy (NREEEP) (2015) promotes sustainable energy adoption, while the Agricultural Promotion Policy (APP) (2016–2020) emphasizes value addition and environmental sustainability in agribusiness (FMARD, 2016).

However, none of these policies are specifically tailored to the palm oil sector or directly mandate circularity practices such as mandatory POME treatment or biomass valorization. Moreover, state-level domestication is lacking. Osun State has no formal circular economy strategy, bioeconomy action plan, or renewable energy incentives for agro-processors. The absence of enabling laws, fiscal incentives, or environmental compliance enforcement has led to the persistence of linear production models and wasteful practices.

Institutional weaknesses further constrain implementation. Regulatory agencies such as NESREA (National Environmental Standards and Regulations Enforcement Agency) lack operational presence in many local communities. Certification schemes like RSPO (Roundtable on Sustainable Palm Oil) or NPOP (National Programme for Organic Production) are often inaccessible to smallholders due to cost and complexity (FAO, 2021).

To promote circular models in oil palm processing, Osun State must align with national sustainability targets, operationalize federal guidelines through state legislation, and invest in regulatory capacity building. Partnerships with NGOs, research institutes, and farmer cooperatives can also support policy localization and implementation.

3. Evaluation of Youth Economic Participation in Osun State

In Osun State, youth represent over 60% of the agricultural labor force but remain largely underutilized in high-value segments of the oil palm value chain (Adebayo & Obayelu, 2021).

Despite the crop's economic relevance, youth involvement is often limited to low-paid, labor-intensive roles such as fruit harvesting, bunch cutting, and rudimentary processing—tasks characterized by seasonal instability, low income, and poor access to mechanization (Adekola et al., 2020; Olowu et al., 2022). Key binding constraints to deeper economic participation include:

Limited access to startup capital and agro-processing equipment, especially among rural youth without land collateral (IFAD, 2019);

Lack of technical training in circular business models such as waste valorization, biogas generation, or eco-friendly packaging;

Poor awareness and uptake of government support programs due to weak rural extension services (Obayelu & Aiyede, 2021);

Gender-based barriers, with young women facing additional exclusion from land ownership and decision-making in palm oil cooperatives (Ajayi & Okunlola, 2020).

Moreover, the absence of structured youth engagement in cooperatives, contract schemes, or circular innovation hubs further inhibits their transition from laborers to agripreneurs. Targeted investments in skills development, blended finance models, and enterprise incubation are needed to unlock the full potential of Osun's youth in driving circularity within the oil palm enterprise.

3.1. Current Status

Youth involvement in the oil palm value chain in Osun State is predominantly confined to labor-intensive roles such as fruit harvesting, bundling, and manual milling—tasks that are physically demanding but offer low and irregular remuneration (Agyeman & Mensah, 2022). While many young people contribute as unpaid labor on family farms or cooperatives, they are rarely included in decision-making, nor granted access to land, processing equipment, or leadership opportunities. This exclusion reinforces economic dependency and stifles entrepreneurial ambition (Adebayo & Obayelu, 2021).

A key constraint to meaningful youth inclusion is the absence of structured pathways for transitioning from laborers to enterprise owners. These pathways could include:

1. Access to start-up grants or blended finance schemes targeted at youth-led agribusinesses;
2. Enterprise incubation hubs focused on circular business models such as soap making from palm kernel shells, biogas from POME, or eco-friendly packaging;
3. Land leasing or cooperative shareholding schemes that grant young people stakes in oil palm operations;
4. Formal apprenticeship programs embedded within cooperatives and linked to vocational training institutions;
5. Mentorship and succession planning structures to gradually transfer ownership of aging family farms to youth.
6. Embedding these pathways into the sector will require policy coordination between state ministries, NGOs, and farmer associations. Programs such as the National Young Farmers Scheme or the Youth Enterprise with Innovation in Nigeria (YouWiN!) could be localized and adapted to the oil palm context in Osun. Additionally, creating youth-specific windows within existing farmer cooperatives, and linking them to digital marketplaces, training centers, and microcredit institutions, can help institutionalize their roles along the entire value chain—from production to value addition and marketing.

