



Research Commons

Publisher

Sustainability for Regions

FROM OPPORTUNITY TO STRATEGY: FUTURE SCENARIOS FOR NIGERIA–EU SCIENCE, TECHNOLOGY, AND INNOVATION COLLABORATION**Leonardo Piccinetti ¹, Trevor Uyi Omoruyi ², Donatella Santoro ³, Mohammed Mahgoub Hassan ⁴, Irie Vroh Bi ⁵, Mohamed Ramadan A. Rezk ⁶**¹ Sustainable Innovation Technology Services Ltd, Ducart Suite, Castletroy, Ireland² Chester Business School, Queens Park Campus, Chester, United Kingdom³REDINN, Italy⁴ National Center for Sustainable Agriculture Research and Development (Estidamah), Riyadh, Saudia Arabia⁴ National Center for Research, Ministry of Higher Education and Scientific Research, Sudan⁵The African Observatory for Science, Technology and Innovation (AOSTI), Malabo, Equatorial Guinea⁵Academy of Scientific Research and Technology (ASRT), 11516, Cairo, EgyptE-mails: ¹leonardo@sinnovations.org; ²t.omoruyi@chester.ac.uk; ³donatella@sinnovations.org; ⁴mohkadis74@gmail.com; ⁵vrohbi@africanunion.org; ⁶mm Ramadan79@gmail.comReceived 25 February; accepted the 2nd May, 2026; published 30 June 2026

Abstract. Science, Technology, and Innovation (STI) have become central to international partnerships in the knowledge economy, particularly in addressing shared development challenges. Within this context, collaboration between Nigeria and the European Union (EU) presents important opportunities for strengthening research cooperation, innovation ecosystems, and technological development. Yet, despite growing policy momentum and expanding scientific engagement, this cooperation remains uneven and often fragmented across institutions, sectors, and funding mechanisms. This paper examines the future trajectory of Nigeria–EU STI collaboration through an integrated analytical framework combining bibliometric analysis, qualitative content analysis, PEST analysis, and scenario planning. Drawing on evidence from 8,468 Nigeria–EU co-authored publications published between 2020 and 2025, the study identifies the main thematic areas of cooperation and the key political, economic, social, and technological drivers shaping the partnership. Based on these drivers, three plausible future scenarios for collaboration by 2040 are developed: Green–Digital Leap, Uneven Pathways, and Drifting Apart. The findings show that Nigeria–EU STI cooperation has a strong foundation in public health, climate and sustainability, governance, education, and emerging digital fields, but its long-term effectiveness will depend on stronger political commitment, more stable and diversified funding, improved institutional and technological capacity, and broader participation across the innovation system. The paper concludes that a more strategic, inclusive, and challenge-oriented partnership could transform Nigeria–EU STI cooperation from fragmented project-based engagement into a resilient framework for co-innovation, capable of advancing sustainable development, green transition, and digital transformation by 2040.

Keywords: Nigeria–EU collaboration; science diplomacy; innovation systems; research partnerships; scenario planning; PEST analysis

Reference to this paper should be made as follows: Piccinetti, L., Omoruyi, T.U., Santoro, D., Hassan, M.M., Bi, I.V., Rezk, M.R.A. 2026. From opportunity to strategy: future scenarios for Nigeria–EU science, technology, and innovation collaboration. *Insights into Regional Development*, 8(2), 95-119. <http://doi.org/10.70132/b5535332757>

JEL Classifications: O2, O31, O32

Additional disciplines: management, public administration

1. Introduction

International cooperation in science and technology enhances the integration and utilisation of global resources, promotes innovation, and strengthens national economic performance. Stable international and regional collaboration networks also support rapid scientific development and improve a country's competitive position in the global arena (Wang et al., 2022). More broadly, collaborative research, innovation, and education initiatives across countries accelerate technological progress and contribute to sustained economic growth through the exchange of knowledge and expertise (Figueiredo et al., 2026; Thach, 2025). Since the late 2000s, the Joint Africa–EU Strategy (JAES) and major African policy frameworks, such as the Science and Technology Consolidated Plan of Action (2005–2014) and the 2007 Addis Ababa Declaration, have encouraged the Africa–EU partnership to prioritise scientific and technological collaboration while promoting both South–South and North–South cooperation in science, technology, and innovation (STI) (Dosso et al., 2022).

Scientific production in Africa is characterised by a high level of international collaboration, although these partnerships often remain uneven in structure and benefit distribution (Confraria et al., 2016). Nevertheless, collaborative networks play an important role in generating knowledge spillovers and strengthening innovation systems across African countries (Toivanen & Ponomarev, 2011). This cooperation has also been institutionalised in strategic sectors. For example, the Africa–EU Energy Partnership, established under the JAES, formalised collaboration on key energy issues and was supported by substantial EU investment in energy access and infrastructure, including more than €12 billion for African, Caribbean, and Pacific countries and targeted mechanisms such as the ACP–EU Energy Facility (Tichý et al., 2022). Similarly, the Pan-African GMES and Africa Support Programme has strengthened African decision-making capacity through Earth Observation services by improving access to data, informing policy, and building institutional and private-sector capabilities (Speranza et al., 2022). Beyond sectoral initiatives, Africa and the EU also cooperate in international fora to address shared global challenges, including climate change, energy security, and sustainable development, through alliances in organisations such as the UNFCCC and OECD (Dodo, 2014). Since 2003, European countries have further expanded research collaboration with sub-Saharan Africa, particularly in poverty-related diseases such as HIV/AIDS, tuberculosis, and malaria. These partnerships have been supported by initiatives such as the European & Developing Countries Clinical Trials Partnership and the EU Research Framework Programmes. This collaboration has produced highly cited research outputs, with greater citation impact than non-collaborative or exclusively intra-African studies (Breugelmans et al., 2018).

The ARISE (African Research Initiative for Scientific Excellence) partnership illustrates this trajectory, as it was established under the AU–EU High-Level Policy Dialogue framework. Aligned with STISA-2024 and Agenda 2063, ARISE aims to strengthen the capacities of African scientists and research institutions while mobilising resources for African development and maintaining European engagement through collaborative networks (Mutua et al., 2025). More broadly, the EU has created multiple scientific and technical agreements globally to provide formal frameworks for research cooperation, with programmes such as Horizon Europe underscoring its commitment to advancing international scientific collaboration and supporting researchers (Di Luca et al., 2021). Within this broader Africa–EU context, Nigeria represents a particularly important case for examining bilateral STI cooperation. Nigeria is a developing country in West Africa, bordered by Benin to the west, Niger to the north, and Chad and Cameroon to the east (Dabara & Chiwuzie, 2022). It possesses considerable development potential, supported by abundant natural resources and a large human-capital base (Grutman & Burnett, 2026). Nigeria has an estimated population of more than 200 million people, with reported figures ranging from approximately 200 million to 216 million, and a population density of about 226 persons per km² (Olaomi et al., 2026). It is also recognised as one of the continent's leading economies, with a GDP estimated between \$472.62 billion and \$522.638 billion (Siéwé et al., 2023; Olabisi et al., 2025). Nigeria's economy is anchored in petroleum, agriculture, trade, and services, alongside an expanding digital and entrepreneurial sector (Ilori et al.,

2002; Abodunde & Jegede, 2020). In science and technology, the country has developed universities, research institutes, innovation hubs, and policy frameworks intended to enhance research and development, build technological capacity, and improve national competitiveness (Abodunde & Jegede, 2020). According to recent studies, STI policy, digital innovation, and technical entrepreneurship are becoming increasingly important to Nigeria's economic transformation (Adeleke, 2021; Rezk et al., 2024).

Nigeria's domestic economic structure reflects a combination of resource dependence and gradual diversification across multiple sectors. While petroleum remains a dominant contributor, agriculture and services also play significant roles in shaping overall economic performance, as illustrated in Figure 1.

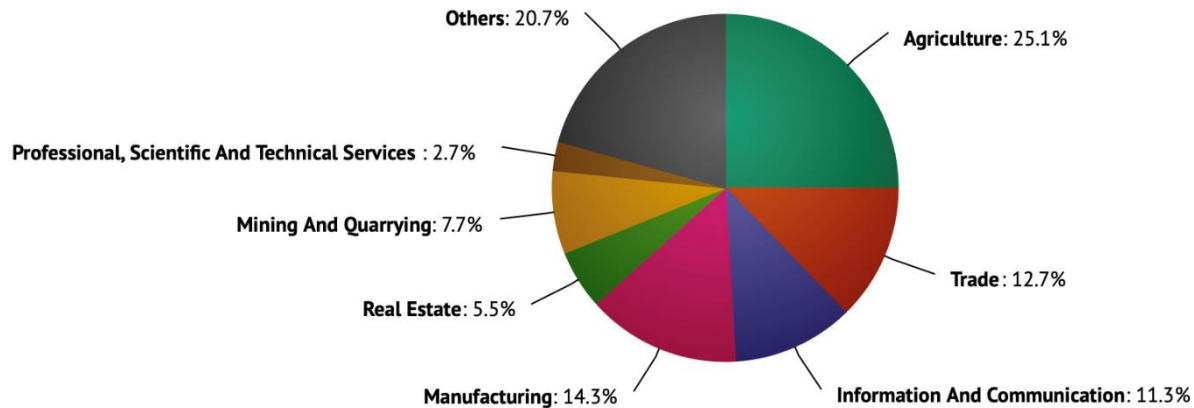
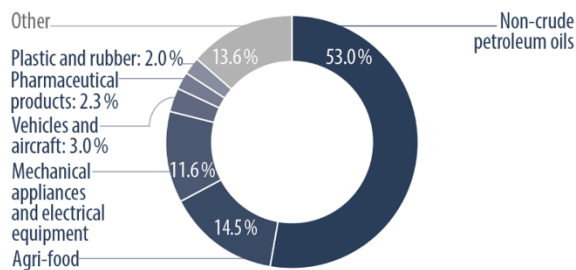


Figure 1. Nigeria's Gross Domestic Product by Economic Activity (% of GDP)

Source: National Bureau of Statistics, 2026

Nigeria's external economic relations, particularly with the European Union, further reveal structural features that shape the context of bilateral cooperation. As illustrated in Figure 2, EU imports from Nigeria are overwhelmingly concentrated in crude petroleum oils and gas, accounting for most trade flows, whereas EU exports to Nigeria are more diversified and include non-crude petroleum products, agri-food goods, and mechanical and electrical equipment. This pattern reflects a persistent asymmetry in which Nigeria continues to export primarily raw or low-value-added commodities while importing more sophisticated industrial and technological products. Such an imbalance underscores the strategic importance of strengthening cooperation in science, technology, and innovation as a pathway toward economic diversification, technological upgrading, and improved integration into higher-value segments of global production and trade.

EU exports of goods to Nigeria (2021)



EU imports of goods from Nigeria (2021)

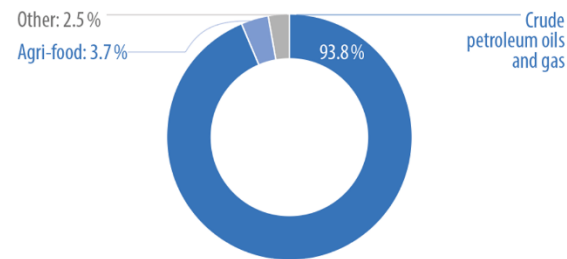


Figure 2. Structure of EU–Nigeria trade in goods by sector (2021).

