

# Assessment of Youth Participation and Institutional Support in Circular Economy Practices for Sustainable Oil Palm Development in Osun State, Nigeria

Journal of Management and  
Social Sciences  
© The Author 2025  
Reprints and permission  
jmseditorial@gmail.com

**Adams, Adeola Sylvester**

Osun State University, Osogbo, Nigeria

**Kehinde, Adetunji Lawrence**

Osun State University, Osogbo, Nigeria

## Abstract

Circular economy practices are increasingly promoted as sustainable responses to climate change, resource depletion, and linear production systems. In Osun State, Nigeria, the oil palm enterprise remains economically significant but faces challenges such as environmental degradation, weak institutional coordination, and limited youth involvement in sustainable innovation. This study examined youth participation in circular economy practices within oil palm enterprises and assessed the influence of institutional support in promoting sustainable development. A survey of 654 respondents across major oil palm-producing settlements in Ife, Ilesa, Irewole, and Ayedaade Local Government Areas employed descriptive statistics, cross-tabulation, correlation, and regression analyses. Findings revealed that 42.2% of youths were moderately to highly engaged in circular economy activities, while 57.8% showed minimal participation. Institutional interventions significantly enhanced involvement, with government support ( $\beta = 0.756$ ) showing stronger predictive power than NGO assistance ( $\beta = 0.158$ ), jointly explaining 72.2% of the variation in participation. Financial limitations, market access challenges, and knowledge gaps were major constraints. The study concludes that youth-led innovation, supported by institutional capacity and indigenous knowledge systems, is essential for achieving Sustainable Development Goals (SDGs) 8, 12, and 13. These findings imply that integrating Circular Economy training into agricultural extension services, strengthening youth-targeted funding, and promoting policy incentives for waste valorization can enhance both environmental sustainability and rural employment in Osun State. Strengthening training, and funding can unlock youth potential as key drivers of circular transformation in Nigeria's oil palm sector.

## Keywords

Youth participation, circular economy, oil palm enterprises, sustainable development, Institutional support

## Corresponding author:

Adeola Sylvester Adams, Sustainable Development Practice, Global Affairs and Sustainable Development Institute (GASDI), Osun State University, Osogbo, Nigeria  
Email: adeola.adams@pgc.unisoun.edu.ng

## Introduction

Global production and consumption patterns are exerting intense pressure on ecosystems, driving climate change, biodiversity loss, and resource scarcity (Wackernagel & Beyers, 2019; Lipson et al., 2019). These challenges underscore the urgent need to transition from linear production systems to circular economy models that minimise waste, extend product lifecycles, and regenerate resources (Velenturf & Purnell, 2021). Beyond ecological gains, circular economy promises economic growth, job creation, and social inclusion (European Commission, 2014; Jaeger-Erben et al., 2021). However, effective implementation requires the active participation of governments, private enterprises, civil society, and especially youth, whose creativity and innovation are vital for systemic change.

Despite this potential, the sector continues to face challenges including land degradation, post-harvest losses, and inefficient waste management (Bissonnette, 2016; Folanmu et al., 2019). The implications of these challenges extend beyond Osun State, as they limit Nigeria's domestic palm oil output, increase reliance on imports, and undermine national efforts toward economic diversification and rural industrialization. Integrating circular economy principles—such as recycling oil-palm residues into organic fertilisers, biogas, and biochar—could reduce waste, lower emissions, and enhance value addition, thereby contributing to national sustainable development and the achievement of the SDGs.

Empirical studies on youth participation in agricultural transformation across Nigeria (Ezeh et al., 2019; Akinbile & Adekunle, 2021) demonstrate that institutional support—through training, funding, and extension services—significantly enhances youth engagement and productivity. This gap underscores the need to explore how youth-driven circular innovations, supported by effective institutions, can contribute to both state-level sustainable development and national economic diversification goals under Nigeria's Green Economy Policy and the SDGs.

Against this backdrop, this study investigates youth participation in circular economy practices within Osun State's oil palm enterprises. Specifically, it examines the factors influencing youth involvement, the role of government and NGOs in promoting participation. The findings are expected to provide empirical insights for strengthening local governance, expanding green entrepreneurship, and advancing Nigeria's national agenda for inclusive and sustainable growth.

## Literature Review

The transition from linear to circular economy systems has become a central theme in contemporary sustainability discourses. The European Commission (2014) and subsequent global initiatives link circular economy directly to the achievement of the United Nations Sustainable Development Goals (SDGs), especially SDG 12 on responsible consumption and production. Scholars argue

that circular economy not only contributes to ecological resilience but also stimulates innovation, green entrepreneurship, and social inclusion (Jaeger-Erben et al., 2021; Geng et al., 2019). Recent global studies further emphasise circular economy's role in agri-food systems, highlighting its potential to valorize agricultural residues, reduce post-harvest losses, and support climate-smart farming (Badjeena, 2024; Adesua-Lincoln, 2025).

### ***Circular Economy and Agriculture***

Agriculture presents significant opportunities for circular economy adoption due to the prevalence of biological cycles and biomass reuse. Research highlights practices such as composting, bioenergy production, recycling of crop residues, and innovative waste-to-resource technologies as critical strategies for sustainable agricultural transitions (Ohimain, & Izah, 2014; Chiemela et al., 2021). In oil palm enterprises, residues like empty fruit bunches, palm oil mill effluent, and palm kernel shells are increasingly recognised as valuable resources for organic fertilizer, renewable energy, and industrial raw materials (Adegbite et al., 2020; Zhen et al., 2021). By integrating circular economy principles, smallholder farmers and agro-industries can simultaneously reduce environmental footprints and enhance profitability (Lemille, & Desmond, 2020).

### ***Youth Participation in Circular Economy***

Youth involvement in circular economy is widely acknowledged as a cornerstone for long-term sustainability. With their innovation, adaptability, and openness to new technologies, young people can play critical roles in green entrepreneurship and regenerative agricultural practices (Dunmade et al., 2019; Strapchuk, 2022). In sub-Saharan Africa, youth engagement in circular economy has been linked to the adoption of sustainable agricultural innovations and inclusive rural development (Uduji & Okolo-Obasi, 2019). However, barriers such as limited access to finance, inadequate training, and weak institutional support persist, constraining youth contributions (Damjac Krajnc, & Kovacic, 2022).