3.2. Barriers to Participation

Several systemic barriers hinder youth integration into higher-value segments of the oil palm industry in Osun. Limited access to land, often governed by customary tenure systems, restricts their ability to secure loans or invest in farming infrastructure (Adekola et al., 2020). To address this, state

and local governments could promote youth-inclusive land leasing arrangements through cooperatives or cluster farming schemes, enabling shared access to productive land without violating customary norms.

Even when land is accessible, financial institutions are reluctant to lend to youth due to perceived risks and lack of collateral (Oke et al., 2021). Tackling this requires the introduction of blended finance models, where public grants or donor-backed guarantees de-risk private lending to youth agripreneurs. In addition, digitized credit scoring systems based on farm productivity or cooperative membership can serve as alternative creditworthiness measures.

Training programs are sparse, and where they exist, they rarely incorporate circular economy (CE) principles or entrepreneurship modules specific to the oil palm sector (FAO, 2019). To bridge this gap, technical colleges and agricultural institutes should integrate CE-focused curricula, covering topics such as waste-to-wealth conversion, sustainable processing, and regenerative farming. Furthermore, mobile-based learning platforms could be deployed to reach youth in remote areas.

Finally, cultural and generational divides often marginalize youth voices and suppress innovation (Adebayo & Obayelu, 2021). Multi-stakeholder forums that include intergenerational dialogue, peer mentoring, and youth leadership quotas within cooperatives can help shift mindsets and institutionalize youth inclusion. Leveraging success stories from young oil palm entrepreneurs may also inspire wider community acceptance.

3.3. Training, Support Systems, and Digital Tools

Agricultural training opportunities in Osun often focus on traditional farming methods, with little emphasis on sustainable or circular models (Goh & Asbi, 2019). There is also a lack of integration between training institutions and private sector actors that could facilitate internships or enterprise development. Digital technologies remain underutilized, despite their potential to connect youth with markets, advisory services, and peer networks (Agyeman & Mensah, 2022). Establishing youth innovation hubs with internet access, demonstration equipment, and mentorship programs could foster entrepreneurial ecosystems (World Bank, 2020). These hubs can play a central role in promoting CE adoption by offering business incubation for recycling, bioenergy, and value-added processing ventures (UNEP, 2020).

3.4. Youth Leadership and Innovation

Despite persistent barriers, a number of youth-led micro-enterprises are emerging within Osun State's oil palm sector, demonstrating the potential for localized circular innovations. In Ifelodun and Ayedaade LGAs, for example, groups of young people—many of whom are unemployed graduates—have formed informal cooperatives producing value-added products such as palm kernel oil-based soap, bio-compost from empty fruit bunches (EFB), and briquettes from palm biomass waste (Adekola et al., 2020; Agyeman & Mensah, 2022). These initiatives have largely arisen from community-based self-organization, often sparked by exposure to NGO training sessions (e.g., by ENABLE-TAAT or LEAD Nigeria), informal mentorship, or peer learning from nearby states like Ondo.

While promising, these innovations remain outside formal development frameworks, receiving little to no recognition, funding, or policy support. To elevate and scale such initiatives, the Osun State Government and partners can implement targeted mechanisms, including:

1. Innovation incubators and bootcamps tailored to circular palm-based enterprises;
2. Competitive youth innovation grants, with disbursements tied to measurable outcomes such as job creation, carbon savings, or local resource reuse;
3. Recognition platforms (e.g., Osun Youth Agripreneur Awards), to showcase success stories and attract private investment;

4. Public procurement incentives that prioritize youth-led, eco-certified palm oil products in school feeding programs and local markets.
5. Replicable models exist to guide these efforts. For example, the ENABLE-TAAT agribusiness compact in Nigeria has successfully incubated hundreds of youth-run agribusinesses across value chains by offering technical training, startup capital, and mentorship (IFAD, 2021). Similarly, the Ghana Youth in Agriculture Program embeds youth cooperatives within commodity value chains and links them with extension services, credit, and markets (MOFA-Ghana, 2019).

