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Innovation research in and on Africa: A literature analysis in 2015–2021

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Innovation scholars disseminate their significant findings through international scientific journals. We conducted content analysis of 2,869 peer-reviewed articles on innovation in Africa, examining their origins, themes, collaborative networks, and scholarly influence. These articles, spanning the years 2015–2021, were curated from the Web of Science database across scientific, social science, and humanities journals. The findings reveal that 46.3% of these articles lacked contributions from African organizations or scholars, while 25.1% involved collaborations between African and non-African entities. A remaining 28.6% were exclusively authored by African scholars, with South African universities being the most frequent contributors. Notably, articles authored by scholars from non-African institutions garnered more citations and appeared in journals with higher impact factors. Key themes within these articles revolved around the knowledge economy, African business innovation, agricultural advancements, and the role of mobile phones in knowledge dissemination and marketing. Surprisingly, sustainability topics were notably absent. South Africa, Kenya, and Ghana featured prominently in the discussions. In conclusion, it is imperative to foster broader participation from African nations and scholars in innovation research and ensure a stronger African perspective in international publications. Additionally, as open-access publishing gains momentum, concerns about escalating publishing costs warrant attention.

Keywords: Africa, innovation, innovation research, knowledge, sustainability, scientific article, South Africa

Introduction

Innovation, encompassing innovation systems, capabilities, and processes, stands as a central focus across various academic disciplines. African scholars engaged in the study of innovation and its processes aspire to make their mark on the global academic stage by disseminating their findings in internationally recognized, peer-reviewed scientific journals. These publications serve as conduits through which valuable insights regarding innovation activities, management, policies, and systems are shared with fellow academics and interested stakeholders, including policymakers.

This exchange of innovation-related knowledge fosters its ongoing development and paves the way for its practical application in driving sustainable societal transformation (Diercks, Larsen, and Steward 2019; Martin 2012). Nevertheless, the existing body of systematic analysis of the latest innovation research specific to Africa remains limited. In fact, there is a notable dearth of understanding concerning Africa's overall contribution to the broader landscape of global innovation research, particularly in the context of innovation activities and processes taking place within the continent itself.

We studied the state of the art of the most recent Africa-topic international peer-reviewed research and academic discourse focused on innovations in Africa. In the process, we formulated the following research questions: What specific themes and topics did scholars explore in innovation articles centred around Africa? To what extent did African scholars and universities contribute to the creation of new scientific knowledge concerning innovations in Africa? How much of this content was generated in the absence of African researchers' involvement? What implications did the origin of these insights have on the potential for harnessing innovations to benefit African nations, businesses, and society at large?

The empirical foundation for our investigation into innovation research within Africa encompassed peer-reviewed scientific literature, specifically articles and review articles published in international serial publications between 2015 and 2021. We screened for articles that intricately explored the intersection of innovation and Africa. Each selected article was sourced from an international, regularly published peer-reviewed journal with an esteemed international scientific editorial board. These articles were accessible via open access or purchase options, ensuring comprehensive availability to researchers. Our search was carried out within the Web of Science database, owned by the private enterprise Thomson Reuters and administered by Clarivate (Web of Science 2022). This database holds a prominent status for the evaluation of scholarly performance, as it is widely employed to assess the contributions of scholars, universities, and countries, allowing for corresponding rankings (ARWU 2021).

Research concerning innovations in Africa is frequently disseminated through non-academic outlets and national academic publications. If one's intention is to explore non-academic discussions on innovations in Africa or study innovation research published in languages other than English, the Web of Science database is not the most suitable choice. However, our

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primary focus centred on research-based, scientifically rigorous dialogues pertaining to innovations related to Africa, encompassing contributions from scholars within and beyond the African continent.

Between 2015 and 2021, the Web of Science indexed over 140,000 articles related to innovation across a multitude of journals. Within this vast array, only a fraction, comprising less than 3,000 articles, concentrated on Africa, as elaborated upon in the subsequent empirical section of this study. The choice of the Web of Science database was well-suited to our research objectives, as publications included in Web of Science are peer-reviewed and typically exhibit a higher scientific impact compared to those exclusively referenced in other databases like Scopus or Google Scholar (Martín-Martín et al. 2018). However, due to this selection criteria, the article does not capture the entirety of innovation research in Africa, and that not containing peer-review process or published outside international academic journals.

In Africa and across the globe, knowledge creation resulting in innovations has garnered recognition as pivotal driver of progress and competitive advantage for nations, businesses, and communities (Robertson, Caruana, and Ferreira 2023). This recognition traces back to the insights of the eminent innovation scholar Joseph Schumpeter. He astutely observed that innovations encompassed a wide spectrum of novel products, services, processes, and markets – a comprehensive definition that remains apt even in contemporary times (Schumpeter 1942). Presently, innovations are universally acknowledged as indispensable tools for fostering long-term sustainable economic, social, and environmental development (Silvestre and Ţîrcă 2019).

In the realm of innovation studies, one of the formidable challenges lies in the remarkable diversity of innovations and innovation processes. Innovations can manifest themselves incrementally or disruptively, in formal or informal capacities, and they can also take shape through resource-efficient means. These transformative developments can be driven by individuals or groups, involving various degrees of openness and collaborative efforts within enterprises or extending beyond the boundaries of private and public sectors (Chesbrough, Vanhaverbeke, and West 2014).