Source: Members' Research Service, 2025

The collaboration between Nigeria and the European Union in science, technology, and innovation has entered a more institutionalised phase, moving beyond adhoc and project-based engagements toward a formal governance framework. This shift is closely aligned with the broader objectives of the AU–EU Innovation Agenda (2023–2033), which seeks to mobilise STI as a key instrument for addressing shared global challenges and advancing sustainable development. In this context, the European Commission and the Federal Republic of Nigeria opened negotiations for a bilateral Science and Technology Cooperation Agreement intended to strengthen collaboration in research and innovation, in line with the outcomes of the 2023 EU–Nigeria Strategic Dialogue and the 2024 EU–Nigeria Summit. The proposed agreement is expected to provide a structured political mechanism for assessing earlier cooperation, drawing lessons from experience, and jointly defining future priorities consistent with bilateral objectives and the AU–EU Innovation Agenda (The AU-EU Innovation Agenda, 2023).

This institutional deepening has coincided with the second EU–Nigeria Science and Innovation Day, held in Lagos on 24 February 2026, which brought together researchers, entrepreneurs, investors, and policymakers to showcase the growing dynamism of the partnership. More broadly, cooperation in STI has expanded under the Joint EU–Nigeria Roadmap that emerged from the 7th EU–Nigeria Ministerial Meeting in 2020. This growing engagement is reflected in Nigeria’s increasing participation in Horizon Europe and the Global Health European and Developing Countries Clinical Trials Partnership 3 (EDCTP3). To date, 55 Horizon Europe projects involving Nigerian entities have been funded, representing 65 participations by Nigerian organisations and approximately €20 million in support, mainly in health, food, agriculture, and environmental fields. In parallel, Nigeria has participated in 12 EDCTP3 projects with a total value of around €75 million, while 15 Nigeria-based organisations involved in these projects have received approximately €9 million (European Commission, 2026; The AU-EU Innovation Agenda, 2023).

More broadly, EU–Nigeria cooperation in STI is embedded within a wider strategic partnership centered on green and digital transformation, governance reform, human development, and inclusive economic growth. Under the EU’s current external cooperation framework, engagement with Nigeria is tied to the Global Gateway strategy, through which STI is framed not as an isolated sector but as a cross-cutting driver of economic diversification, institutional modernisation, and sustainable development. This orientation is reflected in the Multiannual Indicative Programme for Nigeria 2021–2027, which identifies three main priority areas: Green and Digital Economy; Governance, Peace and Migration; and Human Development. Within this framework, the EU allocated €508 million for the 2021–2024 phase of bilateral cooperation, with funding for 2025–2027 to be determined following a review, while the broader grant envelope for the 2021–2027 partnership amounts to €731 million. Nigeria also benefits from several regional EU programmes, including the €10.2 billion programme for Sub-Saharan Africa over the same period (EEAS, 2021; European Commission, 2025).

Table 1. Main dimensions of collaboration between the European Union and Nigeria, 2021–2027.

Dimension	Main Focus of EU–Nigeria Collaboration
Strategic framework	A long-term strategic partnership based on shared values, mutual interests, and common objectives for 2021–2027
Green and digital economy	Support for economic diversification, private-sector-led growth, job creation, digitalisation, and green transition
Migration and mobility	Joint action on migration, forced displacement, and mobility issues
Human development	Investment in Nigeria’s human capital, especially for youth, women, and girls
Research and innovation	Promotion of science, innovation, and knowledge-based development
Business and investment	Enhancing trade relations and positioning the EU as a key commercial and investment partner
Cooperation mechanism	Coordinated delivery through the “Team Europe” approach

Source: European Commission, 2025

At the intercontinental level, the AU–EU framework for research and innovation cooperation is progressively influencing this bilateral partnership. The first R&I Ministerial Meeting of the AU–EU High-Level Policy Dialogue on Science, Technology and Innovation identified four priority areas for joint action: public health, green transition, innovation and technology, and capacities for science. The ministers also agreed to advance a joint AU–EU Innovation Agenda, reflecting a strategic shift toward impact-oriented cooperation designed to strengthen innovation ecosystems, institutional capacities, and scientific competences across both continents. In this sense, the emerging paradigm of AU–EU research and innovation cooperation emphasises not merely joint investment in knowledge production, but also the generation of tangible societal and developmental impact on the ground (European Commission, 2022).

Despite this growing policy and institutional momentum, an important analytical gap remains. Existing studies have largely focused on policy frameworks, funding instruments, sector specific initiatives, or descriptive assessments of Africa–EU and EU–Nigeria cooperation. Far less attention has been paid to how Nigeria–EU STI relations may evolve under conditions of uncertainty shaped by technological disruption, climate pressures, and changing geopolitical dynamics. Limited research has systematically examined the future trajectories of this partnership through a scenario-based analytical approach. This gap is significant because the transition from fragmented, project-based cooperation to a resilient and strategic long-term partnership depends not only on current institutional commitments, but also on the ability of both parties to anticipate and respond to emerging structural transformations.

This paper argues that the future of Nigeria–EU STI cooperation will be shaped by a combination of interrelated political, economic, social, and technological drivers, whose interaction may produce different pathways for collaboration. While current efforts focus on immediate priorities such as agricultural resilience, digital inclusion, and public health, the long-term success of the partnership will depend on the ability of policymakers and institutional actors to navigate broader global shifts, including the rapid advancement of artificial intelligence, the deepening of the climate crisis, and the shifting dynamics of global geopolitics (Hauck et al., 2019). By studying possible future scenarios, policymakers and researchers can identify the critical uncertainties that will shape the science, technology, and innovation landscape, allowing for the co-creation of adaptive strategies that ensure the Nigeria–EU partnership remains an engine for sustainable and inclusive growth in a world of high uncertainty. Accordingly, this study seeks to examine the future evolution of cooperation between Nigeria and the European Union in the fields of science, technology, and innovation (STI), with particular attention to its possible transition from a fragmented, project-based form of engagement to a more strategic, institutionalised, and sustainable long-term partnership by 2040. Using an integrated analytical framework that combines bibliometric evidence, PEST analysis, and scenario planning, the study identifies the key drivers and critical uncertainties shaping Nigeria–EU STI cooperation and assesses a set of plausible future pathways for its development. In this way, the study contributes to the literature on international STI partnerships by providing a structured methodological basis for forward-looking analysis and by offering insights that may help policymakers, researchers, and institutional actors design more adaptive, resilient, and mutually beneficial forms of cooperation.

2. The current collaboration Nigeria – EU countries

This section analyses the current landscape of scientific collaboration between Nigeria and European Union member states by examining Scopus-indexed 8,468 co-authored publications produced from 2020 to 2025. Drawing on bibliometric mapping and qualitative content analysis, it explores the structure of collaboration networks, identifies the main thematic areas shaping bilateral research partnerships, and assesses the extent to which the resulting knowledge contributes to addressing key societal challenges.

2.1. Network Patterns and Thematic Specialisation in Nigeria–EU Scientific Collaboration

From 2020 to 2025, Nigeria demonstrated a strong pattern of scientific collaboration with European Union member states, generating 8,468 co-authored publications. As illustrated in the VOSviewer co-authorship network

(Figure 3), The collaboration profile was led by Germany, Italy, France, the Netherlands, and Spain, which collectively represented nearly half of Nigeria's total EU-linked co-authored output. This distribution suggests that Nigeria's research engagement with Europe is both significant and concentrated, relying primarily on established partnerships with major European research systems. Nevertheless, the presence of collaborative output across all EU member states indicates a broad transnational network. These findings reflect the strategic importance of EU–Nigeria research ties and suggest considerable scope for strengthening collaboration with a wider range of European partners.

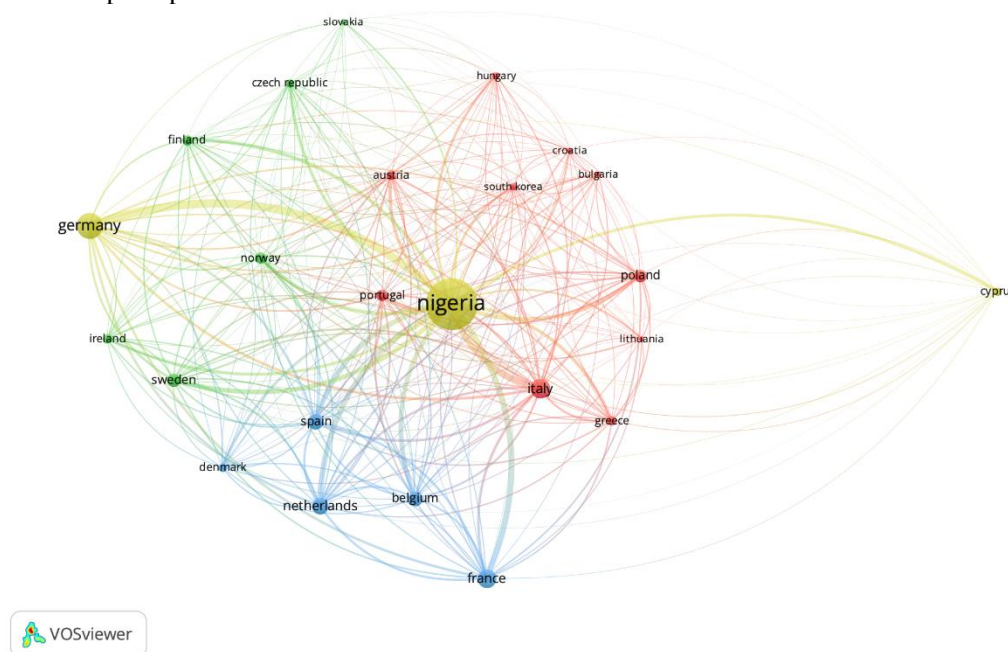


Figure 3. Scientific collaboration network between Nigeria and EU member states based on co-authored publications, 2020–2025

A comparative country–theme analysis, based on affiliation-derived identification of EU partner countries and keyword-assisted coding of titles, abstracts, and author/index keywords, indicates that thematic collaboration between Nigeria and EU member states is differentiated more by emphasis than by fully distinct specialisation. Germany emerged as Nigeria's most extensive EU collaborator in the dataset, appearing in 2,519 records, with strong representation in public health and medicine (1,390 records), climate, environment and sustainability (973), governance, policy and development (964), and artificial intelligence, data science and modeling (538). Italy, which appeared in 1,590 records, and France, represented in 1,411 records, also displayed a predominantly health-oriented profile, with 1,066 and 868 health-related records, respectively, alongside substantial contributions in governance and development (591 and 538) and climate and sustainability (539 and 464). These patterns suggest that the largest Nigeria–EU partnerships are anchored primarily in health-related collaboration, while simultaneously extending into environmental and institutional domains.