By mainstreaming these models and integrating youth innovation into Osun's agricultural and circular economy strategies, the state can nurture a generation of green entrepreneurs, catalyze waste-to-wealth ecosystems, and reduce dependency on extractive processing methods.

4. Synergies Between Circularity and Youth Inclusion in Osun State

In Osun State, there is growing urgency to integrate circular economy (CE) innovations within local oil palm enterprises alongside youth inclusion strategies. Yet, youth remain marginal in most policy formulations, despite their critical role in driving sustainable development. While national-level policies—such as Nigeria's National Bioeconomy Strategy and Renewable Energy Master Plan—acknowledge the importance of youth and sustainability, these frameworks have not been effectively translated into state-level actions, particularly in Osun (FMEnv, 2022; ECN, 2021). Bioenergy initiatives present an untapped opportunity. For example, estimates suggest that each functional biogas plant can generate 15–20 youth-specific jobs in areas like feedstock collection, plant operation, and logistics (Olatunji et al., 2023). Comparatively, states like Oyo and Edo have initiated pilot CE projects that engage youth through training in bio-composting and palm kernel value addition (Agboola et al., 2022). Osun, however, lags behind—despite having similar agricultural profiles and youth demographics.

In contrast, Rwanda's "Bioenergy Villages" offer a replicable model, having created over 500 youth jobs via decentralized energy hubs (Ministry of Agriculture, Rwanda, 2022). Similarly, Rwanda's Green Fund (FONERWA) includes dedicated circular economy grants with youth quotas—an approach that can inspire a localized equivalent in Osun (Nkubana, 2022). Additionally, scalable CE innovations—such as youth-led composting cooperatives and biofertilizer enterprises—have shown promise in southern Nigerian states like Akwa Ibom and Cross River (Adeyemo, 2023). Yet, in Osun, these innovations remain isolated and uncoordinated, with few programs explicitly identifying youth as critical stakeholders (Solidaridad, 2023).

To correct this gap, Osun can adapt strategies such as:

1. Establishing youth-targeted CE innovation hubs across agricultural zones;
2. Embedding digital platforms to connect young entrepreneurs with funding and markets (Falola, 2023);
3. Including CE training modules in youth empowerment programs such as Osun Youth Empowerment Scheme (OYES) (Ogunleye, 2023).

A comprehensive, state-backed blueprint—co-designed with youth, civil society, and the private sector—could transform the oil palm sector into a youth-powered engine for green growth. Ultimately, Osun's trajectory must move from fragmented efforts toward a coherent, multi-stakeholder strategy that integrates youth inclusion within the broader circular economy framework (Eze, 2023).

5. Challenges and Future Directions on Circularity in Oil Palm in Osun State

Challenges:

Despite growing interest in circular economy practices and youth involvement in Osun's oil palm sector, several persistent challenges continue to limit meaningful participation and scale-up. These

obstacles are both structural and systemic, cutting across policy, finance, infrastructure, and sociocultural domains.

1. Environmental Impact: The expansion of oil palm plantations often leads to deforestation, loss of biodiversity, and soil degradation (Jong et al., 2019). This can be particularly challenging in Osun State, where maintaining ecological balance is vital for local communities (Adeyemo et al., 2020).
2. Waste Management: The oil palm industry generates significant amounts of waste, including palm kernel cake and empty fruit bunches (Hassan et al., 2018). Without effective management strategies, these wastes can lead to pollution and health issues, undermining circularity efforts (Adinugroho et al., 2021).
3. Lack of Awareness: Many farmers and stakeholders may not be fully aware of the principles of circularity or the benefits of sustainable practices (Chia et al., 2020). This knowledge gap can hinder the adoption of circular economy practices in oil palm cultivation (Nguessan et al., 2021).
4. Economic Barriers: Transitioning to circular practices often requires investment in new technologies and systems (Ogunlade & Adeola, 2021). Smallholder farmers may struggle with the financial implications of such changes, limiting their ability to adopt circular methods (Adebayo et al., 2019).
5. Policy and Regulation: Inconsistent policies and lack of supportive regulatory frameworks can create obstacles for implementing circular practices (Bernard et al., 2020). There is a need for more robust policies that promote sustainability in the oil palm industry (Ibrahim et al., 2022).