The emergence of innovations can be supported by dedicated innovation policies established at the national, regional, or industrial innovation system levels, yet they can also materialize without any policy interventions. In the African context, innovations may serve as agents of responsible, transformative change geared toward sustainable development, but at times, they may adopt a narrower focus, contributing to unsustainable economic growth and societal exclusion (Amankwah-Amoah 2019; Cozzens et al. 2007; Diercks, Larsen, and Steward 2019; Jauhiainen and Hooli 2020; Kraemer-Mbula et al. 2023).

In the pursuit of sustainable development in Africa, knowledge pertaining to diverse innovations and the sustainable utilization of natural resources holds paramount importance. The continent's share of the global population and economy is on a rapid incline, a trend expected to persist for decades to come. Notably, Africa is projected to account for half of the world's population growth between 2020 and 2050, leading to a remarkable increase of 900 million individuals in its urban population (United Nations 2022).

Leveraging research-derived insights, particularly those related to the adaptation and utilization of new technologies, can play a pivotal role in supporting sustainable development in Africa (Amankwah-Amoah 2019). Furthermore, digitalization has been found to have a positive contribution to economic growth in the continent (Myovella, Karacuka, and Haucap 2020). Access to pertinent scientific publications on innovation is indispensable for augmenting knowledge and facilitating practical applications. However, it is imperative to acknowledge that not all information and knowledge about African innovations and innovation activities are universally deemed relevant. Similarly, not all research findings are readily accessible, and there remains a critical need to ensure that diverse and relevant perspectives are duly considered in the realm of innovation research in Africa.

Historically, the body of knowledge concerning Africa and the methods employed in its generation were predominantly shaped by the Global North, primarily scholars from Western European nations and the United States. The determination of research interests and the establishment of scientifically relevant research methodologies within Africa were decisions made external to the continent (Ndlovu-Gatsheni 2020). Additionally, external resources and funding played a pivotal role in facilitating research activities in and about Africa, a situation aptly highlighted by Owusu-Nimo and Boshoff (2017). This dynamic fostered a division between what was perceived as the academic centre in the Global North and what was seen as the periphery in the Global South, rendering research vulnerable to the interests of external funders.

Valentin-Yves Mudimbe (1994), a Congolese philosopher and professor, eloquently critiqued this colonial influence on African worldviews and knowledge production. A similar sentiment was later expressed by a South African professor, Sabelo J. Ndlovu-Gatsheni (2020, 884), who argued: 'under Euro-American-centric modernity, epistemology was instrumentally and strategically deployed in accordance with the coloniser's model of the world, whereby Europe and North America were put at the centre.' Other Southern African scholars, Amasa Ndofirebi and Ephraim Gwaravanda (2019), advanced the notion that this unjust Eurocentric epistemology continues to exert a dominant influence in African universities, often overshadowing the rich tapestry of African indigenous knowledge systems (see also Amin 2009).

Even in contemporary times, a significant portion of innovation research about Africa continues to unfold without the active participation of African scholars, as elucidated further in this article. The result is that the production of knowledge on Africa takes place within historically determined as well as ongoing asymmetrical relations of power. These unequal categories include the objects of historical knowledge, the producers of such knowledge; and the global structure of knowledge production and distribution (Arowosegbe 2016, 324).

For many Global North researchers, Africa remains an exotic and intriguing reservoir of empirical data, often removed from the continent itself, with valuable knowledge generated elsewhere to catalyze the development of innovations. Africa-related knowledge and its associated benefits have predominantly accrued to scholars, universities, and countries in the Global North (Hountondji 2002; Samoff and Bidemi 2004). Consequently, some vestiges of colonial-era knowledge creation practices endure into the twenty-first century (Collyer et al. 2019).

However, there is evidence of research collaboration, exemplified by co-authored articles involving scholars from the Global North and African countries. In principle, such articles signify that research collaboration has taken place, scholars have conducted themselves professionally, and scientific communication has transpired legitimately (Glänzel and Schubert 2004). Nevertheless, African scholars or organizations very rarely play a substantive or pivotal role in the design, execution, or the publication of research findings. Instead, their involvement is typically confined to aiding local data collection and providing insights into the African context, often operating within Eurocentric scientific frameworks and methodologies imposed on Africa (Keikelame and Swartz 2019; Ndofirepi and Gwaravanda 2019; Seth 2009). This form of collaboration often adheres to scientific paradigms shaped by the Global North and focuses on topics and academic disciplines of interest to scholars from the Global North.

International scientific collaboration serves to expand the global footprint of scientific knowledge. African scholars engaging in international scientific collaboration may experience a substantial and enduring improvement in the quality of their articles, as reflected in their citation counts (Mirzenami and Beaudry 2022). However, the collaboration process can inadvertently perpetuate and reinforce the roles of centres and peripheries in knowledge creation (Olechnicka, Ploszaj, and Celinska-Janowicz 2019). Indeed, the influential academic cores situated in the Global North (core-in-centre) typically shape the primary scientific paradigms. The leading universities of the United States and the United Kingdom stand out as the primary scientific centres in innovation research, followed by a limited number of centres in European countries and China. However, in Africa there are no global core-in-centre universities. Instead, a few centre-in-periphery academic centres outperform other universities in the region. These are consequently sought after as collaboration partners by the Global North stakeholders (Jauhiainen 2023). Regrettably, this collaboration sometimes transforms into a utilization of African scholars and universities to the goals and purposes of their Global North counterparts.