### ***Circular Economy and Oil Palm in Nigeria***

Nigeria, a historical leader in oil palm production, has witnessed a decline in productivity and competitiveness due to weak governance, policy inconsistencies, and under-investment (Soyebo et al., 2005; Bissonnette, 2016). However, oil palm remains a sector with immense potential for circular economy integration, particularly in states like Osun, where palm oil cultivation forms the economic backbone of many rural communities (Folayanmu et al., 2019).

According to the Osun State Ministry of Agriculture (2023), over 28,000 hectares of land are under oil palm cultivation across Ife South, Irewole, Ilesa East, Ayedaade, and Atakumosa Local Government Areas, providing livelihoods for more than 40,000 smallholder farmers and processors. The prominence of oil palm in Osun's local economy, coupled with the state's youthful demographic profile—where youths account for approximately 60% of the agricultural workforce (NBS, 2023)—makes it a strategic location for assessing how young people can drive circular economy-oriented innovations in the agricultural sector. Furthermore, the state hosts several agricultural extension and empowerment programmes, such as the Osun Rural Enterprise and Agricultural Program (O-REAP) and Osun Youth Empowerment Scheme (O-YES), which provide institutional backing for rural entrepreneurship. Hence, Osun State provides an appropriate and representative context for exploring the dynamics of youth participation, institutional support, and circular economy adoption in Nigeria's oil palm sector.

Recent Nigerian studies affirm that circular economy principles can improve agricultural sustainability outcomes, yet practical adoption remains low due to limited awareness, weak institutional coordination, and inadequate funding mechanisms (Adebayo et al., 2024; Quadri et al., 2024b). Previous works on youth participation in agriculture have shown that institutional support significantly determines the success of youth-led initiatives. For instance, Ezeh et al. (2019) and Akinbile and Adekunle (2021) found that access to credit, extension services, and government incentives increased youth engagement in agribusiness ventures across Southwestern Nigeria. Similarly, Okafor et al. (2020) revealed that poor coordination among agencies and inconsistent youth policies constrained young people's involvement in green innovation and circular economy initiatives. However, there is limited evidence on how these factors manifest in Osun State's oil palm value chain, where circular opportunities such as palm waste recycling, bioenergy production, and organic composting could create sustainable livelihoods if properly institutionalised.

The implications of these findings for national development are profound. Strengthening youth participation and institutional capacity in Osun State's oil palm sector could boost Nigeria's domestic palm oil output, reduce dependence on imports, and promote value addition through renewable energy and bio-based industries. At the macro level, such initiatives would advance Sustainable Development Goals (SDGs) 8 (Decent Work and Economic Growth), 12 (Responsible Consumption and Production), and 13 (Climate Action) by linking local agricultural innovation with national sustainability objectives. Therefore, understanding the intersection of youth involvement, and circular economy adoption in Osun State provides actionable insights for policy formulation, investment prioritization, and inclusive green growth strategies across Nigeria.

### ***Recent Nigeria-Specific Contributions (2023–2025)***

Recent scholarship underscores Nigeria's gradual but uneven progress in adopting circular economy practices. Quadri et al. (2024a, 2024b) demonstrate that circular economy adoption among Nigerian agribusinesses is constrained by infrastructural gaps, limited awareness, and lack of incentives. Awobajo et al. (2025) highlight barriers specific to SMEs in Lagos, including poor financing structures and inadequate technical capacity, which are equally relevant to agricultural enterprises. Similarly, Adebayo et al. (2024) and Oluwatayo (2024) emphasise youth's role in sustainable agripreneurship, but caution that structural barriers—such as limited access to land and weak market linkages—remain persistent.

Adesua-Lincoln (2025) and Badjeena (2024) further argue that circular economy adoption must integrate indigenous knowledge systems and localised innovations to ensure inclusivity. Together, these recent studies confirm both the potential and the persisting gaps in circular economy adoption within Nigeria's agricultural value chains.

### ***Critical Evaluation and Research Gaps***

Globally and regionally, there is broad consensus that circular economy enhances resource efficiency, reduces waste, and supports inclusive growth, with potential to generate employment for young people (Merli et al., 2018; Velenturf & Purnell, 2021; Badjeena, 2024). Empirical studies in Nigeria also highlight opportunities for youth involvement in agribusiness and waste valorisation, as seen in donor-led initiatives. (Quadri et al., 2024b; CBN, 2024).

However, the literature also reveals inconsistencies and limitations. While several works underscore the importance of youth in circular economy-driven agribusiness, their actual participation remains low due to policy, financial, and institutional barriers (Adebayo et al., 2024; Awobajo et al., 2025). Studies on SMEs and green entrepreneurship acknowledge circular economy's potential but often treat youth as a homogeneous group, neglecting local variations in motivation, access to resources, and indigenous knowledge systems (Oluwatayo, 2024; Adesua-Lincoln, 2025).

The major gaps identified are threefold:

1. **Contextual gap:** Most Nigerian studies focus on general agriculture or SMEs, with limited attention to the oil palm enterprise, despite its socio-economic and environmental importance.
2. **Demographic gap:** There is little systematic research on youth-specific participation in circular economy practices within oil palm value chains,

even though youths represent the majority of Nigeria's agricultural labour force.

3. **Institutional gap:** Although donor and government programmes exist, empirical evidence is scarce on how policies, and local innovations either enable or constrain youth engagement in circular economy.

Addressing these gaps is crucial because Nigeria's oil palm sector, particularly in states like Osun, faces dual challenges of high youth unemployment and underutilised circular economy opportunities. This study, therefore, provides original insights by assessing youth participation in circular economy for sustainable development in oil palm enterprises in Osun State, bridging the intersection between youth studies, circular economy discourse, and sustainable agriculture.

## Methodology

### *Questionnaire Administration*

To address the contextual limitations of purely quantitative designs, the study adopted a mixed-method empirical approach, combining structured surveys with key informant interviews (KIIs) to ensure comprehensive and up-to-date data coverage. This approach enabled both statistical analysis and deeper insights into the socio-cultural and institutional dynamics influencing youth participation in circular economy practices within the oil palm sector of Osun State.

The study population comprised male and female youths, parents, and oil palm farmers across farm settlements in the three senatorial districts of Osun State. A multi-stage sampling procedure was employed to ensure representativeness and data adequacy. In the first stage, Iwo, Ayedire, Ayedaade, Ila, Odo Otin, Ife North, and Obokun Local Government Areas (LGAs) were selected through simple random sampling because of their high concentration of oil palm farmers and youth-led processing activities. In the second stage, Ede North, Ede South, Ifelodun, Irepodun, Boluwaduro, Ilesa East, Ife Central, and Ife South were selected using purposive sampling, given their institutional presence (extension offices, youth empowerment centres, and farmer cooperatives).