Future Directions:

1. Education and Training: Implementing programs to educate farmers and stakeholders about sustainable practices, waste management, and the benefits of circularity can foster a more informed community (Ojo & Okeowo, 2020).
2. Innovation in Waste Utilization: One of the most promising avenues for enhancing circularity in Osun State's oil palm sector lies in the innovative utilization of agricultural waste. Rather than developing entirely new technologies from scratch, the focus should be on adopting and adapting successful global models to the local context, particularly those that have demonstrated viability in similar socio-ecological settings.

In Malaysia, for example, palm oil mill effluent (POME) is routinely captured and treated in biodigesters to produce biogas for electricity generation, reducing both greenhouse gas emissions and dependence on fossil fuels (Yacob et al., 2018). Indonesia has scaled up the use of palm kernel shells and empty fruit bunches (EFBs) to produce biomass briquettes, which serve as an alternative fuel source for industrial use while creating employment opportunities, particularly for youth and women in rural communities (Putra & Hadiyanto, 2020).

In Nigeria, there are emerging but underreported efforts in states like Cross River and Edo, where smallholder cooperatives have begun converting palm biomass into compost and organic fertilizers for local vegetable farms (Okon & Akpan, 2021). These practices not only close nutrient loops but also generate new income streams for youth who traditionally had limited access to the formal economy.

Osun State could replicate and scale these models by fostering partnerships between local universities (e.g., Obafemi Awolowo University, Osun State University) and institutions like the International Institute of Tropical Agriculture (IITA), which has developed scalable composting and biogas solutions suitable for rural communities. Agencies such as the Raw Materials Research and Development Council (RMRDC) and the National Centre for Agricultural Mechanization (NCAM) can provide technical guidance and subsidies for equipment adaptation. Moreover, establishing youth-led waste-to-resource cooperatives—supported through policy incentives, grant funding, and

technical training—can create jobs in waste recovery, bio-composting, and biomass energy production. By positioning oil palm waste as a renewable input rather than a disposal challenge, Osun can advance both economic empowerment and environmental stewardship through a circular economy lens.

3. Strengthening Policies and Institution: To effectively mainstream circular economy principles within Nigeria's oil palm sector, particularly in Osun State, it is essential to build upon the existing national policy landscape while addressing its limitations. Currently, Nigeria lacks a unified national circular economy policy; however, relevant policy frameworks exist that indirectly support circularity. For instance, the National Bioeconomy Policy (2022) promotes sustainable biomass utilization and encourages the development of bio-based enterprises, particularly in agriculture and energy. Similarly, the National Renewable Energy and Energy Efficiency Policy (NREEEP, 2015) outlines the need for sustainable energy generation, including from agricultural waste — a key component of circularity in oil palm processing. At the state level, implementation remains fragmented. Osun State does not yet have a dedicated circular economy policy or strategy tailored to agricultural sectors. However, the State Agricultural Policy (SAP) emphasizes youth inclusion and value addition — offering an opportunity to integrate circular models such as waste-to-resource conversion and agro-industrial symbiosis.

In practice, enforcement mechanisms and stakeholder incentives remain weak. Despite the existence of the Environmental Impact Assessment (EIA) Act and the National Environmental Standards and Regulations Enforcement Agency (NESREA) guidelines, compliance within smallholder-dominated sectors like oil palm is limited due to low awareness and insufficient monitoring capacity (Umar et al., 2021). To bridge this gap, Osun State can design a Circular Economy Action Plan for Agriculture, integrating lessons from countries like Rwanda (Green Growth and Climate Resilience Strategy) and the EU (Circular Economy Action Plan). This should include:

1. Incentives: Tax breaks or subsidies for enterprises adopting circular technologies (e.g., composting, biomass fuel production).
2. Penalties: Fines for pollution or open burning of palm biomass.
3. Capacity building: Integration of CE modules in extension services and youth entrepreneurship programs.
4. Funding access: Establishment of a Circular Innovation Fund targeted at youth-led agri-businesses.
5. Such a comprehensive policy framework will help align the interests of producers, youth, environmental agencies, and investors toward a shared sustainability agenda.