Publishing research outputs rooted in theories, concepts, and practices primarily developed in Africa can be a daunting challenge, and efforts to decolonize research methodologies – especially in terms of power dynamics, trust, culture, and cultural competence – are notably rare. Equally infrequent are endeavours to establish respectful and legitimate research practices that duly recognize the assets of African individuals and communities (Bernard 2020; Keikelame and Swartz 2019; Seehawer 2018). However, in Africa critical academic edges within the peripheries (edge-in-periphery) can be found that lean more heavily on indigenous knowledge and may offer alternative epistemological and context-specific methodological perspectives, potentially also in innovation studies. However, many scientific institutions in Africa remain peripheral (periphery-in-periphery), struggling to meet international academic standards (Jauhiainen 2023). This dynamic gives rise to hierarchies, casting African researchers in peripheral roles within international research on innovation activities and innovations in Africa. The consequence is that they often lack significant impact in the global scientific arena (Tijssen 2007).

In the realm of innovation research, obtaining access to knowledge deemed globally relevant necessitates adherence to the conventions and standards established by international scientific journals in which researchers aim to disseminate their findings. Rather than striving to introduce fresh perspectives in innovation research drawn from African-originated theories, concepts, and research methodologies, many African innovation scholars tend to rely on innovation frameworks, theories, and research methodologies developed in the Global North. Boladale Abiola Adebowale et al. (2014) aptly identify the challenges associated with transplanting Global Northern concepts or conceptualizations of innovation and innovation systems into the study of innovation activities and processes within Africa. They argue, 'some of the ideas and concepts which have emerged in the innovation systems community have been derived mainly from specific experiences in rich countries and cannot be used as universal templates.' (Adebowale et al. 2014, v).

Besides relying on publishing with Global North researchers, many promising African scholars often find it necessary to migrate to prominent universities in the Global North to publish their research findings and advance their careers in the global academic arena. This phenomenon significantly contributes to the brain drain from Africa to the Global North (Doh and Jauhiainen 2021). Unfortunately, this migration has an inequitable impact on innovation research concerning Africa. While some of these Africans who relocate continue to engage in innovation research in Africa, a considerable number of them lack formal affiliations with any African universities or research institutes. Consequently, their scholarly contributions are primarily credited to institutions in the Global North, and their research pursuits tend to align with topics deemed relevant there, as evidenced later in this article. Nevertheless, American economist William Easterly and Ghanaian-origin economist Yaw Njarko have posited that, in the long run, the brain drain may have positive repercussions for both the migrant scholars and Africa. They argue that these migrants could achieve economic gains from this experience, and the financial remittances they send to Africa might help offset the economic losses associated with the African brain drain (Easterly and Nyarko 2008). Nonetheless, the loss of academic expertise in innovation research within Africa is a clear consequence of this migration.

Material and methods

The empirical foundation underpinning this article's investigation of innovation research in and on Africa was sourced from peer-reviewed scientific articles and review articles published in international serial publications between 2015 and 2021. These selected articles explored the theme of innovation in the context of Africa and were indexed within the Web of Science database. Researchers are notably incentivized to disseminate their research findings through journals included in this database, as it is widely employed for the assessment of scholarly performance at the individual, institutional, and national levels.

To ascertain that the articles analyzed pertained to innovation and Africa, we ensured that both the terms 'innovation' and 'Africa' or 'African' were explicitly referenced in the title, keywords, or abstract of each article, which aligns with the 'Topic' category in the Web of Science database. Additionally, we conducted a thorough examination to confirm that each publication indeed centred around the subject of innovation within the African context. Notably, we excluded topics like 'African American,' and specific domains within the medical sciences where the term 'innovation' carried a distinct connotation and was therefore outside the scope of our material.

Thomson Reuters, the Web of Science database's owner, asserts that the database is curated by impartial subject matter experts who refrain from any alteration aimed at promoting publications from journals under their ownership. We do not assert that publications lying outside the confines of the Web of Science database lack value with respect to studies related to innovation in Africa. However, they might not consistently adhere to the rigorous criteria characteristic of scientific, peer-reviewed publications, which constitute the specific focus of this article. Consequently, our data selection from the Web of Science database deliberately excluded items such as books, book chapters, contributions in seminar publications, or letters, as these did not consistently meet the criteria of peer review.

Upon comprehensive screening of the entire Web of Science database spanning from 2015 to 2021 (as of February 9, 2022), we extracted four distinct datasets. The first dataset encompassed all articles within the Web of Science that centred on innovation topics related to Africa, totalling 2,869 articles. The second dataset encapsulated African innovation-related articles in which no scholars were affiliated with organizations based in Africa, constituting 1,328 articles. These articles pertained to innovation within Africa but were not authored by scholars located on the continent. The third dataset included innovation articles on Africa that were co-authored by scholars, with at least one representing an organization from Africa and another from outside of the continent, amounting to 720 articles. The fourth dataset was composed of innovation articles related to Africa, exclusively authored by scholars situated in Africa, comprising 821 articles. Within this dataset, we conducted further scrutiny, distinguishing between innovation scholars affiliated with organizations in South Africa and those originating from institutions outside of South Africa.

The exploration of innovation encompasses a wide array of academic disciplines. In our analysis, we acknowledged the significance of various fields, including not just the social sciences but also the natural sciences, humanities, and more, in the context of innovation-related research. Among the articles scrutinized, 49.7% were classified within the science subjects, specifically indexed in the Science Citation Index Expanded (SCI). Additionally, 35.4% fell within the realm of the Social Sciences Citation Index (SSCI), while 4.1% were found in the Arts & Humanities Citation Index (AHCI). Furthermore, 32.6% were indexed in the Emerging Sources Citation Index (ESCI), primarily comprising newer journals or those that had yet to be integrated into other Web of Science databases. Some articles might have received multiple index ratings, but we ensured that each article was counted only once in our analysis.