The Netherlands, Spain, Sweden, and Belgium also exhibit clearly identifiable thematic profiles. In the Netherlands, which appeared in 1,241 records, collaboration was led by public health and medicine (931 records) and governance, policy and development (592), while agriculture and food systems accounted for a more limited 186 records. This indicates that, within this dataset, Dutch collaboration with Nigeria is more strongly oriented toward health and governance than toward agriculture. Spain, represented in 1,183 records, combined health-related collaboration (812) with substantial activity in governance and development (461) and climate and sustainability (392). Sweden, which appeared in 913 records, showed a comparatively strong governance profile, with 458 records in governance and development, alongside 669 in health and 311 in climate and sustainability. Belgium, represented in 853 records, followed a similar pattern, with strong concentrations in health (640) and

governance (395). Together, these findings suggest that Nigeria's collaboration with Western and Northern European partners is characterised by a strong health core but also by visible engagement with governance and sustainability-related concerns.

Smaller but still significant EU partners display more differentiated thematic emphases. Finland, represented in 586 records, stands out for its comparatively stronger profile in artificial intelligence, data science and modeling, with 158 records, equivalent to 27.0% of its Nigeria-linked output. Poland, which appeared in 865 records, also showed a relatively stronger computational and technology-related component, with 204 records in AI, data science and modeling and 111 in energy. Although these volumes remain lower than those observed in health-related collaboration, they indicate that certain EU partners contribute more visibly to technology-oriented and computational domains. The comparative evidence indicates that public health and medicine remain the dominant thematic foundation across nearly all Nigeria–EU country partnerships, while cross-national variation is most apparent in the relative strength of climate and sustainability, governance and development, and computational or technology-oriented research areas. As country counts and thematic counts are non-mutually exclusive, these values should be interpreted as indicators of relative thematic prominence within each bilateral collaboration profile rather than as exclusive categories.

2.2. Major Research Themes in Nigeria–EU Scientific Collaboration

An analysis of 8,468 abstracts from Nigeria–EU co-authored publications published between 2020 and 2025 reveals a broad and interdisciplinary collaborative research landscape, with strong thematic emphasis on health, sustainability, governance, and technological innovation (Figure 4). Based on keyword-assisted coding of titles, abstracts, and author and index keywords, public health and medicine emerged as the most prominent theme, appearing in 4,292 records (50.7%), indicating sustained collaborative attention to disease burden, clinical care, epidemiology, infectious diseases, and health systems. Climate, environment, and sustainability constituted the second most prominent thematic domain, represented in 2,989 records (35.3%), reflecting substantial engagement with climate change, environmental management, resilience, pollution, biodiversity, and sustainability transitions. Governance, policy, and development also featured strongly, appearing in 2,936 records (34.7%), which suggests that Nigeria–EU collaboration extends beyond laboratory-based inquiry into institutional, regulatory, and development-oriented concerns.

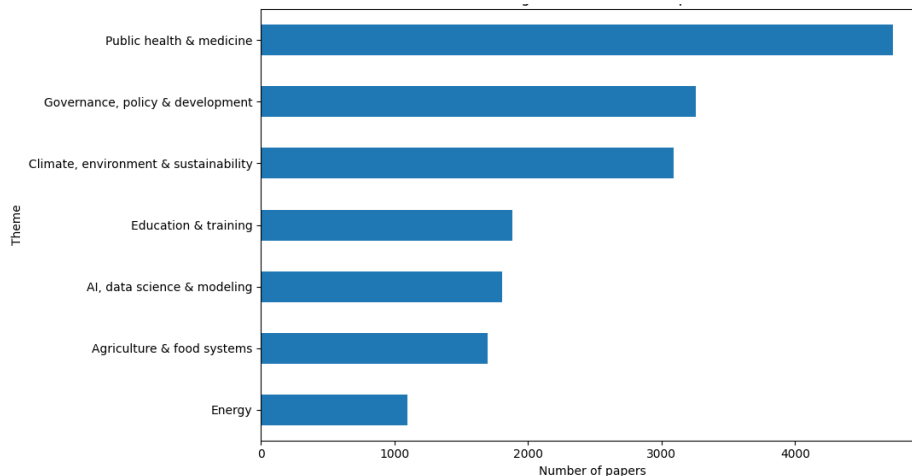


Figure 4. Main research themes in Nigeria–EU co-authored publications, 2020–2025

Additional thematic domains further demonstrate the breadth of the collaboration. Education and training were identified in 1,885 records (22.3%), highlighting the importance of higher education, skills development, and research capacity-building. Agriculture and food systems appeared in 1,679 records (19.8%), underscoring the relevance of food security, crop production, rural sustainability, and agricultural development within the collaborative agenda. Artificial intelligence, data science, and computational modeling were present in 1,257

records (14.8%), pointing to growing engagement with digital methods, predictive systems, and computational approaches across multiple fields. Energy-related research accounted for 924 records (10.9%), indicating an emerging focus on renewable energy, energy systems, and sustainability-linked technological transitions. The Nigeria–EU scientific collaboration is strongly anchored in health research while also displaying increasing diversification toward sustainability, governance, food systems, education, and technology-driven domains, as illustrated in Figure 4.

2.3. Addressing Societal Challenges in Nigeria–EU Research Collaboration

The qualitative content analysis of 8,468 abstracts and their index keywords from Nigeria–EU co-authored publications published between 2020 and 2025 reveals a research landscape characterised by a strong societal challenge orientation. The most prominent challenge domain was health systems and public health, identified in 4,649 records (54.9%), indicating sustained collaborative engagement with disease burden, healthcare delivery, clinical research, epidemiology, and infectious disease management. This was followed by environmental resilience and climate-related challenges, which appeared in 3,024 records (35.7%), reflecting substantial scholarly attention to climate change, adaptation, sustainability, biodiversity, environmental degradation, and resilience. A further 2,576 records (30.4%) addressed poverty reduction, livelihoods, and development-related concerns, suggesting that a considerable proportion of the collaborative output is linked to broader socioeconomic well-being and development outcomes. Governance, institutions, and policy were identified in 2,389 records (28.2%), underscoring the importance of regulatory, institutional, and implementation dimensions within the research corpus.

Additional challenge domains further illustrate the breadth of the collaborative agenda. Education, skills, and capacity building appeared in 1,878 records (22.2%), while food security and agriculture were represented in 1,569 records (18.5%), highlighting the significance of training, agricultural systems, rural livelihoods, and food-related challenges within Nigeria–EU research cooperation. Clean energy and energy transition appeared in 937 records (11.1%), pointing to an emerging, though comparatively smaller, body of collaborative work focused on renewable energy, electrification, and sustainability-oriented energy systems. These findings show that Nigeria–EU co-authored research is strongly oriented toward addressing concrete societal challenges rather than remaining confined to narrow disciplinary boundaries (see Figure 5 below).

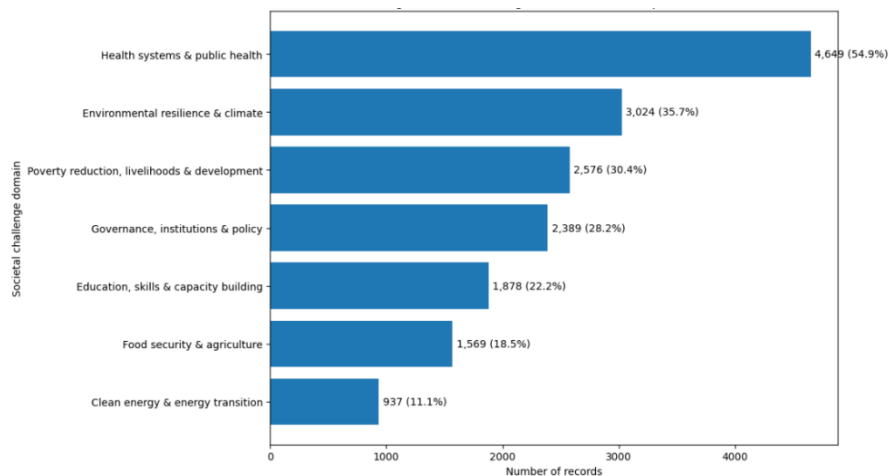


Figure 5. Social Challenge orientation of Nigeria-EU co-authored publication (2020-2025)

The evidence indicates that the collaboration is anchored primarily in health-related concerns, while also engaging substantially with environmental resilience, socioeconomic development, governance, education, food systems, and energy transition.

3. Methodology

This paper adopts a foresight-oriented mixed-methods methodological design to analyse how the partnership between Nigeria and the European Union in science, technology, and innovation may evolve from a fragmented, project-based pattern of cooperation into a more integrated, strategic, and sustainable partnership by 2040. The design is based on the integration of bibliometric analysis, qualitative content analysis, PEST analysis, and scenario planning, thereby enabling the study to combine an empirical and analytical examination of the current state of collaboration with a strategic foresight exploration of its possible future trajectories. The suitability of this methodological framework lies in its capacity to address the complex nature of international STI relations, which are shaped simultaneously by existing institutional patterns, structural transformations, and long-term uncertainties. The selection of this methodological approach is grounded in two main considerations. First, bibliometric analysis and qualitative content analysis allow for a systematic characterisation of the existing structure of Nigeria–EU collaboration, revealing its principal themes, knowledge trends, and policy and institutional orientations. Second, PEST analysis provides a structured explanatory framework for identifying the political, economic, social, and technological factors that shape the environment of this bilateral cooperation, while scenario planning enables the construction of plausible alternative futures for 2040 under conditions of multiple variables and growing uncertainty. Therefore, the study does not seek to predict one deterministic future; rather, it aims to explore a range of possible future alternatives by identifying the key driving forces, critical uncertainties, and strategic configurations that may influence the trajectory of Nigeria–EU relations in science, technology, and innovation.

3.1. PEST Analysis

This study employs PEST analysis as a strategic tool used to assess external macro-environmental factors that influence shaping Nigeria–EU collaboration in science, technology, and innovation (STI). The framework focuses on four interrelated dimensions political, economic, social, and technological factors (Mwogosi & Mambile, 2025; Cox, 2020) and is well suited to the analysis of international STI partnerships, which are influenced by policy environments, funding structures, societal capacities, and technological readiness. In this study, PEST analysis is used not only to assess the current macro-environment of Nigeria–EU STI cooperation, but also to identify the key drivers of change that may shape its future. This analysis is based on qualitative secondary data from multiple documentary sources relevant to Nigeria–EU relations in science, technology, and innovation. These sources include policy documents, strategic frameworks, official reports, program documents, and peer-reviewed academic research. In particular, the analysis draws on materials from the European Commission, Nigerian government institutions, the African Union, EU-AU cooperation frameworks, and international organisations involved in research, innovation, development, and technology policy.

The PEST framework focuses on four interrelated dimensions. The political dimension examines the policy and institutional context within which Nigeria–EU collaboration is embedded, including bilateral and interregional agreements, governance structures, diplomatic relations, regulatory arrangements, and coordination among Nigerian, EU, and African institutions. The economic dimension considers funding arrangements, trade and investment relations, macroeconomic conditions, export competitiveness, and the broader economic factors affecting the sustainability of collaborative research and innovation activities. The social dimension addresses migration dynamics, diaspora engagement, social inclusion, human development conditions, institutional trust, and the societal relevance of scientific cooperation. The technological dimension focuses on research infrastructure, digital capabilities, technological readiness, technology transfer, and the institutional capacity required to support innovation and knowledge exchange.