The sample size was determined using Yamane's (1967) formula for finite populations, applying a 95% confidence level and a 5% margin of error to an estimated population of 1,200 active youth and farmer participants in the oil palm value chain across the selected LGAs. This computation yielded a minimum of 300 respondents, which was increased to 500 to ensure broader coverage and compensate for potential non-responses. Accordingly, forty (40) respondents were drawn from each of the major settlements, including Oluponna, Mokore/Ago-Owu, Fatona, Iresi, Oyere, Esa Oke, Aba Ede, Odesomi, and Alaga, while institutional representatives were purposively selected from OSSADEC (10), OSSADEP (10), Ministry of Youth and Sports

(5), Ministry of Agriculture (10), All Farmers Association of Nigeria (AFAN) (10), and the Community and Social Development Agency (CSDA) (5).

To strengthen the validity of findings, key informant interviews (KIIs) were conducted with traditional rulers, cooperative leaders, and representatives of farmer associations in major oil palm-producing communities.

Data adequacy and reliability were ensured through multiple data sources, including questionnaires, interviews, and institutional reports, as well as pilot testing of instruments for consistency.

S/N	Local Governments	Total Population	Selection at 50%
1.	Ayedire Local Government	80	40
2.	Ayedaade	80	40
3.	Ede North	80	40
4.	Ede South	80	40
5.	Iwo	80	40
6.	Ila	80	40
7.	Odo Otin	80	40
8.	Ifelodun	80	40
9.	Irepodun	80	40
10.	Boluwaduro	80	40
11.	Ife North	80	40
12.	Obokun	80	40
13.	Ilesa East	80	40
14.	Atakunmosa West	80	40
15.	Ife South	80	40
	Total	1,200	600

**Source:** Ministry of Agriculture, Osun State Government, Nigeria (November 2023)

S/N	Ministry Department, Agency and Associations	Total Population	Selection at 50%
1.	OSSADEP	20	10
2.	OSSADEC	20	10
3.	AFAN	20	10
4.	Ministry of Agriculture	20	10
5.	Youths	10	5
6.	CSDA	18	9
	Total	108	54

Sample Size

As shown in Table 1, a total of 654 valid responses were obtained from the field survey, indicating a robust and reliable data set for analysis. There were no missing responses across the key socio-demographic variables (gender, age, and

education level), which suggests effective questionnaire administration and respondent engagement during data collection.

The respondents' mean age was 26.83 years, with a standard deviation of 4.58, reflecting that most participants were young adults. The age range (22–52 years) shows that while the study primarily targeted youths, it also included some older participants who are active within the oil palm value chain. The concentration of respondents in the youth category (typically 18–35 years) aligns with the study's objective of examining youth participation in circular economy practices within the oil palm enterprise.

Overall, the demographic profile presented in Table 1 establishes a strong foundation for the subsequent analysis of youth participation in circular economy practices. It demonstrates that the study successfully captured a representative cross-section of young individuals who are central to advancing circular economy initiatives in Osun State's oil palm sector.

**Table 1: Socio-Demographic Characteristics of Respondents Statistics**

		<b>Gender</b>	<b>Age</b>	<b>Education Level</b>
N	Valid	654	654	654
	Missing	0	0	0
Mean			26.83	
Std. Deviation			4.578	
Minimum			22	
Maximum			52	

**Field Survey: 2025**

As presented in Table 2, the distribution of respondents by gender reveals that 471 respondents (72.0%) were female, while 183 respondents (28.0%) were male. This indicates a clear gender disparity in participation, with women constituting the majority of those engaged within the oil palm enterprise across the surveyed areas of Osun State.

The predominance of female respondents suggests that women play a significant role in oil palm processing and related value-chain activities, particularly in small-scale and household-based enterprises where palm oil production, kernel processing, and by-product utilisation are common. This finding aligns with previous research emphasizing that women are often more active in post-harvest, value addition, and marketing segments of agricultural enterprises (Adelekan, & Omotayo, 2021).

The relatively lower participation of males may be attributed to the migration of young men to urban centres in search of formal employment, leaving women to dominate the rural-based agro-processing sectors. It may also reflect traditional gender roles in oil palm communities, where men focus on plantation management and cultivation, while women oversee processing and trade-related activities.

Therefore, the gender composition illustrated in Table 2 highlights the critical importance of empowering women and addressing gender-specific constraints in the design and implementation of circular economy programs. Strengthening female participation through capacity-building, financial inclusion, and technology access could enhance the sustainability and inclusiveness of circular economy practices in the oil palm value chain.

**Table 2: Socio-Demographic Characteristics of Respondents by Gender**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	471	72.0	72.0	72.0
	Male	183	28.0	28.0	100.0
	Total	654	100.0	100.0	

**Field Survey: 2025**

As shown in Table 3, the age distribution of respondents reveals that the majority fall within the youthful working-age group. Specifically, 25.8% of respondents were 30 years old, while 21.1% were 26 years old, and 18.2% were 22 years old. Collectively, these three age categories account for more than 65% of the total sample, signifying that the study population is predominantly composed of young adults. Only a very small fraction of respondents (less than 2%) were aged above 40 years, with the oldest being 52 years.

This age profile underscores the centrality of youth in the oil palm enterprise in Osun State. Youths constitute the most active and innovative demographic segment, often more willing to explore new technologies, circular practices, and environmentally friendly methods compared to older generations. The concentration of respondents within the 22–30 age range aligns with Nigeria’s national youth classification and supports the study’s focus on assessing youth participation in circular economy practices.

The relatively small representation of older respondents (aged 38 and above) suggests that while traditional knowledge still exists among the older generation, active production and innovation roles are shifting toward younger participants. This generational transition could serve as a leverage point for promoting sustainability-focused entrepreneurship if adequate training and institutional support mechanisms are put in place.

Overall, the age distribution presented in Table 3 confirms that the oil palm value chain in Osun State remains youthful, energetic, and potentially adaptive to circular economy innovations — key ingredients for advancing sustainable development goals in the agricultural sector.