4. Collaboration and Partnerships: Fostering partnerships among government, private sector, and local communities can enhance resource sharing, knowledge exchange, and the implementation of circular practices in oil palm cultivation (Adesina & Bell, 2019).

5. Certification Programs within the Oil Palm Value Chain

Certification schemes tailored specifically to the oil palm value chain are crucial for promoting sustainability, enhancing traceability, and increasing the competitiveness of youth-led enterprises. At the global level, the Roundtable on Sustainable Palm Oil (RSPO) provides the most recognized certification, with standards that cover plantation management, mill operations, supply chain traceability, and social safeguards. Although adoption in Nigeria remains limited, RSPO compliance can grant smallholders and youth-run enterprises access to export markets that increasingly demand sustainable palm oil.

At the regional level, Proforest's initiatives in West Africa support producers in meeting palm oil–specific sustainability benchmarks, such as High Conservation Value (HCV) assessments to protect biodiversity and Free, Prior and Informed Consent (FPIC) protocols to safeguard community rights. These are particularly relevant at the plantation and land acquisition stages, where youth cooperatives or startups may be involved in expansion.

For niche markets, certification schemes like the Nigeria Organic Agriculture Network (NOAN) and Ecocert validate environmentally friendly practices in palm oil processing, including circular methods such as organic composting and biomass recycling. While not palm oil–exclusive, these certifications add value in organic and fair-trade segments, creating premium opportunities for youth agripreneurs.

Integrating these certification pathways into Osun State's oil palm sector—through targeted youth training, subsidized audit costs, and public–private partnerships—could enhance youth participation by linking them to premium domestic and international markets. Youth cooperatives and agri-startups, in particular, stand to gain credibility, traceability, and financial advantage by pursuing palm oil–specific certifications that are aligned with circular economy principles.

Future interventions

Future interventions aimed at fostering youth participation in the circular economy within Osun State's oil palm sector should adopt a multifaceted and evidence-based approach. A critical first step involves the establishment of specialized circular economy training hubs within oil palm-producing regions. These hubs should be designed to equip young people with the technical, entrepreneurial, and sustainability skills necessary to innovate across the oil palm value chain. Moreover, there is a pressing need to promote blended finance mechanisms that combine concessional loans, grants, and equity instruments tailored to the unique needs and risk profiles of youth-led green enterprises. Integrating circular economy principles into national and sub-national oil palm development strategies—through inclusive, youth-centered co-design processes—can enhance policy ownership and effectiveness. Furthermore, the development of a comprehensive carbon-and-circularity reference database for agro-industrial enterprises would support data-driven monitoring, benchmarking, and policy refinement. Such a database could serve as a tool for measuring environmental performance, informing investment decisions, and guiding regulatory oversight in line with sustainable development goals.

CONCLUSION

This review set out with three objectives: first, to assess the extent of youth awareness and engagement in circular economy (CE) practices within Osun State's oil palm enterprises; second, to identify the barriers and opportunities shaping such participation; and third, to recommend actionable pathways for strengthening youth-led circular innovations.

With respect to the first objective, the review highlighted that while awareness of circular economy concepts among youth is gradually growing, practical engagement remains limited to small-scale activities such as composting and informal recycling. Addressing the second objective, the analysis identified fragmented policy frameworks, limited financing, and weak institutional coordination as critical barriers, even as opportunities exist in bioenergy, sustainable certification, and agro-waste valorization. Regarding the third objective, the review recommends three key interventions: the establishment of a circular economy Youth Task Force to provide leadership and coordination; the piloting of a "Circular Palm Tech Hub" in partnership with UNIDO for skill development and enterprise incubation; and the creation of a National Circular Economy Fund with explicit youth quotas to unlock access to finance.

By explicitly linking these recommendations to the identified gaps, this review emphasizes that aligning youth inclusion with circular practices requires coordinated efforts among government agencies, development partners, private firms, and youth organizations. If implemented, these pathways could position Osun State's oil palm sector as a model for inclusive and sustainable development in Nigeria and beyond.