3.2. Development of Future Scenarios

The development of future scenarios in this study was grounded in the identification of key drivers of change derived from two complementary analytical sources: the analysis of Nigeria–EU co-authored scientific publications and the PEST analysis results. The co-authorship analysis provided insights into the existing structure, thematic trends, and collaborative patterns of Nigeria–EU STI relations, while the PEST framework enabled a systematic assessment of the political, economic, social, and technological factors shaping the broader environment of this partnership. By combining these two sources, the study was able to distinguish relatively stable trends from critical uncertainties with the potential to influence the future trajectory of Nigeria–EU collaboration in science, technology, and innovation. The scenario-building process was refined through two workshops involving 15 experts selected based on their experience in science, technology, and innovation policy, international research collaboration, higher education, innovation systems, and EU–Africa or Nigeria–EU cooperation. The panel included academics, policy specialists, research managers, and innovation practitioners with relevant expertise in both the African and European STI landscape. Their multidisciplinary backgrounds ensured that the scenario exercise captured a broad range of institutional, policy, and strategic perspectives.

The selection of key drivers was guided by three main criteria: relevance, impact, and uncertainty. First, each driver had to demonstrate clear relevance to the future of Nigeria–EU STI collaboration based on evidence from the co-authorship analysis and the PEST framework. Second, the driver had to have a potentially high impact on the direction, quality, or sustainability of the partnership. Third, particular attention was given to drivers characterised by a high degree of uncertainty, since these were considered most likely to shape divergent futures. Through this process, an initial set of potential drivers was identified and subsequently presented to the expert panel during the workshop. The experts critically reviewed, validated, and refined these drivers, and collectively selected those considered most significant based on their relevance, impact, and uncertainty. This step enabled the study to distinguish between relatively stable background trends and critical uncertainties with strategic significance for scenario development.

The final three scenarios were agreed through a structured workshop process in which the experts reviewed the selected drivers, discussed their relative influence and uncertainty, and grouped them into coherent combinations of future conditions (Rezk et al., 2025). Following this discussion, the most significant and uncertain drivers were used to frame alternative trajectories for Nigeria–EU STI collaboration by 2040. The scenarios were then refined collectively to ensure that each one was plausible, internally consistent, analytically distinct, and policy relevant. This process resulted in the selection of three future scenarios representing contrasting but credible pathways for the evolution of the partnership.

4. Results and Discussion

4.1. PEST Analysis Results

The PEST analysis shows that Nigeria–EU collaboration is shaped by a complex external environment in which political, economic, social, and technological factors interact in ways that both enable and constrain long-term cooperation. The results indicate that the partnership is underpinned by important formal institutional arrangements and shared strategic interests. However, its future effectiveness will depend on how successfully both sides address persistent governance challenges, economic instability, social inequalities, and technological capacity gaps.

4.1.1. Political Factors Influencing Nigeria–EU Collaboration

The political dimension shows that Nigeria–EU collaboration is becoming more inclusive of embedded in formalised bilateral and multilateral governance structures, cooperation has been guided by strategic instruments such as the EU Country Strategy Paper and National Indicative Programmes, which define priority sectors and funding allocations, including €512 million under the 11th European Development Fund for 2014–2020, of which €150 million was allocated to sustainable energy and electricity access in Nigeria (Tichý et al., 2022). This

indicates that the political relationship is supported by structured policy frameworks rather than ad hoc engagement. Nigerian government institutions also play a central role in aligning domestic systems with EU standards, especially in export-related sectors such as agriculture. Measures such as full pre-export testing of cocoa beans, the issuance of health certificates, and coordination with EU border control authorities have strengthened regulatory compliance, while training programmes and workshops for food processors, handlers, and exporters have supported adherence to food safety standards and improved market access (Tijani & Kehinde, 2026). In this context, agencies such as the Federal Government, the Cocoa Research Institute of Nigeria, and NAFDAC are important institutional actors in operationalising Nigeria–EU regulatory cooperation (Tijani & Kehinde, 2026).

At the same time, the effectiveness of political cooperation is shaped by domestic institutional conditions and multilevel governance arrangements. Access to credit, women's participation in agricultural decision-making, and the ability of local actors to engage in land-use and investment systems all affect the outcomes of Nigeria–EU collaboration, particularly in fragile and conflict-affected regions (Olanrewaju et al., 2025). Nigeria–EU cooperation is further influenced by partnerships involving Nigerian state governments, the EU, and international organisations such as DFID, the World Bank, and USAID, especially in sectors such as health, agriculture, and education (Ukhurebor et al., 2021). At the regional level, bodies such as NEPAD and the African Union place Nigeria–EU relations within wider continental and plurilateral governance frameworks aimed at collective self-reliance and strategic engagement with global markets, although their effectiveness is often constrained by internal contradictions and limited resources (Ndayi, 2009; Kotsopoulos & Mattheis, 2018; Chidozie et al., 2024). In addition, non-formal actors, including market associations, town unions, civil society organisations, and informal groups, continue to shape policy implementation, sometimes privileging localised interests over broader national priorities (Schreier, 2024).

The broader political context also reflects longstanding structural weaknesses in Nigeria's development planning. Although the country has introduced laws and policies intended to promote indigenous technological development and the acquisition of foreign technology, earlier national development plans did not adequately position science and technology as a strategic driver of development (Okejiri, 2000). Despite multiple National Development Plans, Nigeria has remained heavily dependent on crude oil, while manufacturing growth and industrial capacity utilisation have remained weak. High production costs, weak demand, expensive maintenance, the influx of cheap imports, and political instability have all contributed to poor industrial performance (Ilori et al., 2002). The findings indicate that the political environment for cooperation between Nigeria and the European Union has become more structured and supportive, but it remains constrained by fragmented governance, institutional weaknesses, and uneven policy implementation.

4.1.2. Economic Factors Shaping Nigeria–EU Partnerships

The economic dimension Shows both the potential and the fragility of Nigeria–EU cooperation. Nigeria's economic expansion depends significantly on trade openness and integration into global markets, yet policy choices have not always supported this objective. For example, land border closures have negatively affected trade flows and undermined broader economic engagement, including with European partners (Joshua et al., 2020). At the macroeconomic level, export trade contributes positively to growth, while import dependence and policy uncertainty tend to have adverse effects. These negative outcomes may be moderated by stronger institutional quality, which remains an important condition for sustainable external partnerships (Elijah & Musa, 2019).

Nigeria–EU economic relations are also shaped by trade governance frameworks, particularly Economic Partnership Agreements, which have influenced tariff structures and promoted trade liberalisation. At the same time, these frameworks have underscored the importance of tariff adjustment, export diversification, and competitiveness in improving access to European markets (Hout & Salih, 2019; Mbroh, 2021). However, Nigeria's economic environment remains highly vulnerable to oil price fluctuations and exchange rate volatility,

reflecting the country's continued dependence on crude oil exports. These shocks have significant short-run effects on GDP and foreign direct investment flows and also reduce investor confidence, thereby affecting trade and investment relations with the EU (Yunusa, 2020; Uzo-Peters et al., 2018).

The agri-food sector further illustrates the mixed character of this economic relationship. Although Nigeria possesses considerable export potential, its agri-food exports to the EU remain relatively inefficient, indicating substantial untapped opportunities. Income levels, exchange rates, and compliance with EU standards all shape export performance and determine the extent to which producers can benefit from European market access (N. M. Abdullahi et al., 2021). These findings suggest that the economic basis of Nigeria–EU cooperation remains promising but unstable. While trade, funding, and market access provide important opportunities, long-term sustainability will require greater diversification, stronger institutions, and reduced exposure to external shocks.

4.1.3. Social Factors Affecting Nigeria–EU Collaboration

The social dimension of Nigeria–EU collaboration is strongly influenced by migration dynamics, human development conditions, and broader questions of social inclusion. Migration governance is shaped by a complex set of pressures, including unemployment, and limited economic opportunities, all of which affect mobility decisions and reintegration processes (Komolafe, 2008). Although governmental bodies, international organisations, and civil society actors are involved in supporting returnees and migrant communities, many of these interventions remain limited in inclusivity and long-term sustainability (Olakpe, 2022). This suggests that migration-related cooperation between Nigeria and the EU is not only a policy issue, but also a reflection of deeper structural and social challenges.

Diaspora networks constitute an additional and important social dimension of the relationship. Nigerian communities in the EU play a role in circulating information, influencing migration decisions, and supporting transnational connections that shape broader governance processes (Yakubu et al., 2022). Diaspora engagement in policy frameworks is increasingly recognised as a potential asset for development and cooperation. However, this potential is often limited by mistrust, institutional fragmentation, and the adjustment difficulties faced by migrants and returnees. (Akanle & Ola-Lawson, 2021). As a result, the social contribution of diaspora engagement remains significant but not fully institutionalised. The findings point to deeper cultural and social barriers that influence collaboration outcomes. Ethnocentrism, gender norms, traditional practices, and forms of discrimination continue to shape migration management and social integration processes, often limiting inclusiveness and undermining the effectiveness of policy interventions (Cornelius & Greg, 2013). The results show that the social foundation of Nigeria–EU cooperation cannot be understood only in terms of migration flows, but must also be linked to questions of equity, social cohesion, institutional trust, and human capability development.

4.1.4. Technological Factors in Nigeria–EU Collaboration

The technological dimension reveals that innovation, digital transformation, and scientific capacity are of growing importance to Nigeria–EU cooperation, although significant structural limitations remain. Technological advancement is widely recognised as essential for Nigeria's sustainable development, yet policy design and implementation have not been sufficiently effective in driving this transition (Chiemeke & Imafidor, 2020). Evidence shows that digital technology adoption contributes positively to economic growth and labour productivity, but these gains depend on workforce training, regulatory support, and institutional readiness (Ufua et al., 2021). Technology transfer has also been influenced by trade openness, collaborative policy arrangements, and regional integration frameworks such as the African Continental Free Trade Area. These processes have created opportunities for the diffusion of ICT-related technologies, although weak institutional frameworks still limit the effectiveness of technological cooperation (Olaoye & Zerihun, 2023). In practical terms, progress in e-governance and digital service delivery remains constrained by major deficits in electricity supply, broadband access, and ICT literacy (Abdullahi & Mustafa, 2021). While collaboration with the EU has contributed to improvements in transparency and public service delivery, persistent challenges remain in relation to interoperability, systems integration, and citizen inclusion.

Similar patterns are evident in education and workforce development. The integration of Industry 4.0 technologies into vocational education offers substantial opportunities for curriculum modernisation and stronger industry collaboration, but implementation has been slowed by infrastructure shortages, insufficient funding, and low levels of digital competence (Oyetade et al., 2025). In the environmental and energy sectors, EU-funded projects have supported sustainable energy systems and environmental governance in Nigeria, particularly through the strengthening of regulatory frameworks and the promotion of cleaner production practices (Ukhurebor et al., 2021). However, collaborative research in agroforestry and sustainable agriculture remains comparatively limited, indicating a need for greater investment in scientific infrastructure, research capacity, and academic collaboration (Sharma et al., 2025). Through technological analysis, it was found that cooperation between Nigeria and the European Union has great transformative potential, but this potential will depend on stronger implementation capacity, better infrastructure, and more inclusive innovation systems.