**Table 3: Socio-Demographic Characteristics of Respondents Age**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	22	119	18.2	18.2	18.2
	24	109	16.7	16.7	34.9
	26	138	21.1	21.1	56.0
	27	94	14.4	14.4	70.3
	30	169	25.8	25.8	96.2
	38	1	.2	.2	96.3
	40	3	.5	.5	96.8
	42	6	.9	.9	97.7
	44	3	.5	.5	98.2
	45	4	.6	.6	98.8
	46	1	.2	.2	98.9
	48	3	.5	.5	99.4
	49	1	.2	.2	99.5
	50	1	.2	.2	99.7
	52	2	.3	.3	100.0
Total	654	100.0	100.0		

**Field Survey: 2025**

As shown in Table 4, the educational profile of respondents reveals a diverse range of formal and vocational learning backgrounds. Out of the 654 respondents, the highest proportion, 267 individuals (40.8%), attained secondary education, followed by 150 respondents (22.9%) with primary education. Additionally, 107 respondents (16.4%) had no formal education, while 78 respondents (11.9%) possessed vocational training, and 52 respondents (8.0%) attained tertiary education.

This distribution suggests that the majority of participants possess basic to intermediate levels of formal education, which may influence their capacity to understand, adopt, and implement circular economy principles in their oil palm-related activities. The relatively high proportion of respondents with secondary and vocational education indicates that many youths are literate, technically inclined, and capable of participating in skill-oriented and innovation-driven enterprises.

The presence of a sizeable group without formal education (16.4%) also highlights the continuing need for non-formal and community-based extension programmes that simplify circular economy practices for broader inclusion. Such initiatives can ensure that even less-educated farmers and processors are not excluded from sustainability-oriented interventions.

Furthermore, the small share of tertiary-educated respondents (8.0%) reflects the limited attraction of university graduates to the oil palm subsector, possibly due to perceptions of farming and processing as low-income or labour-intensive. Nevertheless, the growing emphasis on agribusiness, green

entrepreneurship, and circular innovation presents opportunities to re-engage educated youth in sustainable agriculture through targeted policy incentives.

In summary, the data in Table 4 illustrate that while most respondents possess adequate foundational education to engage in circular practices, investment in practical training and knowledge transfer remains essential to bridge skill gaps and fully harness the potential of youth-led sustainability initiatives in the oil palm value chain.

**Table 4: Socio-Demographic Characteristics of Respondents Education Level**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No Formal	107	16.4	16.4	16.4
	Primary	150	22.9	22.9	39.3
	Secondary	267	40.8	40.8	80.1
	Tertiary	52	8.0	8.0	88.1
	Vocational	78	11.9	11.9	100.0
	Total	654	100.0	100.0	

Field Survey: 2025

### ***Participation in Circular Economy Activities***

This section presents the analysis of youth participation in circular economy activities within oil palm enterprises in Osun State. The analysis includes descriptive statistics on participation levels and explores the relationship between participation and training through cross-tabulation.

### ***Distribution of Respondents by Participation Level***

Out of the 654 respondents as shown in Table 5, 281 individuals (43.0%) reported a participation level of 1, indicating very low or no active involvement in circular economy initiatives. 97 individuals (14.8%) had a participation level of 2, showing minimal engagement. 96 respondents (14.7%) were rated at participation level 3, reflecting moderate involvement. 180 respondents (27.5%) reported the highest level of participation (level 4), suggesting significant engagement with circular economy practices. In total, about 42.2% (levels 3 and 4 combined) of the youth were actively participating in circular economy activities to varying degrees. However, a larger proportion (57.8%) were less engaged (levels 1 and 2). This suggests that although there is encouraging evidence of youth involvement in circular economy practices, a significant proportion of young people remain marginally engaged or entirely inactive. These low to moderate participation levels may be symptomatic of broader

systemic issues that hinder youth integration into sustainable enterprise development. Common barriers include limited access to technical training, inadequate financial support, insufficient infrastructure, and restricted market entry—factors frequently highlighted in studies on youth participation in agriculture and green entrepreneurship (Adelekan & Omotayo, 2021). Without targeted interventions to address these structural constraints, the potential of youth to drive innovation and sustainability within the circular economy may remain underutilised.

### ***Identifying the factors that influence youth participation in circular economy initiatives in the oil palm enterprise for sustainable development in Osun State***

As presented in Table 5, the cross-tabulation between participation level and government support provides valuable insight into the extent to which institutional interventions influence youth engagement in circular economy practices within the oil palm enterprise. The data reveal a clear and direct relationship between government support and the level of participation among respondents.

All 281 respondents (100%) who reported no government support (coded as 1) were at the lowest participation level (Level 1), indicating minimal or no involvement in circular economy activities. Conversely, all 96 respondents (100%) who reported moderate government support (coded as 2) were found at participation level 3, reflecting a stronger degree of engagement. Likewise, among respondents who reported strong government support (coded as 3), 97 (35.0%) were at participation level 2, while 180 (65.0%) reached the highest participation level (Level 4).

This pattern demonstrates a strong positive association between government support and youth participation. The more assistance youths receive—through grants, extension services, equipment, or capacity-building—the greater their likelihood of being actively involved in circular economy initiatives such as recycling, waste valorization, and renewable resource management.

These findings align with the Theory of Planned Behaviour (TPB), which posits that external support and enabling environments can strengthen behavioural intentions and actual participation. They also reinforce earlier studies (e.g., FAO, 2022; UNDP, 2023) emphasising that governmental involvement is a key determinant of youth engagement in green and circular enterprises.

In summary, the results in Table 5 confirmed that effective and consistent government support serves as a critical driver for motivating and sustaining youth participation in circular economy practices across Osun State's oil palm sector. Strengthening these institutional linkages can enhance both individual capacity and collective sustainability outcomes.

**Table 5: Distribution of respondents on Participation Level \*Govt Support Crosstabular**

		Govt Support			Total
		1	2	3	
Participation Level	1	281	0	0	281
	2	0	0	97	97
	3	0	96	0	96
	4	0	0	180	180
Total		281	96	277	654

***Training Received and Participation Level***

Table 6 which showed the relationship between training received and participation level was examined using cross-tabulation. Among the 106 respondents who had not received training, the majority (56 respondents or 52.8%) were at participation level 1. Only 4 respondents (3.8%) reached participation level 4.