Following the compilation of our datasets, we conducted a quantitative analysis utilizing descriptive statistics, with a specific emphasis on discerning distinctions within the four datasets. In our first stage of analysis, we scrutinized the volume of innovation articles pertaining to Africa in these datasets, spanning the years from 2015 to 2021.

The second phase involved identifying prevalent research topics (areas), themes, countries, and organizations within the scope of innovation articles concerning Africa. To facilitate this, we employed the Visualization of Similarities programme (VOSviewer) and harnessed its algorithms for clustering. VOSviewer is commonly used for analyzing large data of bibliographic references (for general use, see Jauhiainen, Krohn, and Junnila 2023, 6–7). This enabled us to unveil connections among the research areas featured in the articles, the countries participating, and the organizations involved, including universities and research institutes.

In the third phase of our analysis, we gauged the scientific impact of the articles. This evaluation encompassed factors such as accessibility, which included considerations of open-access categories, as well as an assessment of the prestige associated with the publication venues and an exploration of the number of citations received.

In the fourth and final stage of our analysis, we pinpointed the most prolific innovation scholars authoring works related to Africa. Our investigation extended to an exploration of their demographic backgrounds, including their native countries, the nations where they pursued their doctoral studies, and their present affiliations and countries of residence. This was presented to provide more information about key individual contributors to innovation scholarship regarding Africa.

Findings

Development of innovation articles regarding Africa

Between 2015 and 2021, a total of 2,869 international peer-reviewed scientific articles focusing on innovation in Africa were catalogued in the Web of Science database. Among these, 821 articles (28.6%) exclusively featured scholars affiliated with organizations located in Africa,

720 articles (25.1%) were co-authored by scholars from both African and non-African organizations, and 1,328 articles (46.3%) lacked any involvement from African organizations. In the subset of Africa-related innovation articles featuring solely African organizations, scholars from institutions in South Africa were represented in a substantial 68.4% of cases. Furthermore, when considering all international innovation research outputs pertaining to Africa in peer-reviewed journals, a mere 8.1% were authored entirely by scholars associated with universities, research institutes, or other organizations within Africa, excluding South Africa.

In the broader context of innovation research about Africa culminating in international peer-reviewed scientific articles, a noteworthy trend was the prevalence of multilateral international collaboration. These publications frequently emerged from joint efforts involving scholars hailing from universities or research institutes in at least two countries, sometimes including an African nation. Consequently, the incidence of single-author articles witnessed a decline, reflecting the evolving landscape of research collaboration. In innovation articles exclusively authored by African organizations, the proportion of single-author articles decreased from 22.8% in 2015 to 13.8% in 2021, while in articles devoid of scholars affiliated with African organizations, the figures dropped from 32.0% to 19.6%.

Several factors contributed to this decline. On the one hand, the transdisciplinary nature and intricate facets of innovation topics frequently demand a confluence of diverse expertise, skills, and financial resources beyond what an individual scholar might possess. On the other hand, the intensifying pressures of internationalization in academic publishing have fuelled the trend toward international co-authored articles. Such articles play a pivotal role in enhancing university rankings and advancing the academic careers of researchers (Kwiek 2021). In Africa, research funding originating from external sources typically triggers international research cooperation and gives rise to co-authored publications (Pouris and Ho 2014).

Innovation is increasingly taking a more prominent place on the research agenda concerning Africa, evident in the burgeoning number of related articles (Figure 1). The annual count of innovation articles dedicated to Africa more than doubled, registering a significant increase of 143% between 2015 and 2021. Nonetheless, these articles constituted only a fraction of the total, representing a mere 1.3% among all Web of Science articles related to Africa and a modest 2.0% among all innovation-related articles.

The most notable relative growth during this period, from 2015 to 2021, was observed in the category of innovation articles exclusively authored by scholars affiliated with organizations in Africa, demonstrating an impressive increase of 172%. This surge outpaced the growth in Africa-topic innovation articles that excluded organizations from Africa (increasing by 126%), those executed through collaboration between scholars from organizations both within and outside of Africa (rising by 143%), and all innovation articles not exclusively focused on Africa (advancing by 131%). However, the the absolute growth in Africa-related innovation articles was most pronounced in the subset of articles that excluded scholars in Africa.

Geography of innovation articles regarding Africa

In articles concerning innovations with Africa as their central theme, the term 'geography' pertains to two aspects: the country where the article was produced (indicating the locations of the authors' affiliations) and the specific African countries and regions that the articles addressed.

From 2015 to 2021, affiliations from a total of 154 countries were engaged in Africa-related innovation articles. Out of these countries, 112 hailed from outside the African continent, while 42 were African nations. This extensive international participation can be attributed to the involvement of numerous scholars in global science and medical research networks, which featured certain aspects of innovation and had the collaboration of African scholars.

The countries that featured most frequently in the authors' affiliations were South Africa (accounting for 29.0% of the total with 832 articles), followed by the United States (19.6%, 563), the United Kingdom (16.1%, 463), Germany (7.1%, 204), and the Netherlands (6.8%, 194). Non-African nations are known for their advanced status in research, development, and innovations, boasting internationally acclaimed universities and prominent scholars in the field of innovation studies.