4.2. Key Drivers of Change

The combined findings from the co-authorship analysis and the PEST framework indicate that the future of Nigeria–EU collaboration in science, technology, and innovation (STI) will be shaped by a set of interrelated high-impact drivers. These drivers reflect both current structural conditions within the partnership and wider international trends affecting global research and innovation systems, including digital transformation, artificial intelligence, climate transition, shifting trade and investment patterns, and geopolitical uncertainty. At the same time, they embody critical uncertainties that may steer the partnership toward deeper strategic integration, selective and uneven adaptation, or more fragmented forms of cooperation. Table 2 summarises the main drivers of change and presents their possible positive and negative directions, together with their relative levels of uncertainty.

Table 2. Main Drivers of Change and Their Positive and Negative Directions in Nigeria–EU STI Collaboration

Key driver of change	Positive direction	Negative direction	Level of uncertainty
1. Political commitment and strategic alignment	Stronger EU–Nigeria and AU–EU policy coordination; more stable STI agreements; clearer long-term governance for joint research and innovation	Weaker political commitment; fragmented implementation; geopolitical tensions reducing continuity of cooperation	High
2. Research and innovation funding	More predictable and diversified funding; stronger public–private co-financing; better capacity to mobilise STI for transformative change	Funding volatility; overdependence on short project cycles; reduced fiscal space and weaker long-term institutional support	High
3. Governance and regulatory quality	Improved policy coherence, regulatory stability, and implementation capacity; more efficient coordination across institutions	Governance fragmentation; weak implementation; regulatory uncertainty discouraging long-term collaboration	High
4. Institutional and network capacity	Stronger university–industry–policy linkages; broader participation across Nigerian and EU institutions; more resilient collaboration networks	Collaboration concentrated in a limited number of institutions and countries; weak institutional coordination; low scaling capacity	Medium
5. Technological transformation and AI readiness	Joint investment in AI, digital infrastructure, data systems, and skills; more inclusive technology adoption and co-development	Concentration of AI capabilities in a few countries and firms; widening digital gaps; weak infrastructure, data, and skills limiting participation	High
6. Research infrastructure and digital connectivity	Improved laboratories, broadband, electricity, cloud systems, and digital research platforms supporting effective knowledge exchange	Persistent infrastructure deficits; weak connectivity; unreliable electricity and limited digital access constraining STI collaboration	High
7. Skills, education, and human capital	Expanded research training, mobility, digital upskilling, and workforce adaptation to new technologies	Persistent skills gaps; weak absorptive capacity; uneven access to advanced training and innovation opportunities	Medium

Key driver of change	Positive direction	Negative direction	Level of uncertainty
8. Green transition and climate cooperation	Deeper collaboration in climate adaptation, renewable energy, sustainability, and green innovation	Climate pressures outpacing institutional response; fragmented green transition; weak implementation capacity	Medium to High
9. Trade, investment, and economic diversification	More balanced trade and investment relations; stronger support for value addition, innovation ecosystems, and technology-intensive sectors	Continued dependence on raw commodity exports; macroeconomic instability; limited diversification and weak innovation-based industrial upgrading	High
10. Social inclusion and development orientation	More equitable and challenge-oriented STI cooperation addressing health, food, energy, gender inclusion, and social resilience	Unequal distribution of benefits; exclusion of less-capable institutions and marginalised groups; reduced developmental impact	Medium
11. Migration, mobility, and diaspora engagement	Stronger researcher mobility, academic exchange, and productive engagement of diaspora networks in knowledge transfer, innovation, and institutional cooperation	Brain drain, mobility restrictions, weak reintegration mechanisms, and limited institutional use of diaspora capacities reducing long-term STI benefits	Medium to High
12. Human development and social capacity	Greater investment in education, skills, youth inclusion, women's participation, and social capabilities that strengthen the societal base of STI cooperation	Persistent inequalities in education, weak skills formation, exclusion, low institutional trust, and limited human development capacity constraining broader participation in STI collaboration	Medium

Source: Authors

4.3. Future Scenarios of Nigeria–EU STI Collaboration

The future scenarios of Nigeria–EU collaboration in science, technology, and innovation (STI) were developed based on the key drivers of change identified in the previous section and their interaction with major global trends expected to shape international research and innovation systems toward 2040. In particular, the scenarios reflect variations in political commitment and strategic alignment, the continuity of research and innovation funding, institutional and network capacity, technological readiness, the green transition, skills and human capital development, and the wider geopolitical environment. These drivers are closely linked to broader global trends, including the expansion of artificial intelligence, accelerating digital transformation, increasing climate and sustainability pressures, shifting trade and investment patterns, and rising geopolitical uncertainty. The scenarios do not represent predictions, but plausible and internally coherent futures showing how different combinations of drivers and trends may shape the trajectory of Nigeria–EU STI collaboration. The three scenarios reflect contrasting pathways: one in which global transformations reinforce strategic partnership and co-innovation, one in which cooperation continues but remains selective and uneven, and one in which external pressures and internal weaknesses lead to fragmentation and reactive engagement. Together, these scenarios provide a structured basis for understanding the opportunities, risks, and strategic choices that may define the partnership by 2040.

4.3.1. Scenario 1: Green–Digital Leap

This scenario emerges when the principal drivers of change evolve in a positive and mutually reinforcing direction. Strong political commitment and strategic alignment sustain the continuity of Nigeria–EU cooperation, while research and innovation funding becomes more stable, diversified, and better aligned with long-term priorities. At the same time, improvements in institutional and network capacity, research infrastructure, digital connectivity, and skills development strengthen the ability of Nigerian and European actors to engage in more balanced and effective collaboration. These favorable conditions are reinforced by wider international trends, especially the acceleration of digital transformation, the expansion of artificial intelligence, and growing pressure for green transition and climate resilience. In this context, Nigeria–EU STI cooperation moves beyond fragmented, project-based engagement toward a more institutionalised and strategically coordinated model of co-innovation.

Under this scenario, cooperation expands in areas where both partners have shared strategic interests and where the developmental relevance of STI is particularly strong, including public health, sustainable agriculture, renewable energy, climate adaptation, digital governance, and AI-enabled innovation. Nigeria strengthens its research and innovation ecosystem through greater domestic investment, improved absorptive capacity, stronger university–industry–policy linkages, and broader participation in international research programmes. At the same time, the European Union supports a more inclusive and development-oriented partnership that places greater emphasis on co-creation, technology transfer, capacity-building, and joint agenda-setting. As a result, scientific cooperation produces not only higher research output, but also more visible technological, economic, and societal benefits. A defining feature of this future is that green and digital transformation become mutually reinforcing pillars of the partnership. Advances in technological readiness and AI capability are matched by stronger collaboration in clean energy, climate-smart agriculture, environmental monitoring, and sustainable industrial innovation. Research collaboration is increasingly linked to practical innovation outcomes, including start-up development, digital platforms, technology testing, joint postgraduate training, and the application of scientific knowledge to pressing societal challenges. Researcher mobility and diaspora engagement also play a more constructive role in deepening knowledge exchange and strengthening long-term institutional ties between both regions.

By 2040, this scenario results in a more resilient, inclusive, and strategically significant Nigeria–EU STI partnership. Cooperation is no longer concentrated mainly in isolated externally funded projects, but is embedded in durable governance arrangements, broader institutional participation, and shared long-term objectives. In this future, science, technology, and innovation function not only as areas of collaboration in themselves, but also as strategic instruments for economic diversification, technological upgrading, human development, and sustainable development. The partnership therefore becomes a model of green and digital co-innovation in which both sides benefit from more adaptive, equitable, and future-oriented cooperation.

Table 3. Scenario 1 (Green–Digital Leap): future images, realisation pathway, and high-impact drivers of change

Year	Future Image	Description of Future State	Key Drivers with Highest Impact on Realisation	Expected Realisation
2026	Bilateral cooperation agreements	Bilateral agreements and early-stage STI cooperation with fragmented but active engagement	Political commitment and strategic alignment; Research and innovation funding	Immediate / Short-term (2025–2026)
2028	Coordinated governance frameworks	Establishment of joint STI coordination bodies and standardised policy and data-sharing frameworks	Political commitment and strategic alignment; Research and innovation funding; Trade, investment, and economic diversification	Short-term (2027–2028)
2030	Shared digital research infrastructure	Deployment of federated research platforms, high-speed connectivity, and shared digital systems	Technological transformation and AI readiness; Research infrastructure and digital connectivity; Research and innovation funding	Early medium-term (2029–2031)
2032	Advanced human capital and research capacity systems	Expansion of joint education programs, advanced training centers, researcher mobility schemes, and stronger university–industry collaboration	Technological transformation and AI readiness; Research infrastructure and digital connectivity; Green transition and climate cooperation	Medium-term (2031–2033)
2035	Integrated co-innovation and green technology ecosystems	Development of joint innovation hubs, green technology pilot initiatives, and interconnected startup and applied research ecosystems	Trade, investment, and economic diversification; Technological transformation and AI readiness; Green transition and climate cooperation	Mid-to-long term (2033–2036)
2038	Cross-border integrated STI and innovation systems	Integration of cross-border research systems, shared intellectual property frameworks, coordinated innovation networks, and interoperable digital collaboration mechanisms	Political commitment and strategic alignment; Research infrastructure and digital connectivity; Trade, investment, and economic diversification	Late-stage (2036–2039)
2040	Green–digital integrated ecosystem	Mature and institutionalised Nigeria–EU STI ecosystem supporting sustainable innovation, AI-driven governance, and green industrial	Political commitment and strategic alignment; Research and innovation funding; Technological transformation and AI readiness; Research infrastructure and digital connectivity; Green	Long-term (2038–2040)

Year	Future Image	Description of Future State	Key Drivers with Highest Impact on Realisation	Expected Realisation
		transformation	transition and climate cooperation; Trade, investment, and economic diversification	

Source: Authors

4.3.2. Scenario 2: Uneven Pathways

By 2040, Nigeria–EU collaboration in science, technology, and innovation remains active and productive, but it does not mature into a fully broad-based strategic partnership. Instead, cooperation adapts selectively to global change. The partnership benefits from continued political support, the availability of some research and innovation funding, and the persistence of established collaboration networks. Yet, these gains are offset by uneven institutional capacity, patchy technological readiness, and an incomplete spread of skills, infrastructure, and absorptive capability across the wider Nigerian STI system. In effect, the partnership advances, but not evenly. This unevenness becomes the defining feature of the scenario. Opportunities created by digitalisation, climate transition, and technological upgrading are real, but they are captured mainly by institutions that already possess stronger international linkages, better infrastructure, and higher implementation capacity. As a result, cooperation becomes concentrated in fields that combine strong external support with clear international relevance, especially public health, food systems, climate-related innovation, and selected digital applications. These areas continue to generate visible outputs and policy relevance, but the benefits do not diffuse widely across institutions, sectors, or regions.

A small group of Nigerian universities, research institutes, and innovation actors therefore becomes more embedded in EU-linked programmes, platforms, and networks, while many others remain only marginally connected. Some progress is made in digital tools, data systems, researcher training, and project management capacity, but these improvements are clustered rather than systemic. Green and sustainability-oriented collaboration also continues, although it is driven largely by flagship projects and targeted external programmes rather than by a deeper restructuring of the partnership around long-term co-innovation. The same pattern holds for capacity-building: leading centres improve, but the broader STI ecosystem does not advance at the same pace. The result of this scenario is a partnership that remains relevant but only partially transformative. Nigeria–EU STI cooperation under this scenario is neither stagnant nor fully strategic; it is adaptive, but in a selective way that reproduces existing asymmetries. Collaboration survives, and in some domains performs well, yet it continues to depend on a limited number of institutions, sectors, and funding channels. This makes the partnership more resilient than a fragmented future, but less inclusive, less balanced, and less system-building than the strategic co-innovation pathway described in Scenario 1.