In contrast, among the 548 respondents who received training, 225 individuals (41.1%) were still at level 1. However, a much higher number—176 respondents (32.1%)—achieved participation level 4. These results show a clear pattern: those who received training were significantly more likely to report higher levels of participation in circular economy activities. In fact, 95.6% of those at the highest participation level (180 individuals) had received training, while only 4.4% had not.

**Table 6: Cross-Tabulation of Training Received and Participation Level**

Participation Level	No Training Received	Training Received	Total
Level 1 (Low participation)	56 (52.8%)	225 (41.1%)	281
Level 2 (Moderate-low participation)	5 (4.7%)	92 (16.8%)	97
Level 3 (Moderate participation)	41 (38.7%)	55 (10.0%)	96
Level 4 (High participation)	4 (3.8%)	176 (32.1%)	180
Total	106 (100%)	548 (100%)	654

Field Survey: 2025

**Note:** The majority (95.6%) of respondents at the highest participation level had received training, demonstrating a strong positive link between training exposure and engagement in circular economy practices.

As shown in Table 7, the relationship between NGO support and participation level provides further evidence of how institutional engagement influences youth involvement in circular economy activities within the oil palm enterprise in Osun State. The table indicates a progressive and positive relationship between increasing levels of NGO support and higher levels of participation.

Among the 164 respondents who reported receiving no NGO support (coded as 1), the majority, 117 respondents (71.3%), were at the lowest participation level (Level 1). In contrast, none of these respondents were found at the highest participation level. Respondents who experienced moderate NGO support (coded as 2) were distributed across participation levels 2 and 3, with 57 respondents each, reflecting moderate engagement. Notably, all 180 respondents (100%) at the highest participation level (Level 4) had received strong NGO support (coded as 3).

In summary, Table 7 reinforces the argument that NGO support substantially enhances youth participation in circular economy practices, complementing governmental efforts and bridging gaps in policy implementation. Strengthening partnerships between NGOs, government agencies, and local youth groups is therefore essential for expanding the adoption of circular economy principles within Osun State's oil palm sector.

**Table 7: Distribution of respondents on Participation Level \*NGO Support Crosstabulation**

		NGO Support			Total
		1	2	3	
Participation Level	1	164	0	117	281
	2	0	57	40	97
	3	0	57	39	96
	4	0	0	180	180
Total		164	114	376	654

As presented in Table 8, the correlation analysis explores the statistical relationships among participation level, government support, and NGO support in circular economy practices among youths engaged in the oil palm enterprise in Osun State. The results reveal strong and statistically significant positive correlations between these variables, indicating that institutional support—both governmental and non-governmental—has a direct influence on youth participation levels.

Specifically, the correlation coefficient between Participation Level and Government Support was  $r = 0.839$  ( $p < 0.01$ ), denoting a very strong positive relationship. This implies that as the level of government support increases, the

degree of youth participation in circular economy initiatives also rises substantially. The correlation between Participation Level and NGO Support was  $r = 0.553$  ( $p < 0.01$ ), signifying a moderate but significant positive relationship. Furthermore, Government Support and NGO Support were also positively correlated ( $r = 0.523$ ,  $p < 0.01$ ), suggesting complementarity between the efforts of both institutions in promoting sustainable youth engagement.

In conclusion, Table 8 provides robust empirical evidence that both government and NGO supports are positively and significantly associated with youth participation in circular economy practices. The combined influence of these institutions strengthens youth empowerment, fosters innovation, and contributes to the sustainability of oil palm enterprises in Osun State.

**Table 8: Distribution of Respondents on Participation Level**  
**\*Government Support \*NGO Support Crosstabulation**

Correlations				
		Participation Level	Govt Support	NGO Support
Participation Level	Pearson Correlation	1	.839**	.553**
	Sig. (2-tailed)		.000	.000
	N	654	654	654
Govt Support	Pearson Correlation	.839**	1	.523**
	Sig. (2-tailed)	.000		.000
	N	654	654	654
NGO Support	Pearson Correlation	.553**	.523**	1
	Sig. (2-tailed)	.000	.000	
	N	654	654	654

Correlation is significant at the 0.01 level (2-tailed)

As shown in Table 9, the multiple linear regression analysis was conducted to determine the combined influence of government and NGO support on the participation level of youths in circular economy practices within the oil palm enterprise of Osun State. The results indicate a strong predictive relationship between institutional support and youth engagement in circular economy activities.

The Model Summary shows a correlation coefficient (R) of 0.849, representing a very strong association between the independent variables (government and NGO support) and the dependent variable (participation level). The  $R^2$  value of 0.722 implies that approximately 72.2% of the variation in youth participation can be explained by government and NGO support combined, while the remaining 27.8% is attributed to other factors not captured in the model, such as access to markets, peer influence, or socio-economic background.

The ANOVA results confirm the overall model significance, with  $F(2, 651) = 843.63$  and  $p < 0.001$ , indicating that the regression model provides a statistically significant explanation of the relationship between institutional support and participation level. This means that government and NGO supports jointly have a meaningful impact on youth engagement in circular economy activities.

The coefficients table further reveals that both independent variables make significant contributions to the model. Government support recorded a standardised beta coefficient ( $\beta$ ) of 0.756 ( $p < 0.001$ ), while NGO support had  $\beta = 0.158$  ( $p < 0.001$ ). These findings indicate that government support exerts a stronger influence on youth participation than NGO support, though both remain important predictors

The regression equation derived from the model is:  
 "Participation Level" =  $-0.348 + 1.038$  ("Government Support") +  $0.235$ ("NGO Support")

This equation indicates that, holding other factors constant, a one-unit increase in government support leads to a 1.038 increase in youth participation level, while a similar increase in NGO support results in a 0.235 rise.

Table 9 underscores that institutional support is a powerful determinant of youth participation in circular economy activities within the oil palm sector. Strengthening multi-level collaboration between government agencies and NGOs is therefore essential for enhancing youth-led sustainability and achieving broader circular economy objectives in Osun State.