A robust cluster and network dedicated to Africa-related innovation research was notably centred around Wageningen University in the Netherlands (Figure 2). Additionally, other influential centres or hubs for innovation research focused on Africa can be found at the Science Policy Research Unit (SPRU) at the University of Sussex and University College London in the United Kingdom.

Of the 54 African countries, scholars from 42 African nations (77.8%) were actively involved in publishing innovation articles related to Africa between 2015 and 2021. However, 12 countries (22.2%) did not have any authors or affiliations contributing to innovation articles on Africa during this period. These non-participating countries included African nations with relatively small populations, along with Somalia and South Sudan, which faced severe political instability during the study period.

Conversely, South Africa emerged as a robust cluster in the realm of innovation research. Notably, South Africa's innovation research networks thrived around institutions such as the University of Cape Town, the University of Johannesburg, and Stellenbosch University (Figure 2). Following South Africa (representing 29.0% with 832 articles), the most common African country affiliations in innovation articles were Kenya (6.6%, 190 articles), Ghana (5.2%, 148), Nigeria (4.6%, 131), and Tanzania (2.8%, 81). These countries boasted several universities that held prominent positions within Africa, even though they may not have ranked as highly on a global scale (ARWU 2021). Organizations in these

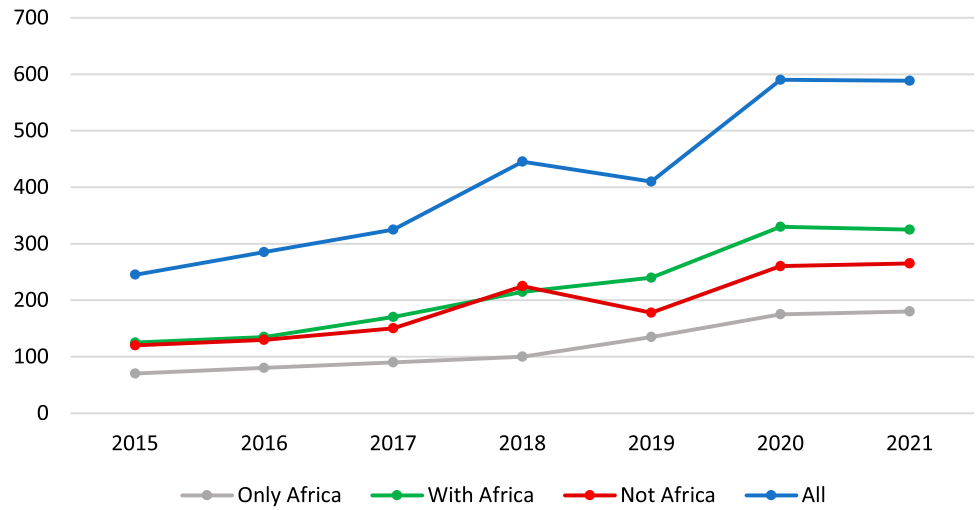

Figure 1. International peer reviewed innovation articles regarding Africa, 2015–2021.
***Source*:** Calculated from Web of Science (2022)

five countries collectively published an average of more than 10 innovation-related articles focused on Africa each year between 2015 and 2021. Affiliations from 23 African countries were represented in at least 10 innovation articles during the study period, while organizations from 14 additional countries contributed to between 1 and 9 articles within these seven years.

Countries themselves did not produce innovation articles; rather, these articles were authored by individuals affiliated with universities or research institutes located in various countries, both within and outside of Africa. Among the top 10 universities that actively published articles related to innovation in Africa, seven were based in South Africa, while the remaining three represented the Netherlands, the United Kingdom, and the Consultative Group for International Agricultural Research (CGIAR), an international research network organization with a presence in Africa through affiliations in Kenya, Nigeria, Ethiopia, and South Africa, as well as programmatic activities across the continent.

The CGIAR stood out as the most prolific publisher, contributing 158 innovation articles. Of these, 79.7% were co-authored by organizations within and outside of Africa, 12.7% were exclusively affiliated with organizations in Africa, and 7.6% lacked the involvement of organizations in Africa. The University of Cape Town in South Africa emerged as the most active university, producing 123 articles in collaboration with 196