Table 4. Scenario 2 (Uneven Pathways): future images, realisation pathway, and high-impact drivers of change

Year	Future Image	Description of Future State	Key Drivers with Highest Impact on Realisation	Expected Realisation
2026	Sustained but selective cooperation arrangements	Nigeria–EU STI cooperation continues through existing agreements, networks, and funding channels, but without a major shift toward deeper strategic integration	Political commitment and strategic alignment; Research and innovation funding	Immediate / Short-term (2025–2026)
2028	Clustered governance and project coordination	Coordination mechanisms improve in selected domains and institutions, but governance gains remain uneven and concentrated among stronger actors	Political commitment and strategic alignment; Institutional and network capacity; Research and innovation funding	Short-term (2027–2028)
2030	Uneven digital and research infrastructure access	Some institutions benefit from improved digital tools, research platforms, and connectivity, while many others continue to face infrastructure and access constraints	Technological transformation and AI readiness; Research infrastructure and digital connectivity; Institutional and network capacity	Early medium-term (2029–2031)
2032	Concentrated skills and capacity development	Training, mobility, and project management capacity improve mainly in leading universities and research centres, while broader system-wide capacity gaps persist	Skills, education, and human capital; Institutional and network capacity; Research infrastructure and digital connectivity	Medium-term (2031–2033)

Year	Future Image	Description of Future State	Key Drivers with Highest Impact on Realisation	Expected Realisation
2035	Flagship green and innovation collaboration clusters	Green transition projects, digital applications, and innovation initiatives continue in selected flagship areas with strong external support, but diffusion remains limited	Green transition and climate cooperation; Technological transformation and AI readiness; Research and innovation funding; Trade, investment, and economic diversification	Mid-t-long term (2033–2036)
2038	Partially connected STI collaboration networks	A limited group of Nigerian institutions becomes more embedded in EU-linked programmes and networks, while many actors remain marginal to international collaboration	Institutional and network capacity; Migration, mobility, and diaspora engagement; Skills, education, and human capital	Late-stage (2036–2039)
2040	Selective and uneven partnership ecosystem	Nigeria–EU STI cooperation remains relevant and productive in specific domains, but it is still dependent on a limited number of institutions, sectors, and funding streams, making it adaptive but only partially transformative	Political commitment and strategic alignment; Research and innovation funding; Institutional and network capacity; Technological transformation and AI readiness; Research infrastructure and digital connectivity; Skills, education, and human capital	Long-term (2038–2040)

Source: Authors

4.3.3. Scenario 3: Drifting Apart

In this scenario, Nigeria–EU collaboration in science, technology, and innovation loses strategic coherence and becomes increasingly difficult to sustain as a long-term partnership. By 2040, cooperation still exists, but it is no longer driven by a shared forward-looking agenda. Instead, it is shaped by instability, uneven commitment, and a succession of external pressures that push both sides toward shorter-term and more reactive forms of engagement. What remains is a partnership that survives in fragments rather than evolving through durable institutional consolidation.

This outcome becomes more likely when several key drivers move in an unfavorable direction at the same time. Political commitment weakens, research and innovation funding become less predictable, and institutional and network capacity fail to deepen in ways that would support continuity. At the same time, technological transformation and AI readiness advance unevenly, leaving major gaps in infrastructure, digital access, and absorptive capacity. These internal weaknesses are further intensified by broader international pressures, including geopolitical rivalry, economic volatility, climate-related disruption, and unequal global access to frontier technologies. Under such conditions, Nigeria–EU STI cooperation becomes more exposed to shocks and less capable of sustaining coordinated long-term priorities.

The practical effect is that collaboration narrows rather than expands. Joint activities continue mainly in issue-specific areas where immediate needs, donor priorities, or crisis-response mechanisms still provide incentives for engagement. Health emergencies, food insecurity, environmental stress, migration pressures, and selected governance challenges may still generate collaborative projects, but these efforts remain episodic and disconnected from any broader strategy of innovation-system building. More ambitious forms of cooperation in green transition, advanced digital systems, frontier science, or long-term capacity development lose momentum because the institutional and financial conditions needed to sustain them are no longer sufficiently strong.

A striking feature of this future is the widening gap between isolated scientific outputs and broader developmental transformation. Some collaboration persists through individual researchers, temporary grants, or existing networks, but it does not accumulate into strong and resilient partnership structures. Advanced capabilities in AI, data systems, and research infrastructure remain concentrated in a small number of actors, while many Nigerian institutions remain peripheral to frontier STI domains. As fragmentation deepens, the partnership becomes less inclusive, less developmental, and less able to generate cumulative long-term impact. By 2040, the overall result is a weakly coordinated and strategically diminished relationship in which STI no longer functions as a robust pillar of Nigeria–EU partnership. Cooperation remains possible, but mostly through scattered projects, temporary

alignments, and problem-driven interventions rather than through a stable model of co-innovation. In this future, the partnership is defined less by strategic ambition than by constrained adaptation to crisis, leaving both sides with a relationship that is active in places, but fragmented in substance and limited in transformative effect.

Table 5. Scenario 3 (Drifting Apart): future images, realisation pathway, and high-impact drivers of change

Year	Future Image	Description of Future State	Key Drivers with Highest Impact on Realisation	Expected Realisation
2026	Fragile cooperation continuity	Nigeria–EU STI collaboration formally continues, but growing instability, weak strategic commitment, and uneven institutional capacity begin to undermine momentum and long-term confidence	Political commitment and strategic alignment; Research and innovation funding; Institutional and network capacity	Immediate / Short-term (2025–2026)
2028	Weakening governance and coordination	Coordination mechanisms lose coherence, long-term planning weakens, and partnerships rely more heavily on existing informal networks than on strong institutional frameworks	Political commitment and strategic alignment; Institutional and network capacity; Wider geopolitical environment	Short-term (2027–2028)
2030	Unequal and fragile research infrastructure	Digital systems, research infrastructure, and technological readiness improve only in limited pockets, while wider infrastructure deficits and weak absorptive capacity constrain collaboration	Technological transformation and AI readiness; Research infrastructure and digital connectivity; Institutional and network capacity	Early medium-term (2029–2031)
2032	Narrow and uneven capacity retention	Skills development, researcher mobility, and training opportunities remain limited and uneven, while brain drain and weak institutional retention reduce broader STI capability	Skills, education, and human capital; Migration, mobility, and diaspora engagement; Human development and social capacity	Medium-term (2031–2033)
2035	Crisis-driven cooperation	Joint activities focus mainly on urgent pressures such as health emergencies, food insecurity, migration challenges, and environmental stress rather than long-term innovation-system development	Green transition and climate cooperation; Wider geopolitical environment; Research and innovation funding	Mid-to-long term (2033–2036)
2038	Widening technology gaps	Advanced digital, AI, and innovation capabilities remain concentrated in a small number of institutions, while many Nigerian actors remain peripheral to frontier STI fields and high-value collaboration networks	Technological transformation and AI readiness; Research infrastructure and digital connectivity; Skills, education, and human capital	Late-stage (2036–2039)
2040	Weak institutional continuity	Cooperation remains possible but is scattered, short-term, and weakly coordinated, with limited durable structures, low cumulative developmental impact, and declining strategic significance for the broader partnership	Political commitment and strategic alignment; Research and innovation funding; Institutional and network capacity; Technological transformation and AI readiness; Wider geopolitical environment; Migration, mobility, and diaspora engagement	Long-term (2038–2040)

Source: Authors

4.3.4. Comparative Discussion of the Scenarios

The three scenarios indicate that the future of Nigeria–EU STI collaboration will be shaped by the interaction between domestic drivers and broader global developments. The first scenario presents a positive outlook in which political will, reliable funding, digital preparedness, and green transition priorities work together to promote deeper co-innovation and more balanced forms of partnership. The second scenario reflects a more cautious path, where cooperation continues but without major structural change. In this case, collaboration remains active and productive, yet uneven, selective, and concentrated within a limited number of institutions and sectors. In contrast, the third scenario highlights the risk that geopolitical tensions, unstable funding, technological concentration, and limited institutional capacity could weaken cooperation, leading to fragmentation and reduced strategic relevance. From a comparative perspective, these scenarios suggest that the future of Nigeria–EU STI relations will depend not only on bilateral intentions, but also on the ability of both partners to respond to an

increasingly complex and rapidly evolving global environment. In this context, digital transformation, climate action, global innovation competition, and geopolitical shifts represent key external forces shaping the direction and quality of cooperation. Accordingly, stronger alignment between domestic reforms, institutional capacity-building, and global innovation trends will be essential if the partnership is to evolve by 2040 into a more resilient, inclusive, and development-oriented framework for STI collaboration.

4.4. Policy Recommendations

Drawing on the scenario analysis, this study proposes nine policy recommendations that are directly linked to the conditions, opportunities, and risks identified across the three future pathways of Nigeria–EU collaboration in science, technology, and innovation (STI). Rather than offering general prescriptions, these recommendations are grounded in the enabling factors associated with Scenario 1, the structural constraints evident in Scenario 2, and the fragmentation risks highlighted in Scenario 3. In this sense, the recommendations are intended not only to strengthen the likelihood of a more strategic and inclusive partnership, but also to reduce the probability that cooperation will remain selective, uneven, or vulnerable to disruption by 2040

Strengthen long-term political commitment to prevent fragmented cooperation

The contrast between the strategic coherence of Scenario 1 and the weakened continuity of Scenario 3 suggests that sustained political commitment is a foundational condition for future cooperation. Nigeria and the European Union should therefore reinforce high-level political support for STI collaboration through durable bilateral commitments, regular strategic dialogue, and long-term policy alignment. Such measures would help prevent the partnership from becoming dependent on temporary priorities or reactive engagement.

Institutionalise governance structures for sustained STI coordination

Scenario 1 indicates that deeper cooperation is more likely where institutional coordination is clear and stable, whereas Scenario 3 illustrates the consequences of weak continuity and fragmented implementation. For this reason, both partners should establish more formalised governance structures capable of coordinating ministries, research agencies, universities, and innovation actors across multiple levels. Stronger governance would improve policy coherence, implementation capacity, and long-term strategic consistency

Develop more stable and diversified funding arrangements

One of the clearest differences between the scenarios concerns the continuity and quality of funding. While Scenario 1 is supported by stable and diversified financing, Scenario 3 is characterised by uncertainty and overreliance on temporary support. A key policy priority is therefore to combine EU funding instruments with stronger domestic STI investment in Nigeria, co-financing arrangements, and wider participation by private and innovation-sector actors. This would increase resilience and reduce vulnerability to external funding fluctuations

Reduce institutional concentration by widening participation

Scenario 2 shows that collaboration may continue without becoming transformative if it remains concentrated in a limited number of institutions and sectors. To address this structural imbalance, policies should aim to broaden participation across Nigerian universities, research centres, and innovation hubs, including those outside the most internationally connected networks. A more inclusive model of participation would strengthen the national innovation system and improve the developmental reach of the partnership.