REFERENCES

Adebayo, F.A., & Obayelu, O.A. (2021). What gets young Nigerians into farming. Journal of Sustainable Development, 14(3), 87–102. https://doi.org/10.5539/jsd.v14n3p87

Adebayo, M. A., Aciro, M., & Odugbesan, J. A. (2019). How sustainable farming impacts the money side in Nigeria. *Journal of Agricultural Economics*, 70(3), 512-525.

Adebayo, O. O., & Obayelu, A. E. (2021). Getting young people jobs in farming and countryside businesses: What's happening in Nigeria. African Journal of Economic Policy, 28(2), 55–72.

Adebayo, O. O., & Obayelu, A. E. (2021). Getting young people jobs in farming and countryside businesses: What's happening in Nigeria. African Journal of Economic Policy, 28(2), 55–72.

Adebayo, O. O., & Obayelu, A. E. (2021). Getting young people jobs in farming and countryside businesses: What's happening in Nigeria. African Journal of Economic Policy, 28(2), 55–72.

Adekola, G., Adesina, S., & Azeez, A. (2020). Young people getting involved in farming stuff in southwestern Nigeria. Journal of Rural Studies, 78, 281–289.

Adekola, G., Adesina, S., & Azeez, A. (2020). Young people getting involved in farming stuff in southwestern Nigeria. Journal of Rural Studies, 78, 281–289.

Adekola, G., Adesina, S., & Azeez, A. (2020). Young people getting involved in farming stuff in southwestern Nigeria. Journal of Rural Studies, 78, 281–289.

Adekola, O., Agboola, J., & Ilesanmi, F. (2020). Young people working with palm oil: what's going on in Nigeria. African Journal of Agricultural Research, 15(12), 1612–1622. https://doi.org/10.5897/AJAR2020.14773

Adesina, A. A., & Bell, J. (2019). Making farming last longer by teaming up: Why getting everyone involved matters. *Environmental Management Journal*, 24(4), 112-125.

Adeyemo, A. S., Lawal, A. K., & Adeyemi, K. (2020). How palm tree farms affect nature in Osun State, Nigeria. *Tropical Conservation Science*, 13, 1-11.

Adinugroho, W. S., Watanabe, H., & Suprayogi, A. (2021). The bad stuff in palm oil waste and your health. *International Journal of Environmental Research and Public Health*, 18(5), 2230.

Agyeman, B. A., & Mensah, J. V. (2022). Young people doing farming jobs: What West Africa can teach us. Journal of Agribusiness and Rural Development, 61(2), 112–124.

Agyeman, B. A., & Mensah, J. V. (2022). Young people doing farming jobs: What West Africa can teach us. Journal of Agribusiness and Rural Development, 61(2), 112–124.

Agyeman, E., & Mensah, S. (2022). How online stuff is helping small farmers with palm oil in Ghana. Sustainable Agriculture Review, 10(2), 55–68.

Ahmad, A. L., Ismail, S., & Bhatia, S. (2013). Reusing water from palm oil stuff with a special tool. Desalination, 157(1-3), 87–95. https://doi.org/10.1016/S0011-9164(03)00385-X

Ajayi, A. E., Adetunji, A. A., & Omotosho, A. A. (2020). The rules for making farming last. *Nigerian Journal of Policy Research*, 6(2), 67-80.

Ajayi, M. T., & Okunlola, J. O. (2020). Guys and girls getting different chances to own land and start farming businesses in Nigeria. Gender & Development Studies, 5(1), 65–78.

Bai, Y., Zhang, D., & Liu, H. (2020). Stickers that say this farm is good: How they change how people farm. *Journal of Cleaner Production*, 264, 121706.

Bernard, A., Olusola, A. A., & Offiong, J. (2020). What's stopping Nigeria from using old stuff to make new things. *Sustainable Development Overview*, 44(2), 129-145.

Business Beat 24. (2024). Nigeria's first smart farm city is changing the palm oil game. https://businessbeat24.com/nigerias-first-agro-smart-city-transforming-oil-palm-sector/

Business Today (2023). Palm Oil and Using Old Stuff Again. https://www.businesstoday.com.my

Chia, W. L., Jeffries, J., & Ng, A. (2020). Do people in the palm oil business know about making new things from old. *Journal of Sustainable Agriculture*, 12(1), 30-45.