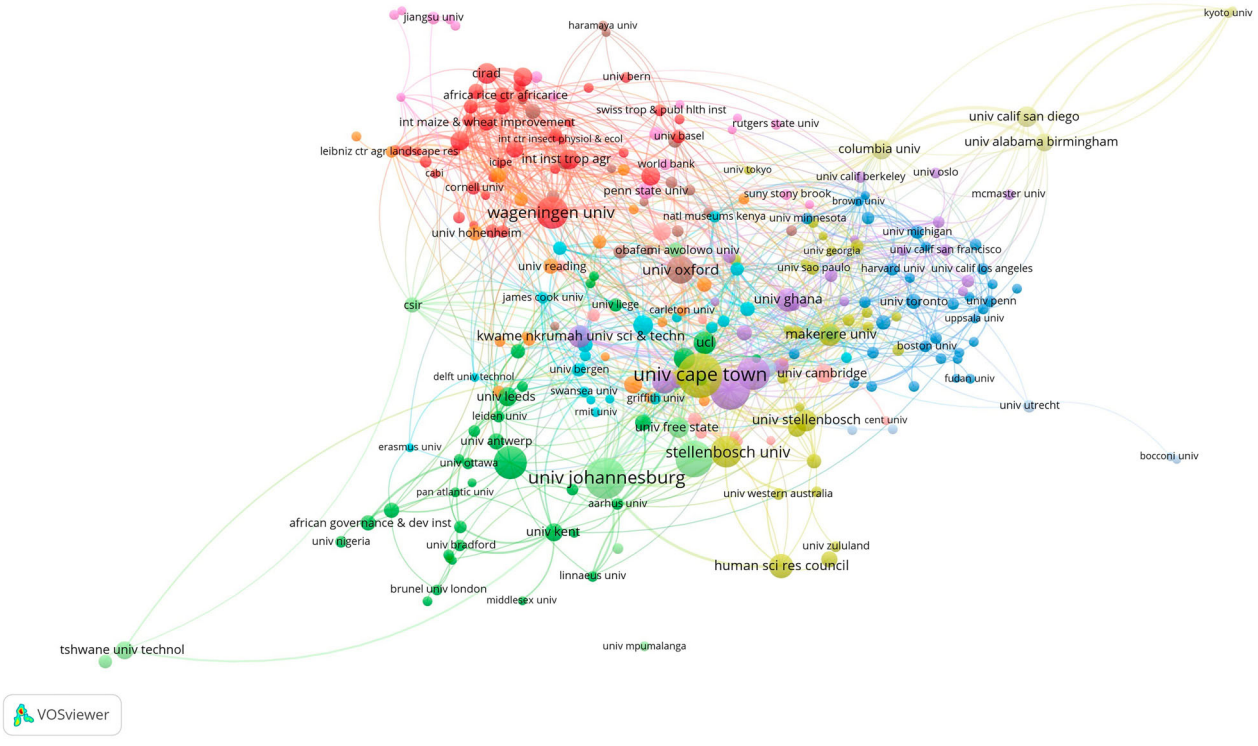

Figure 2: Research networks of international peer reviewed innovation articles regarding Africa, 2015–2021 (n = 2,869).
***Source*:** Calculated from Web of Science (2022)

organizations. The majority of this university's innovation articles centred on Africa were published in partnership with scholars from outside the African continent. This aligns with the overarching academic trend of increasing collaboration with scholars from organizations in leading publishing countries (for quantitative measures, see Kwiek 2021). Nevertheless, the University of Cape Town also engaged in collaborations with scholars from other South African organizations and institutions across Africa. In the broader context of innovation articles not specifically focused on Africa, the most prolific universities primarily hailed from the United Kingdom, the United States, and China. However, scholars from China were not yet extensively involved in research related to innovation in Africa.

Among the articles exclusively authored by organizations in Africa, South African institutions dominated the scene, accounting for nine out of every 10 most active contributors, with the remaining one originating from the CGIAR. Notably, these South African organizations included scholars from some of the highest-ranked universities in both South Africa and the broader African continent, as per the ARWU 2021 rankings. After South African universities, the next most active contributors to innovation articles related to Africa were universities from Ghana, as well as one university each from Uganda, Kenya, and Benin. Additionally, several international organizations with affiliations or research centres in Africa were actively involved. In the global academic ranking system, these universities were positioned substantially lower than South African institutions, despite their prominence and leadership within their respective national contexts (ARWU 2021).

Concerning articles lacking the involvement of scholars from any African organizations, the five most active contributors to innovation research related to Africa were based in the United States. Additionally, among the top 10 there were three organizations from the United Kingdom, one from France, and one international organization without a presence in Africa. These organizations included universities that were highly ranked within their respective countries, although not necessarily at the very top of their national rankings (ARWU 2021). Notably, only two organizations from Africa were among the affiliations responsible for producing a significant number of highly cited articles. These included one university and one research network (Table 1).

Previous studies have suggested that prolific researchers in Africa often have a PhD from a well-regarded English-speaking university in countries like the United States, Canada, the United Kingdom, or Australia. These African scholars typically engage in collaborations with non-African partners, particularly in foreign universities where they completed their PhDs (Confraria, Blanckenberg, and Swart 2018). The 20 most active academic scholars specializing in innovation research on Africa collectively authored 155 articles, accounting for approximately 5.4% of all such articles. This group included 11 men and nine women, with eight of them being native Africans. Furthermore, seven out of these 20 researchers obtained their PhDs in Africa, while six acquired their doctorates in the United States, three in the Netherlands, and four in other countries. In terms of their current affiliations, seven authors were affiliated with African organizations (with six working in South African universities), six were affiliated with organizations in the United States, three in the Netherlands, and four elsewhere.

The most prolific African innovation scholars were typically native South Africans who held PhDs from South Africa. This background provided them with both contextual knowledge about innovations in Africa and a solid understanding of contemporary innovation concepts and theories. Many of these highly productive scholars came from medical sciences and social sciences. The 20 most prolific scholars focused on innovation articles related to Africa and lacking the involvement of African universities or research institutes, collectively authored 45 articles. These accounted for 1.6% of all Africa-related innovation articles and 3.6% of all articles that did not involve African organizations.

The geographical focus was another aspect analyzed. As previously mentioned, all 2,869 articles were related in some way to Africa, its countries, and regions. Some articles covered several African countries, while others concentrated on individual countries. There were also articles that zoomed in on African macro-regions, like East Africa or West Africa, or encompassed larger geographical areas, such as sub-Saharan Africa or Mediterranean Africa.