Invest in institutional absorptive capacity to support deeper collaboration

The scenarios suggest that the quality of future cooperation depends not only on access to partnerships, but also on the ability of institutions to absorb, manage, and translate collaborative opportunities into sustained outcomes. Greater investment is therefore needed in research management systems, postgraduate training, administrative capability, digital research support, and organisational learning. Strengthening absorptive capacity would help Nigerian institutions move from peripheral participation toward more substantive roles in joint research and innovation activities

Prioritise digital readiness to avoid widening technology gaps

Scenario 1 assumes improvements in digital preparedness and technological capability, whereas Scenario 3 highlights the danger of widening gaps in AI, data systems, and advanced research infrastructure. In response, future cooperation should place greater emphasis on digital infrastructure, cloud-based research systems, data governance capacity, and frontier technology readiness. This is essential if Nigeria is to participate more effectively in technology-intensive and innovation-driven forms of STI collaboration

Embed green transition priorities within long-term co-innovation strategies

The first scenario demonstrates that green transition and digital transformation can become mutually reinforcing pillars of the partnership when they are strategically integrated. By contrast, the more limited trajectory in Scenario 2 implies that such collaboration may otherwise remain selective and sector-specific. Policy should therefore support long-term co-innovation in renewable energy, climate adaptation, sustainable agriculture, and environmental monitoring, ensuring that green cooperation is institutionalised rather than confined to isolated initiatives

Expand mobility and research network formation as mechanisms of continuity

Scenario 1 highlights the positive role of researcher mobility, diaspora engagement, and networked collaboration in deepening institutional ties, while Scenario 3 suggests that cooperation becomes fragile when it depends on scattered projects and temporary alignments. Both partners should therefore strengthen mobility schemes, joint postgraduate programmes, collaborative supervision, and interdisciplinary research networks. These mechanisms would help build trust, circulate expertise, and create more durable foundations for long-term cooperation.

Focus cooperation on challenge-oriented fields with high societal relevance

Across the scenarios, the most sustainable and legitimate forms of collaboration are those linked to areas of shared developmental importance, including public health, food systems, climate resilience, digital governance, and inclusive innovation. A stronger challenge-oriented approach would increase the practical relevance of STI cooperation and improve its contribution to broader development goals. It would also reduce the risk, evident in Scenario 3, that collaboration becomes reactive, episodic, and disconnected from longer-term transformation

5. Conclusion

This study examined the future trajectory of Nigeria–EU collaboration in science, technology, and innovation (STI) against the backdrop of increasing global uncertainty and transformation. Using an integrated analytical framework that combined bibliometric analysis, qualitative content analysis, PEST analysis, and scenario development, the study demonstrated that Nigeria–EU STI cooperation already rests on an important scientific and institutional foundation. Existing collaboration is particularly visible in areas such as public health, climate and sustainability, governance, education, and selected digital and technological fields. However, the analysis also showed that the future of this partnership will depend not only on the continuation of current research linkages, but also on the broader political, economic, social, and technological conditions within which such cooperation is embedded.

The findings revealed that Nigeria–EU STI collaboration is supported by growing policy alignment, expanding institutional engagement, and shared interests in green and digital transformation. At the same time, the partnership remains constrained by governance fragmentation, uneven institutional capacity, funding uncertainty, technological asymmetries, and wider geopolitical pressures. On this basis, the study identified a set of key drivers of change, including political commitment, funding continuity, institutional and network capacity, technological readiness, skills development, green transition priorities, and the broader international environment. These drivers were used to construct three plausible future scenarios: a more strategic and co-innovative pathway, a selective but uneven pathway, and a fragmented pathway shaped by instability and weakened cooperation. The

scenarios indicate that the future of Nigeria–EU STI collaboration is neither fixed nor linear. Rather, it will be shaped by how effectively both partners strengthen institutional coordination, reduce structural asymmetries, expand participation, and align cooperation with major global transformations, particularly in digitalisation, artificial intelligence, climate action, and innovation governance. The analysis suggests that the most desirable trajectory is one in which STI cooperation becomes more institutionalised, inclusive, challenge-oriented, and development-focused. Under such conditions, the partnership would be better positioned to move beyond fragmented and project-based engagement toward a more resilient framework of co-innovation capable of generating scientific, technological, economic, and societal benefits by 2040.

The study also contributes to existing literature by demonstrating the analytical value of combining bibliometric evidence with macro-environmental assessment and scenario planning in the study of international STI partnerships. Methodologically, this approach makes it possible to connect present collaboration patterns with long-term strategic uncertainties, thereby offering a more forward-looking basis for analysis than descriptive mapping alone. Substantively, the study highlights that Nigeria–EU STI relations should be understood not simply as a matter of scientific cooperation, but as part of a wider process of institution-building, innovation capacity development, and sustainable transformation within an evolving interregional context. From a policy perspective, the findings suggest that a stronger future partnership will require sustained political commitment, more stable and diversified funding, broader institutional inclusion, improved digital and research infrastructure, stronger absorptive capacity, and a continued focus on challenge-oriented collaboration in fields of shared societal relevance. Equally important is the need to embed foresight and adaptive governance within bilateral and interregional STI policy processes. In this sense, the future of Nigeria–EU STI collaboration will depend not only on preserving existing ties, but on actively shaping the conditions under which cooperation can become more equitable, strategic, and transformative in the years leading to 2040.

References

- Abdullahi, A., & Mustafa, A. S. (2021). Barriers to the effective implementation of e-parliament in Africa: A case study on the 8th Nigeria National Assembly (2015–2019). *Electronic Government, an International Journal*, 17(4), 438. <https://doi.org/10.1504/eg.2021.118088>
- Abdullahi, N. M., Huo, X., Zhang, Q., & Azeez, A. B. (2021). Determinants and potential of agri-food trade using the stochastic frontier gravity model: Empirical evidence from Nigeria. *SAGE Open*, 11(4). <https://doi.org/10.1177/21582440211065770>
- Abodunde, O., & Jegede, O. (2020). R&D productivity for science, technology and innovation policy development in Nigeria: A scientometric analysis of academic literature. *African Journal of Science, Technology, Innovation and Development*, 12(7), 787–795. <https://doi.org/10.1080/20421338.2020.1718364>
- Adeleke, R. (2020). Digital divide in Nigeria: The role of regional differentials. *African Journal of Science, Technology, Innovation and Development*, 13(3), 333–346. <https://doi.org/10.1080/20421338.2020.1748335>
- Akanle, O., & Ola-Lawson, D. O. (2021). Diaspora networks and investments in Nigeria. *Journal of Asian and African Studies*, 57(7), 1310–1324. <https://doi.org/10.1177/00219096211052970>
- Breugelmans, J. G., Roberge, G., Tippet, C., Durning, M., Struck, D. B., & Makanga, M. M. (2018). Scientific impact increases when researchers publish in open access and international collaboration: A bibliometric analysis on poverty-related disease papers. *PLoS ONE*, 13(9), e0203156. <https://doi.org/10.1371/journal.pone.0203156>
- Chidozie, F., Osimen, G. U., Bhadmus, J., & Newo, O. (2024). Sustainable development goals implementation in a post-colonial African state: Any future for the African Continental Free Trade Area? *Sustainable Development*, 33(1), 1479–1490. <https://doi.org/10.1002/sd.3183>

Chiemeke, S. C., & Imafidor, O. M. (2020). An assessment of the impact of digital technology adoption on economic growth and labour productivity in Nigeria. *NETNOMICS: Economic Research and Electronic Networking*, 21(1–3), 103–128. <https://doi.org/10.1007/s11066-020-09143-7>

Confraria, H., Godinho, M. M., & Wang, L. (2016). Determinants of citation impact: A comparative analysis of the Global South versus the Global North. *Research Policy*, 46(1), 265–279. <https://doi.org/10.1016/j.respol.2016.11.004>

Cornelius, O. O., & Greg, E. (2013). Federal character principles, nation building and national integration in Nigeria: Issues and options. *Mediterranean Journal of Social Sciences*. <https://doi.org/10.5901/mjss.2013.v4n16p33>

Cox, J. (2020). The higher education environment driving academic library strategy: A political, economic, social and technological (PEST) analysis. *The Journal of Academic Librarianship*, 47(1), 102219. <https://doi.org/10.1016/j.acalib.2020.102219>

Dabara, D. I., & Chiwuzie, A. (2022). Female-led agrarian households and the question of sustainable land and food security in an emerging economy: Evidence from Tula Baule. *Habitat International*, 120, 102512. <https://doi.org/10.1016/j.habitatint.2022.102512>

Di Luca, M., Destrebecq, F., & Kramer, S. (2021). Future of the aging brain: Bridging the gap between research and policy. *Aging Brain*, 1, 100002. <https://doi.org/10.1016/j.nbas.2020.100002>

Dodo, M. K. (2014). Examining the potential impacts of climate change on international security: EU-Africa partnership on climate change. *SpringerPlus*, 3(1), 194. <https://doi.org/10.1186/2193-1801-3-194>

Dosso, M., Cassi, L., & Mescheba, W. (2022). Towards regional scientific integration in Africa? Evidence from co-publications. *Research Policy*, 52(1), 104630. <https://doi.org/10.1016/j.respol.2022.104630>

EEAS. (2021). *EU projects with Nigeria*. Retrieved January 10, 2026, from https://www.eeas.europa.eu/nigeria/eu-projects-nigeria_en?s=114

Elijah, S., & Musa, A. B. (2019). Dynamic impact of trade openness on the economic growth in Nigeria. *International Journal of Engineering and Advanced Technology*, 8(5C), 609–616. <https://doi.org/10.35940/ijeat.e1087.0585c19>

European Commission. (2022). *EU-Africa cooperation in research and innovation*. Retrieved March 14, 2026, from https://research-and-innovation.ec.europa.eu/strategy/strategy-research-and-innovation/europe-world/international-cooperation/regional-dialogues-and-international-organisations/eu-africa-cooperation_en

European Commission. (2025). *Directorate-General for International Partnerships, Nigeria*. Retrieved March 14, 2026, from https://international-partnerships.ec.europa.eu/countries/nigeria_en

European Commission. (2026, February 23). *EU and Nigeria open negotiations on a bilateral Science & Technology Cooperation Agreement*. Retrieved March 1, 2026, from https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/eu-and-nigeria-open-negotiations-bilateral-science-technology-cooperation-agreement-2026-02-23_en

Figueiredo, N., Fernandes, C. I., & Abrantes, J. L. (2026). The moderating effect of absorptive capacity on the relationship between knowledge transfer and innovative capacity. *Technology in Society*, 86, 103248. <https://doi.org/10.1016/j.techsoc.2026.103248>

Grutman, A. J., & Burnett, A. L. (2026). Fidelis Udeh: Expanding the legacy of Black urologists in the United States. *Urology*. <https://doi.org/10.1016/j.urology.2026.01.027>

Hauck, J., Schleyer, C., Priess, J. A., Veerkamp, C. J., Dunford, R., Alkemade, R., Berry, P., Primmer, E., Kok, M., Young, J., Haines-Young, R., Dick, J., Harrison, P. A., Bela, G., Vadineanu, A., & Görg, C. (2019). Combining policy analyses, exploratory scenarios, and integrated modelling to assess land use policy options. *Environmental Science & Policy*, 94, 202–210. <https://doi.org/10.1016/j.envsci.2018.12.009>