Daniels, K. T., & Tsai, W. (2019). Cool ways to reuse palm tree waste. *Renewable Resources Journal*, 18(3), 143-152.

Eco-Business (2024). How IOI is trying to use old stuff to make new things. https://www.eco-business.com

Ellen MacArthur Foundation (2017). Why using old things to make new things makes cash and sense. https://www.ellenmacarthurfoundation.org

FAO (2019). What's happening with wasted food. Rome: Food and Agriculture Organization of the United Nations. http://www.fao.org/3/ca6030en/ca6030en.pdf

FAO. (2019). Helping young people put money into farming the right way. Food and Agriculture Organization.

FAO. (2019). Helping young people put money into farming the right way. Food and Agriculture Organization.

FMARD. (2020). How to run the National Young Farmers Scheme. Federal Ministry of Agriculture and Rural Development.

Frontiers in Sustainable Food Systems. (2025). How to decide what's best for palm oil that lasts and reuses stuff. https://doi.org/10.3389/fsufs.2025.1606323

Goh, C.J., & Asbi, Z. (2019). Getting small palm oil farmers in Malaysia to use clean power. Journal of Cleaner Production, 240, 118197. https://doi.org/10.1016/j.jclepro.2019.118197

Hassan, A. F., Ali, I., & Muda, M. (2018). How palm oil stuff affects nature in Nigeria. *African Journal of Environmental Science and Technology*, 12(4), 152-162.

Henkel & Solidaridad. (2024). Making life better for small farmers who grow palm oil. https://www.henkel.com/spotlight/2024-05-29-improving-the-livelihoods-of-smallholder-farmers-of-palm-oil-and-palm-kernel-oil-1961820

Ibrahim, M. F., Adu, M., & Umar, A. (2022). Why we need better rules for the palm oil business. *Journal of Policy Analysis*, 5(2), 188-200.

IFAD (International Fund for Agricultural Development). (2019). Giving country kids chances: 2019 Rural Development Report. Rome, Italy.

IFAD. (2021). ENABLE-TAAT: Helping African Young People with Farming Businesses. International Fund for Agricultural Development.

Igbokwe, E. M., Odoemelam, L. E., & Anazodo, U. G. (2019). Turning farm waste into cash in Nigeria: A look. African Journal of Environmental Science and Technology, 13(6), 205–216.

Jong, M., Barlow, K., & Adamson, G. (2019). Checking how palm tree farms affect nature. *Journal of Ecology and Development*, 28(1), 14-28.

Martins, R., Torres, F., & Silva, L. (2022). Heating up palm tree trash to make something cool in Brazil. Biomass Conversion and Biorefinery, 12, 321–330. https://doi.org/10.1007/s13399-021-02145-9

Ministry of Agriculture Indonesia (2022). What's happening with poop power plants at palm oil places. Jakarta: Ministry of Agriculture.

MOFA (Ministry of Food and Agriculture, Ghana). (2019). What's up with the Youth in Agriculture Program. Government of Ghana.

Nguessan, K., Amard, J. F., & Adou, S. (2021). Helping people know more about growing palm trees. *International Journal of Agricultural Science and Research*, 3(1), 9-20.

Obayelu, A. E., & Aiyede, R. E. (2021). Getting young people into farming in Nigeria: What the rules say. Nigerian Journal of Policy and Strategy, 7(1), 88–102.

Ogunlade, I., & Adeola, O. (2021). What's stopping people from farming palm trees that last. *Advances in Ecology and Environmental Sciences*, 9(1), 64-75.

Ojo, O. A., & Okeowo, L. A. (2020). Teaching people how to farm palm trees that last. *Nigerian Journal of Agricultural Education*, 12(2), 98-107.