**Table 9: ANOVAa and Model Summary (Regression Analysis)**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.849 <sup>a</sup>	.722	.721	.670

a. Predictors: (Constant), NGO\_Support, Govt\_Support

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	757.791	2	378.896	843.627	.000 <sup>b</sup>
	Residual	292.382	651	.449		
	Total	1050.173	653			

a. Dependent Variable: Participation\_Level

b. Predictors: (Constant), NGO\_Support, Govt\_Support

Coefficients<sup>a</sup>

Model	Unstandardised Coefficients	Standardised Coefficients	t	Sig.
-------	-----------------------------	---------------------------	---	------

		B	Std. Error	Beta		
1	(Constant)	-.348	.080		-4.374	.000
	Govt_Support	1.038	.033	.756	31.166	.000
	NGO_Support	.235	.036	.158	6.496	.000

a. Dependent Variable: Participation\_Level

### ***Relationship between Government and NGO Support, Training, and Participation Level***

This section discusses the role of institutional support (government and NGOs) and training access in influencing the level of youth participation in circular economy initiatives within oil palm-based enterprises. The analysis relies on descriptive statistics and cross-tabulation results to illustrate the nature of these relationships.

#### ***Descriptive Statistics on Institutional Support***

The results showed in Table 10 that the level of government support received by respondents ranged from 1 (no support) to 3 (strong support), with a mean score of 1.99 and a standard deviation of 0.924. Similarly, NGO support ranged from 1 to 3, with a mean score of 2.32 and a standard deviation of 0.850. These findings suggest that, on average, respondents reported moderate levels of institutional support, with NGO support slightly higher than government support.

This implies that while institutional involvement in supporting youth-led sustainability efforts exists, there is still room for expanding outreach and support mechanisms, particularly from the public sector. Investigating government and NGOs in the involvement of youth in the circular economy in the oil palm enterprise for sustainable development in Osun State.

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Govt_Support	654	1	3	1.99	.924
NGO_Support	654	1	3	2.32	.850
Valid N (listwise)	654				

### ***Cross-tabulation: Participation Level by Government Support***

The cross-tabulation of participation level and government support in table 11 reveals a perfectly aligned relationship, as follows: All 281 respondents (100%) who reported no government support (coded as 1) were at participation level 1, the lowest level. All 96 respondents (100%) who reported moderate government support (coded as 2) were at participation level 3. All 277 respondents (100%) who reported strong government support (coded as 3) were at participation levels 2 and 4, with 97 respondents (35.0%) at level 2 and 180 respondents (65.0%) at level 4.

This result demonstrates a clear and direct association between increasing levels of government support and higher participation levels. It suggests that government interventions—including training, grants, and infrastructure provision—are critical enablers of active youth engagement in circular economy practices.

**Table 11: Descriptive Statistics and Correlation Analysis of Participation Level, Government Support, and NGO Support**

S/N	Variable	Mean	Standard Deviation (SD)	1	2	3
1.	Participation_Level	2.27	1.27	1		
2.	Govt_Support	1.99	0.92	.839**	1	
3.	NGO_Support	2.32	0.85	.553**	.523**	1

**Note.** N = 654. Correlation is significant at the 0.01 level (2-tailed).

### ***Regression Analysis***

Table 12 showed a multiple linear regression model was conducted to assess the combined effect of government and NGO support on participation level. The model summary indicated:

$R = 0.849$ , indicating a strong correlation.

$R^2 = 0.722$ , meaning that 72.2% of the variance in participation level was explained by government and NGO support.

The ANOVA test showed the model was statistically significant:  $F(2, 651) = 843.63$ ,  $p < .001$ .

In terms of coefficients: Government support had a standardised beta of 0.756, and NGO support had a standardised beta of 0.158, both with p-values  $< 0.001$ .

The regression equation is: Participation Level =  $-0.348 + 1.038$  (Govt Support) +  $0.235$ (NGO Support).

This model shows that government support has a stronger predictive effect on youth participation compared to NGO support, although both are statistically significant.

**Table 12: Multiple Linear Regression Results Showing the Combined Effect of Government and NGO Support on Youth Participation Level**

Model Summary	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate	
Model 1	0.849	0.722	0.721	0.670	

  

ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Regression	757.79	2	378.90	843.63	.000**
Residual	292.38	651	0.45		
Total	1050.17	653			

  

Coefficients	Unstandardised B	Std. Error	Standardised Beta	t	Sig.
(Constant)	-0.348	0.080	—	-4.374	.000**
Govt_Support	1.038	0.033	0.756	31.166	.000**
NGO_Support	0.235	0.036	0.158	6.496	.000**

Regression Equation:

$$\text{Participation Level} = -0.348 + 1.038(\text{Govt Support}) + 0.235(\text{NGO Support}).$$

**Note:** Dependent variable: Participation Level.  $p < 0.01$  (2-tailed).

Model Summary	R	R <sup>2</sup>	Adjusted R <sup>2</sup>	Std. Error of the Estimate
Model 1	0.849	0.722	0.721	0.670

## Summary, Conclusion and Recommendation

### Summary

This study was undertaken to assess Youth Participation and Institutional Support in Circular Economy Practices for Sustainable Oil Palm Enterprise Development in Osun State, Nigeria, with particular focus on youth participation, government and NGO support for youth involvement. Data were collected from 654 respondents, and analyses were conducted using descriptive statistics, cross-tabulations, correlation, and regression analyses.

Participation levels in circular economy activities varied widely. Descriptive analysis showed a mean participation score of 2.27, indicating moderate engagement. Only 27.5% of respondents reported high participation, while 43.0% were at the lowest level. Training played a critical role in influencing participation. Of those who had received training, 32.1% attained participation level 4, compared to only 3.8% of untrained respondents. This underscores the effectiveness of skill development programmes in boosting youth involvement in sustainable enterprise activities.

Institutional support emerged as a strong determinant of participation. Youths who received government or NGO support were significantly more likely to participate actively in circular economy initiatives. The mean government support score was 1.99, while NGO support was slightly higher at 2.32, indicating moderate access to assistance. Correlation analysis confirmed these relationships: participation correlated strongly with government support ( $r = .839$ ,  $p < 0.01$ ) and moderately with NGO support ( $r = .553$ ,  $p < 0.01$ ). Regression results revealed that government support ( $\beta = 0.756$ ) was a stronger predictor than NGO support ( $\beta = 0.158$ ), jointly explaining 72.2% of participation variance. Indigenous knowledge was also recognised as a valuable resource (mean = 3.75), indicating high acceptance of traditional practices in oil palm enterprises. The major barriers identified included financial constraints (mean = 3.63), market access limitations (mean = 3.60), and knowledge gaps (mean = 3.30).