In terms of geographical focus, 2,311 (80.6%) of the innovation-related articles mentioned at least one African country in their research. The most frequently studied country was South Africa, as it is the most developed in both innovation activities and academic research on innovation in Africa. South Africa was referenced in 919 articles, accounting for 39.8% of all articles mentioning a country or 32.0% of all articles. The next most-mentioned countries, each with over 100 articles related to Africa from 2015 to 2021, were Kenya (8.3% / 6.7%), Ghana (6.8% / 5.5%), Nigeria (5.2% / 4.2%), and Tanzania (4.7% / 3.7%). Out of all 54 African countries, three were not mentioned specifically in any articles, and 24 were discussed in fewer than ten articles. In general, research tended to focus more on areas where the common academic language was English rather than French. This observation was influenced by the predominance of English-language articles in the Web of Science database (Figure 3).

Innovation scholars in Africa tended to study more frequently the countries in which they resided than other African countries. For instance, innovation scholars from South Africa primarily focused on their own country in 76.7% of the articles, with very few articles concentrating on other specific African nations. In contrast, fewer African scholars directed their focus toward South Africa in innovation articles. Most commonly, these scholars had affiliations in Nigeria, Kenya, and Ghana.

Topics of African innovation articles

As previously noted, each article included in the study focused on both innovation and Africa as topics. The

Table 1: Most frequently appearing universities and research organizations in international peer reviewed innovation articles regarding Africa, 2015–2021.

Name	NR articles	ARWU rank	Name	NR articles	ARWU rank
All articles (n = 2,869)			Top-300 most cited articles (n = 300)		
CGIAR	158	–	CGIAR	40	–
University of Cape Town	123	201–300	Wageningen University Research	18	–
University of Johannesburg	100	601–700	University of California System	16	–
University of the Witwatersrand	98	301–400	Alliance	13	–
Wageningen University Research	92	101–150	University of the Witwatersrand	13	301–400
Stellenbosch University	87	401–500	University of London	12	–
University of Pretoria	83	401–500	CNRS	11	–
University of South Africa	81	601–700	CIAT	11	–
University of London	72	–	University of Oxford	11	7
University of KwaZulu-Natal	68	601–700	IFPRI	9	–
Only African organizations (n = 821)			Without African organizations (n = 1,328)		
University of Cape Town	67	201–300	University of California System	47	–
University of Johannesburg	67	601–700	University of London	41	–
University of South Africa	64	601–700	CGIAR	35	–
University of the Witwatersrand	61	301–400	University of Oxford	28	7
University of Pretoria	58	401–500	University of California San Diego	25	18
University of KwaZulu-Natal	49	601–700	Columbia University	23	8
Stellenbosch University	47	401–500	CNRS	19	–
Human Sciences R. C. South Africa	32	–	PCSHE	18	–
North-West University South Africa	28	601–700	State University of Florida	17	201–300
CGIAR	25	–	University College London	17	17