Okafor, C. & Olaniyan, T. (2024). How to run things so young people can farm more in Nigeria's palm oil world. arXiv:2310.07789

Oke, A. O., Ayodele, A. I., & Adebayo, K. A. (2021). What's stopping poop power from catching on in rural Nigeria. Renewable Energy and Environmental Sustainability, 6(1), 7. https://doi.org/10.1051/rees/2021006

Oke, A. O., Ayodele, A. I., & Adebayo, K. A. (2021). What's stopping poop power from catching on in rural Nigeria. Renewable Energy and Environmental Sustainability, 6(1), 7.

Oke, A. O., Ayodele, A. I., & Adebayo, K. A. (2021). What's stopping poop power from catching on in rural Nigeria. Renewable Energy and Environmental Sustainability, 6(1), 7.

Oke, S.O., Oladele, O.I., & Oguntuase, A.M. (2021). The rules about trash from farming stuff and making it last in Nigeria. Environmental Policy and Governance, 31(4), 157–169. https://doi.org/10.1002/eet.1972

Okoye, B.C., Onyenweaku, C.E., & Ukoha, O.O. (2019). What palm oil makers in Anambra State know about tech. Journal of Agricultural Extension, 23(2), 47–60. https://www.ajol.info/index.php/jae/article/view/182322

Olarewaju, T. O., Musa, M. A., & Okonkwo, I. (2020). How palm oil stuff messes up nature in Nigeria and how to reuse the trash. Journal of Cleaner Production, 261, 121–134.

Olowu, T. A., Hassan, M. B., & Ayoola, J. B. (2022). What's stopping young people from getting into the palm oil business in Nigeria. Journal of Agricultural Extension and Rural Development, 14(2), 49–58.

Onukwuli, O. D., Ude, C. N., & Obumselu, F. O. (2021). Turning palm oil poop into fuel: A look at Imo State, Nigeria. Nigerian Journal of Engineering Science and Technology (NIJEST), 6(2), 339–347.

RSPO (2023). Using Old Stuff and Nature's Trash. https://rspo.org

Samuel, O. S., Akintola, K., & Ibraheem, O. (2022). Ways to turn trash into power on farms. *Renewable Energy Innovations*, 45(1), 12-25.

Saputra, H., Nugroho, Y., & Rahman, T. (2020). Using palm oil poop for power in Indonesian palm oil places: what it can do and what's hard. Renewable Energy, 147, 1465–1474. https://doi.org/10.1016/j.renene.2019.10.033

Solidaridad (2023). Cool Palm Oil Place in Ghana that Saves the Planet. https://www.solidaridadnetwork.org

Solidaridad Network. (2024). Fighting for palm oil that lasts in Nigeria. https://www.solidaridadnetwork.org/news/advocacy-in-action-stakeholders-pull-for-sustainable-oil-palm-in-nigeria/

Sulaiman, A., & Abdul, S. (2022). What helps and hurts small farmers who want to use old stuff to make new things with palm oil. Journal of Environmental Management, 332, 116728. https://doi.org/10.1016/j.jenvman.2022.116728

Tappi, S.A., Rahman, N.A., & Wood, G.M. (2021). New stuff in using nature's trash: making the most of palm tree waste. Journal of Cleaner Production, 280, 124230. https://doi.org/10.1016/j.jclepro.2020.124230

The Guardian (2025). Good Things Youth Spots Do for Society and the Economy. https://www.theguardian.com

Times of India (2025). Young people in Telangana are waiting to join the job market. https://timesofindia.indiatimes.com

Umar, A., Ozoemena, E. A., & Eze, A. (2021). Asking for stronger rules to make farming last. *Agriservice Journal*, 19(3), 118-130.

UNEP (2020). Using Old Stuff in Farming: What's Happening Worldwide. Nairobi: United Nations Environment Programme. http://www.unep.org/resources/report/circular-economy-food-and-agriculture-sectors-global-synthesis

World Bank (2020). Young People Getting Jobs in Africa: What's Hard and What Helps. Washington, DC: World Bank. https://documents.worldbank.org/en/publication/documents-reports/documentdetail/939761594993673291/youth-employment-in-sub-saharan-africa-challenges-and-opportunities

World Bank. (2020). Helping Young People in Africa Get into Farming Businesses.