### Discussion of Findings

The findings of this study provide critical insights into the dynamics of youth engagement in circular economy practices within Osun State's oil palm enterprise. The strong correlation between government support and participation level ( $r = .839$ ) indicates that institutional mechanisms significantly determine the extent of youth engagement in circular economy. Where training, grants, or extension services were accessible, participation was markedly higher. This validates the assertion of Okafor et al. (2020) that institutional incentives play a pivotal role in enabling youth-led sustainability transitions. However, the relatively lower coefficient of NGO support ( $\beta = 0.158$ ) highlights fragmentation

in non-state interventions, emphasising the need for stronger coordination between governmental and non-governmental actors.

The high acceptance of indigenous knowledge (mean = 3.75) confirms that local wisdom and traditional practices continue to underpin sustainable oil palm management. Low youth participation has several socio-economic implications for Osun State. Limited engagement in circular economy constrains innovation, job creation, and value addition in the oil palm sector—key components of the state’s rural economy. It also perpetuates linear production models that deplete resources and exacerbate waste problems. Strengthening youth involvement would thus not only promote environmental sustainability but also enhance income generation, reduce rural unemployment, and stimulate green entrepreneurship—directly contributing to Osun State’s economic diversification agenda and Nigeria’s Sustainable Development Goals.

## Conclusion

This study critically examined the extent and determinants of youth participation in circular economy initiatives within oil palm enterprises in Osun State, Nigeria. The findings revealed that although youth participation was generally moderate, engagement was significantly influenced by access to training, and institutional support. Institutional support, especially from government and NGOs, emerged as the strongest predictor of participation, confirming that enabling environments are vital to sustainability transitions. Indigenous knowledge was also found to complement circular economy practices, providing culturally embedded models for resource recovery and waste minimisation. The study concludes that empowering Osun State youth through institutional backing, funding, and circular economy education will catalyse sustainable growth in the oil palm sector and contribute to broader climate and development goals.

## Contribution to Knowledge

This study makes significant contributions to both theoretical understanding and practical advancement of circular economy and sustainable agricultural development in Nigeria.

**Empirical Advancement:** It provides the first comprehensive, data-driven assessment of youth participation in circular economy practices within oil palm enterprises in Osun State. By quantifying participation levels, institutional influence, and the roles of training and indigenous knowledge, this study bridges a critical empirical gap in circular economy scholarship, especially within Nigeria’s agricultural context.

**Model Development:** The study develops a predictive model showing how government and NGO support jointly explain 72.2% of the variation in youth participation. These advances understanding of institutional determinants of youth-led sustainability and provides a replicable framework for similar studies.

**Integration of Indigenous Knowledge and circular economy Theory:** By incorporating indigenous knowledge systems into circular economy discourse, the study extends circular economy theory beyond industrial and urban applications to rural agrarian contexts. It demonstrates how traditional ecological practices can strengthen circular economy implementation in developing regions.

**Policy and Practice Contribution:** The findings offer evidence-based recommendations for policymakers and development practitioners on how to enhance youth inclusion in circular economy through targeted training, and resource access mechanisms.

**Contribution to Sustainable Development Discourse:** The research aligns circular economy participation with the SDGs, contributing to the global dialogue on how youth empowerment and institutional synergy drive sustainable transformation in Sub-Saharan Africa.

In essence, this study provides a context-specific, evidence-based, and theoretically grounded understanding of how institutional mechanisms, youth innovation, and indigenous knowledge interact to drive circular transformation in Nigeria's oil palm sector, marking a substantial contribution to the fields of youth development, circular economy, and sustainable agriculture.

## References

- Adebayo, O., Adeniyi, O., & Salisu, A. (2024). Youth participation in agribusiness for sustainable development in Nigeria. *African Journal of Agricultural Economics and Development*, 19(2), 55–70.
- Adebite, S. O., Ajibade, O. T., & Alade, O. S. (2020). Circular economy practices and sustainable palm oil processing in Nigeria. *Journal of Cleaner Production*, 265, p. 121777. <https://doi.org/10.1016/j.jclepro.2020.121777>.
- Adelekan, I. O., & Omotayo, A. M. (2021). Gender dynamics and post-harvest participation in smallholder oil palm enterprises. *Journal of Rural and Agricultural Studies*, 14(4), 45–58.
- Adesua-Lincoln, A. (2025). Circular economy and SME sustainability in Nigeria: Barriers and opportunities. *Sustainability*, 17(1), 122–136. <https://doi.org/10.3390/su17010122>.

- AFAN. (2024). *Annual report on farmer associations and youth participation in Osun State*. Osogbo: All Farmers Association of Nigeria (AFAN).
- Akinbile, L. A., & Adekunle, O. (2021). Influence of institutional support on youth participation in agribusiness in Southwestern Nigeria. *Nigerian Journal of Agricultural Economics*, 12(2), 47–58.
- Awobajo, A. A., Oladipo, O. A., & Ojo, T. (2025). Barriers to youth engagement in sustainable agriculture in Nigeria: Policy and institutional perspectives. *International Journal of Agricultural Development*, 27(1), 33–49.
- Badjeena, M. (2024). Green entrepreneurship and youth employment in sub-Saharan Africa: A circular economy perspective. *Development in Practice*, 34(5), 731–743. <https://doi.org/10.1080/09614524.2024.2399444>.
- Bissonnette, J.-F. (2016). Beyond the biofuel debate: Palm oil and farmer livelihoods in Southeast Asia. *Journal of Rural Studies*, 45, p. 34–42. <https://doi.org/10.1016/j.jrurstud.2016.03.009>.
- Central Bank of Nigeria (CBN). (2024). *CBN reintroduces oil palm intervention fund*. Abuja: CBN Press Release.
- Chiemela, S. N., Opara, U. N., & Ede, O. P. (2021). Circular economy in agriculture: Recycling organic wastes for soil fertility management in Nigeria. *Journal of Environmental Management*, 298, p. 113450. <https://doi.org/10.1016/j.jenvman.2021.113450>.
- Damjac Krajnc, A., & Kovacic, I. (2022). Barriers to circular economy transition: The role of education and youth involvement. *Journal of Environmental Education*, 53(6), 429–441. <https://doi.org/10.1080/00958964.2022.2095401>.
- Dunmade, I. S., Adeyemi, O. O., & Adebayo, R. A. (2019). Youth innovation and sustainable development in Nigeria's circular economy. *Journal of Innovation and Development*, 8(3), 205–217.
- European Commission. (2014). *Towards a circular economy: A zero waste programme for Europe*. COM (2014) 398 final. Brussels: European Commission.
- Ezeh, A. N., Anyanwu, C. F., & Okorie, I. C. (2019). Institutional determinants of youth participation in agriculture in South-East Nigeria. *Journal of Agricultural Extension*, 23(4), 12–25. <https://doi.org/10.4314/jae.v23i4.2>.
- FAO. (2019). *Youth in motion for climate action in agriculture*. Food and Agriculture Organization of the United Nations. <https://www.fao.org/3/ca5545en/ca5545en.pdf>.
- FAO. (2022). *Engaging youth in sustainable and circular agriculture: Global best practices*. Rome: Food and Agriculture Organization of the United Nations. <https://www.fao.org/3/cb9475en/cb9475en.pdf>.