Hout, W., & Salih, M. (2019). A political economy of African regionalisms. In *Edward Elgar Publishing eBooks*. <https://doi.org/10.4337/9781785364372>

Ilori, M., Adeniyi, A., Oyewale, A., Sanni, S., & Irefin, I. (2002). Developing a manufacturing-based economy in Nigeria through science and technology. *Technovation*, 22(1), 51–60. [https://doi.org/10.1016/S0166-4972\(00\)00054-7](https://doi.org/10.1016/S0166-4972(00)00054-7)

Joshua, U., Salami, O. M., & Alola, A. A. (2020). Toward the path of economic expansion in Nigeria: The role of trade globalization. *Journal of Labor and Society*, 23(2), 205–220. <https://doi.org/10.1111/wusa.12471>

Komolafe, J. (2008). Nigerian migration to Ireland: Movements, motivations and experiences. *Irish Geography*, 41(2), 225–241. <https://doi.org/10.1080/00750770802077016>

Kotsopoulos, J., & Mattheis, F. (2018). A contextualisation of EU–Africa relations: Trends and drivers from a reciprocal perspective. *South African Journal of International Affairs*, 25(4), 445–460. <https://doi.org/10.1080/10220461.2018.1551154>

Mbroh, F. K. (2021). *The evolution of economic development in Africa*. <https://doi.org/10.4324/9781003160243>

Members' Research Service. (2025, May 22). *Nigeria: Economic indicators and trade with EU*. Epthinktank. <https://epthintank.eu/2023/03/07/nigeria-economic-indicators-and-trade-with-eu/>

Mutua, M. N., Nakidde, C., & Mukumbang, F. C. (2025). Advancing the decolonisation agenda through an Indigenous realist evaluation approach: A case-based methodological reflection. *International Journal of Qualitative Methods*, 24. <https://doi.org/10.1177/16094069251349468>

Mwogosi, A., & Mambile, C. (2025). Applying PEST analysis to evaluate the adoption of electronic health records in Tanzanian healthcare: A scoping review. *Digital Health*, 11, 20552076251334029. <https://doi.org/10.1177/20552076251334029>

National Bureau of Statistics. (2026). *Nigerian gross domestic product report (Q2 2024)*. Retrieved February 22, 2026, from <https://nigeria.opendataforafrica.org/NGNBSNGDPPTO2016>

Ndayi, Z. (2009). Contextualising NEPAD: Regionalism, plurilateralism and multilateralism. *South African Journal of International Affairs*, 16(3), 371–387. <https://doi.org/10.1080/10220460903495132>

Okejiri, E. (2000). Foreign technology and development of indigenous technological capabilities in the Nigerian manufacturing industry. *Technology in Society*, 22(2), 189–199. [https://doi.org/10.1016/S0160-791X\(00\)00009-9](https://doi.org/10.1016/S0160-791X(00)00009-9)

Olabisi, M., Adeyemi, U., Maredia, M. K., Ajibade, T., & Ajeigbe, H. (2025). High frequency phone surveys for tracking food prices: Evidence from the KasuwaGo project. *Global Food Security*, 45, 100863. <https://doi.org/10.1016/j.gfs.2025.100863>

Olakpe, O. (2022). Views on migration partnerships from the ground: Lessons from Nigeria. *International Migration*, 60(4), 28–37. <https://doi.org/10.1111/imig.12974>

Olaomi, O. O., Fasina-Ayoola, A., Tunde-Ayinmode, M. F., Orji, E. O., Usang, U. E., Desalu, I., Adesoji, A., Aje, A., Ibeanusi, S., Imogu, A. O., Ikem, I., Wahab, Y., Madugu, N. H., Ekanem, E. E., & Anumah, F. (2026). Progress in emergency medicine in Nigeria: Where we are in 2025. *African Journal of Emergency Medicine*, 16(1), 100937. <https://doi.org/10.1016/j.afjem.2025.100937>

Olaoye, O., & Zerihun, M. F. (2023). Financial inclusion and poverty reduction in Nigeria: The role of information and communication technology (ICT). *African Journal of Economic and Management Studies*, 14(4), 726–740. <https://doi.org/10.1108/AJEMS-12-2022-0488>

Olanrewaju, O., Bamiwuye, T., & Omotayo, A. O. (2025). Impact of conflict shocks on land rental market dynamics: Panel evidence from Nigeria. *Land Use Policy*, 158, 107748. <https://doi.org/10.1016/j.landusepol.2025.107748>

Oyetade, K., Zuva, T., & Harmse, A. (2025). Integrating Industry 4.0 technologies into IT education. *Cogent Education*, 12(1). <https://doi.org/10.1080/2331186X.2025.2479195>

Rezk, M. R. A., Piccinetti, L., Salem, N., Kapiel, T. Y. S., Hassan, M. M., Omoruyi, T. U., & El-Bary, A. A. (2025). Exploring future scenarios for strengthening science, technology, and innovation collaboration between Egypt and BRICS countries. *Journal of Business and Management Sciences*, 13(3), 59–69. <https://doi.org/10.12691/jbms-13-3-3>

Rezk, M. R., Piccinetti, L., Salem, N., Omoruyi, T. U., & Santoro, D. (2024). Nigeria's transition to a circular economy: Challenges, opportunities and future perspectives. *Insights into Regional Development*, 6(2). <https://doi.org/10.9770/IRD.2024.6.2>

Schreier, S. (2024). From policy to reality: Examining the rippling effects of return migration governance in Nigeria. *International Migration Review*. <https://doi.org/10.1177/01979183241293388>

Sharma, U., Sharma, S., Sharma, S., Sankhyani, N., Sharma, S., Sharma, S., Sharma, S., & Sharma, S. (2025). A global review of agroforestry research and policy directions: Addressing ecological and socioeconomic challenges through systematic review and bibliometric analysis. *Forest Policy and Economics*, 181, 103639. <https://doi.org/10.1016/j.forpol.2025.103639>

Siéwé, F., Egwuma, H., Ahmed, B., Sanni, A., Abu, S. T., Ojeleye, O. A., Nwahia, C. O., Choumbou, R. F. D., & Abdulahi, A. A. (2023). A best-bet system of rice intensification and poverty alleviation in Zamfara State, Nigeria: A mixed method analysis. *Agricultural Systems*, 213, 103805. <https://doi.org/10.1016/j.agry.2023.103805>

Speranza, C. I., Akinyemi, F. O., Baratoux, D., Benveniste, J., Ceperley, N., Driouech, F., & Helmschrot, J. (2022). Enhancing the uptake of earth observation products and services in Africa through a multi-level transdisciplinary approach. *Surveys in Geophysics*, 44(1), 7–41. <https://doi.org/10.1007/s10712-022-09724-1>

Thach, N. N. (2025). Which explains income differences across advanced economies: Solow model or MRW specifications? Fresh evidence from Bayesian Monte Carlo simulations. *SAGE Open*, 15(1). <https://doi.org/10.1177/21582440251327016>

The AU-EU Innovation Agenda. (2023). In *Global Gateway*. https://research-and-innovation.ec.europa.eu/system/files/2023-07/ec_rtd_au-eu-innovation-agenda-final-version.pdf

Tichý, L., Prouza, J., Šmolík, V., & Yakubu, Y. (2022). Is the EU perceived and recognised as an actor in international relations? The case of EU-Nigeria energy relations. *The Extractive Industries and Society*, 10, 101056. <https://doi.org/10.1016/j.exis.2022.101056>

Tijani, A. A., & Kehinde, A. D. (2026). European Union (EU) pesticide regulations and cocoa trade with Africa: Evidence from Nigeria. *World Development Sustainability*, 8, 100282. <https://doi.org/10.1016/j.wds.2026.100282>

Toivanen, H., & Ponomarev, B. (2011). African regional innovation systems: Bibliometric analysis of research collaboration patterns 2005–2009. *Scientometrics*, 88(2), 471–493. <https://doi.org/10.1007/s11192-011-0390-1>

Ufua, D. E., Emielu, E. T., Olujobi, O. J., Lakhani, F., Borishade, T. T., Ibidunni, A. S., & Osabuohien, E. S. (2021). Digital transformation: A conceptual framing for attaining Sustainable Development Goals 4 and 9 in Nigeria. *Journal of Management & Organization*, 27(5), 836–849. <https://doi.org/10.1017/jmo.2021.45>

Ukhurebor, K. E., Athar, H., Adetunji, C. O., Aigbe, U. O., Onyancha, R. B., & Abifarin, O. (2021). Environmental implications of petroleum spillages in the Niger Delta region of Nigeria: A review. *Journal of Environmental Management*, 293, 112872. <https://doi.org/10.1016/j.jenvman.2021.112872>

Uzo-Peters, A., Laniran, T., & Adenikinju, A. (2018). Brent prices and oil stock behaviors: Evidence from Nigerian listed oil stocks. *Financial Innovation*, 4(1). <https://doi.org/10.1186/s40854-018-0092-2>

Wang, F., Dong, Z., & Dong, J. (2022). Can international cooperation base for science and technology drive cooperation ability? Evidence from Xinjiang, China. *International Review of Economics & Finance*, 82, 699–706. <https://doi.org/10.1016/j.iref.2022.08.003>

Yakubu, K., Blacklock, C., Adebayo, K. O., Peiris, D., Joshi, R., & Mondal, S. (2022). Social networks and skilled health worker migration in Nigeria: An ego network analysis. *The International Journal of Health Planning and Management*, 38(2), 457–472. <https://doi.org/10.1002/hpm.3595>

Yunusa, L. A. (2020). Exchange rate volatility and Nigeria crude oil export market. *Scientific African*, 9, e00538. <https://doi.org/10.1016/j.sciaf.2020.e00538>

Author Contributions: Conceptualisation: *Leonardo PICCINETTI*; methodology: *Leonardo PICCINETTI*; Trevor Uyi OMORUYI; data analysis: *Leonardo PICCINETTI*; Donatella SANTORO, writing—original draft preparation: *Leonardo PICCINETTI*; Mohamed Ramadan A, REZK writing; review and editing: *Leonardo PICCINETTI*; Mohamed Ramadan A. REZK; Donatella SANTORO; Mohammed Mahgoub HASSAN, Irie Vroh BI, Mohamed Ramadan A. REZK; visualization: *Leonardo PICCINETTI*. All authors have read and agreed to the published version of the manuscript.

Leonardo PICCINETTI

ORCID: <https://orcid.org/0000-0002-7861-5668>

Trevor Uyi OMORUYI

ORCID: <https://orcid.org/0009-0006-0205-2383>

Donatella SANTORO

ORCID: <https://orcid.org/0000-0002-5651-8584>

Mohammed Mahgoub HASSAN

ORCID: <https://orcid.org/0000-0002-5224-2656>

Irie Vroh BI

ORCID: <https://orcid.org/0009-0009-2357-5361>

Mohamed Ramadan A. REZK

ORCID: <https://orcid.org/0000-0002-7677-3072>

This is peer-reviewed scientific journal <https://jssidoi.org/ird/page/peer-review-policy>

Copyright © 2026 by author(s). Publishing rights by [UAB Sustainability for Regions](#)

This work is licensed under the Creative Commons Attribution International License (CC BY).

<http://creativecommons.org/licenses/by/4.0/>

Open Access | Open Access