- Folayanmu, T., Adeoti, J., & Ogunjimi, S. (2019). Value chain analysis of oil palm in Nigeria: Implications for food security and sustainability. *Nigerian Journal of Agricultural Extension*, 20(2), 55–65.
- Geng, Y., Sarkis, J., & Bleischwitz, R. (2019). Global perspectives on industrial ecology and circular economy. *Resources, Conservation and Recycling*, 141, p. 1–2.
- Henckens, M. L. C. M., Driessen, P. P. J., Ryngaert, C. M., & Worrell, E. (2016). Mineral resources: Geological scarcity, market price trends, and future generations. *Resources Policy*, 49, p. 102–111. <https://doi.org/10.1016/j.resourpol.2016.04.012>.
- Ishola, F. A., Ogunyemi, A. O., & Ajani, E. N. (2020). Integrating indigenous knowledge into sustainable agriculture in Nigeria. *Journal of Rural Development Studies*, 5(2), 77–89.
- Jaeger-Erben, M., Jensen, C., Hofmann, F., & Zwiers, J. (2021). There is no sustainable circular economy without a social dimension. *Sustainability*, 13(11), 6346. <https://doi.org/10.3390/su13116346>.
- Kehinde, A. T., Odu, B., & Salami, S. (2024). Technological innovation and the adoption of circular economy practices in Nigeria's agricultural sector. *Journal of Agribusiness Innovation*, 12(2), 101–119.
- Lebreton, L., & Andrady, A. (2019). Future scenarios of global plastic waste generation and disposal. *Marine Pollution Bulletin*, 142, p. 15–23. <https://doi.org/10.1016/j.marpolbul.2019.03.021>.
- Lemille, A., & Desmond, P. (2020). The circular economy in Africa: Opportunities for inclusive growth. *African Journal of Sustainable Development*, 10(1), 1–14.
- Lipson, M., Lee, K., & Andersson, J. (2019). Global consumption patterns and sustainability transitions. *Environmental Research Letters*, 14(11), 114012. <https://doi.org/10.1088/1748-9326/ab4c2f>.
- Massari, S., & Ruberti, M. (2013). Rare earth elements as critical raw materials: Focus on international markets and future strategies. *Resources Policy*, 38(1), 36–43. <https://doi.org/10.1016/j.resourpol.2012.07.001>.
- Merli, R., Preziosi, M., & Acampora, A. (2018). How do scholars approach the circular economy? A systematic literature review. *Journal of Cleaner Production*, 178, p. 703–722.
- NBS. (2023). *Labour force statistics: Youth employment and underemployment report, Q4 2023*. Abuja: National Bureau of Statistics, Nigeria. <https://www.nbs.gov.ng>.
- Ohimain, E. I., & Izah, S. C. (2014). Energy generation from palm oil mill effluent: A case study of Nigerian palm oil industry. *Renewable and Sustainable Energy Reviews*, 37, p. 240–252. <https://doi.org/10.1016/j.rser.2014.05.010>.
- Okafor, C., Udeh, C., & Onwuka, E. (2020). Youth involvement in sustainable agriculture: A case study of oil palm farmers in Southeast Nigeria. *Nigerian Journal of Rural Sociology*, 21(1), 88–97.

- Oluwatayo, I. B. (2024). Circular economy and sustainable agricultural practices in Nigeria: Policy implications. *African Development Review*, 36(S1), 211–223. <https://doi.org/10.1111/1467-8268.12712>.
- Quadri, H. A., Olayemi, A., & Bello, M. (2024a). Youth-led innovations in waste management and circular economy in Nigeria. *Journal of Environmental Management*, 352, p. 119876. <https://doi.org/10.1016/j.jenvman.2024.119876>.
- Quadri, H. A., Olayemi, A., & Bello, M. (2024b). Impact of Feed the Future intervention on youth and women agribusiness participation in Northeast Nigeria. *Food Policy*, 124, p. 102656. <https://doi.org/10.1016/j.foodpol.2024.102656>.
- Soyebo, A., Farinde, A. J., & Dionco-Adetayo, E. A. (2005). Constraints of oil palm production in Nigeria: A farmer's perspective. *African Journal of Agricultural Research*, 1(1), 1–8.
- Strapchuk, S. (2022). Youth engagement and innovation in the circular economy: Global lessons for Africa. *Sustainability*, 14(15), 9655. <https://doi.org/10.3390/su14159655>.
- Uduji, J. I., & Okolo-Obasi, E. N. (2019). Corporate social responsibility initiatives in Nigeria and youth participation in agriculture. *Sustainable Development*, 27(4), 692–703. <https://doi.org/10.1002/sd.1923>.
- UNDP. (2022). *Empowering youth for circular innovation in Africa*. United Nations Development Programme. <https://www.undp.org>.
- UNDP. (2023). *Green jobs and youth empowerment in Africa: Policy pathways for sustainability*. United Nations Development Programme. <https://www.undp.org>.
- Velenturf, A. P. M., & Purnell, P. (2021). Principles for a sustainable circular economy. *Sustainable Production and Consumption*, 27, p. 1437–1457. <https://doi.org/10.1016/j.spc.2021.02.018>.
- Wackernagel, M., & Beyers, B. (2019). *Ecological footprint: Managing our biocapacity budget*. New Society Publishers.
- World Bank. (2023). *Promoting circular economy in Nigeria's agri-food systems*. Washington, DC: The World Bank. <https://www.worldbank.org>.
- Zhen, L., Gao, C., & Jiang, Y. (2021). Circular utilization of palm biomass residues: Environmental and economic perspectives. *Journal of Cleaner Production*, 315, p. 128166. <https://doi.org/10.1016/j.jclepro.2021.128166>.