***Source*:** Calculated from ARWU (2021) and Web of Science (2022)

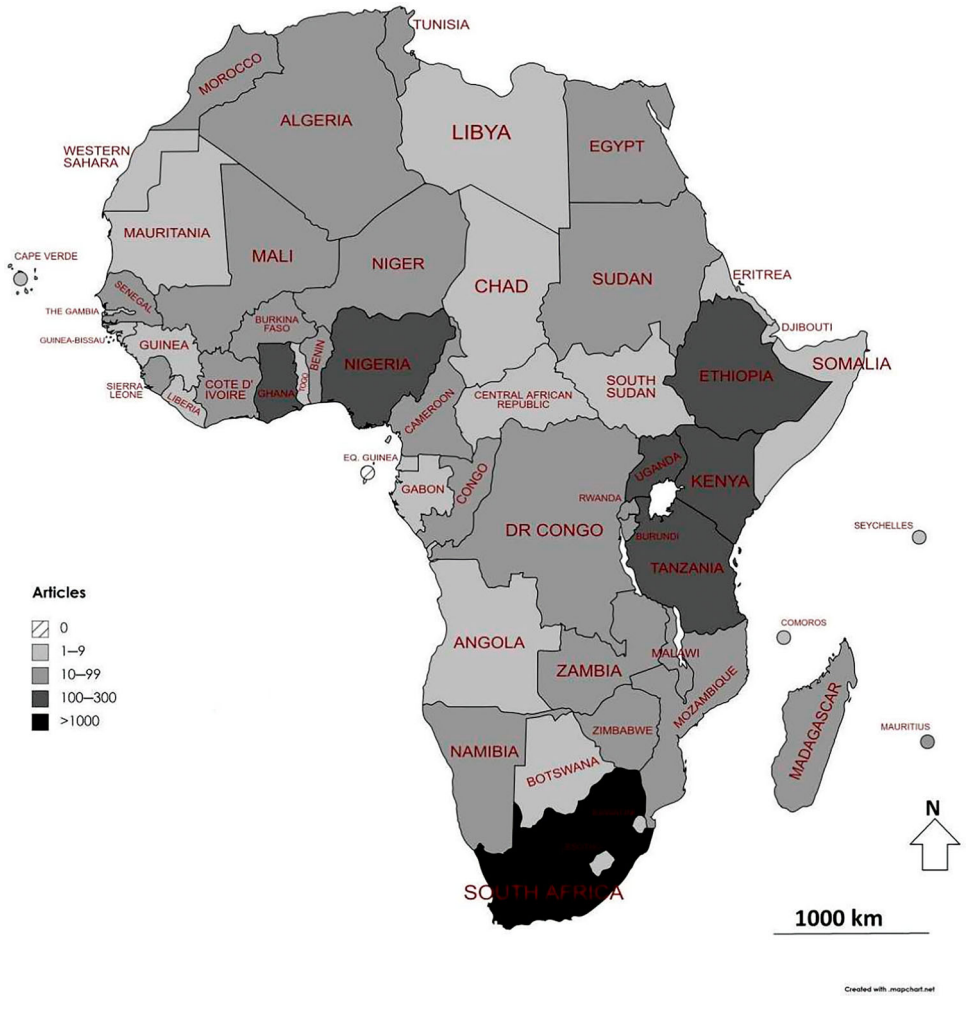

Figure 3: Geographical focus of international peer reviewed innovation articles regarding Africa, 2015–2021 (n = 2,311).
***Source*:** Calculated from Web of Science (2022).

Web of Science classifies articles into 20 main categories and 256 subcategories, with each article receiving at least one subcategory, often multiple ones. Among all the innovation articles related to Africa, 54 subcategories (22.2%) were mentioned at least once annually from 2015 to 2021. In articles without the involvement of scholars in Africa, 42 subcategories (17.3%) were mentioned, and this figure dropped to 28 subcategories (11.5%) in articles written exclusively by scholars in Africa, suggesting a narrower scope among the latter.

In the field of Africa-topic innovation articles, the most frequent category among articles written by scholars solely affiliated with African organizations was business economics, which accounted for 27.3% of the articles. Similarly, scholars from outside African organizations primarily focused on business economics (27.5%). Following this, environmental sciences and ecology were a significant field, making up 17.4% of the articles. In publications where there was no involvement of organizations in Africa, other science and technology topics were the second most common (12.0%). In the case of articles authored exclusively by scholars in African organizations, the next common research fields included other science and technology topics (17.8%) and education (8.6%) (Table 2).

According to the VOSviewer analysis, in the innovation articles exclusively authored by scholars in Africa, the most prevalent research topics included sustainability, climate change, food security, and developing countries (Figure 4). Sustainable development is a significant current challenge and future opportunity for Africa, with sustainability being the focus of 10.8% of innovation articles related to Africa. Interestingly, none of the articles managed to combine innovation with sustainability for 26 African countries. There is a need for more research at the intersection of innovation and sustainability in these regions.

The highest number of sustainability-related articles were found in South Africa (9.3% of all Africa-topic innovation articles from the country), followed by Kenya (11.0%), Ghana (13.5%), and Nigeria (11.4%). These countries have been active in developing technological innovations that have the potential to promote sustainability. However, to fully operationalize these innovations, additional research and knowledge are required (Amankwah-Amoah 2019). These nations are also home to research institutions dedicated to innovation policy, such as the African Technology Policy Studies (ATPS) network in Kenya, Nigeria, and Ghana, as well as the Africa Centre for Technology Studies (ACTS) in Kenya. Among research organizations, the CGIAR led in innovation-related sustainability research, with lesser contributions from Stellenbosch University and the University of Johannesburg in South Africa, both of which have established centres dedicated to sustainability science.

Indigenous knowledge, while not a common focus, did appear in a small proportion of innovation articles related to Africa (1.1%). Notably, the share of articles addressing indigenous knowledge increased over the years. This trend may be attributed to the rising research funding allocated to the study of indigenous knowledge and innovation, particularly by agencies such as the National Research Foundation (NRF) in South Africa.

In the analyzed articles, the conceptual, theoretical, and methodological frameworks for discussing innovation were predominantly rooted in the paradigms developed by scholars from the Global North. As a result, the generation of knowledge and research concerning innovation activities and innovations in Africa were significantly influenced, and sometimes even dictated, by Western ideals (Collyer et al. 2019; Ndlovu-Gatsheni 2020; Ndofirepi and Gwaravanda 2019). Notably, the most common themes in the articles exhibited remarkable consistency regardless of whether African authors were involved. However, in articles where scholars in Africa were absent, there were proportionally fewer references to African scholars. References related to Africa often highlighted earlier empirical examples from the focal country or other regions in Africa. Nevertheless, there were some exceptional cases in which the African perspective was emphasized, particularly in contextualizing concepts and theories. Nevertheless, research methodologies primarily adhered to mainstream approaches developed in the Global North (Seehawer 2018). Few articles by African scholars made explicit efforts to establish new theoretical frameworks for investigating innovation.

Scientific impact of innovation articles regarding Africa

Research articles on innovation in the context of Africa have been disseminated through international peer-reviewed scientific journals, with contributions from academic scholars hailing from diverse geographic regions. These studies have consistently prioritized the attainment of scientific impact as a central objective, and their

Table 2: Research areas in international scientific innovation articles regarding Africa, 2015–2021.

Only African organizations (n = 821)			Without African organizations (n = 1,328)		
Research area	n	%	Research area	n	%
Business Economics	224	27.3	Business Economics	365	27.5
Science Technology Other Topics	146	17.8	Environmental Sciences Ecology	231	17.4
Education Educational Research	71	8.6	Science Technology Other Topics	160	12.0
Environmental Sciences Ecology	70	8.5	Agriculture	85	6.4
Social Sciences Other Topics	51	6.2	Development Studies	84	6.3
Information Science Library Science	42	5.1	Government Law	64	4.8
Public Administration	34	4.1	Public Administration	60	4.5

***Source*:** Calculated from Web of Science (2022)

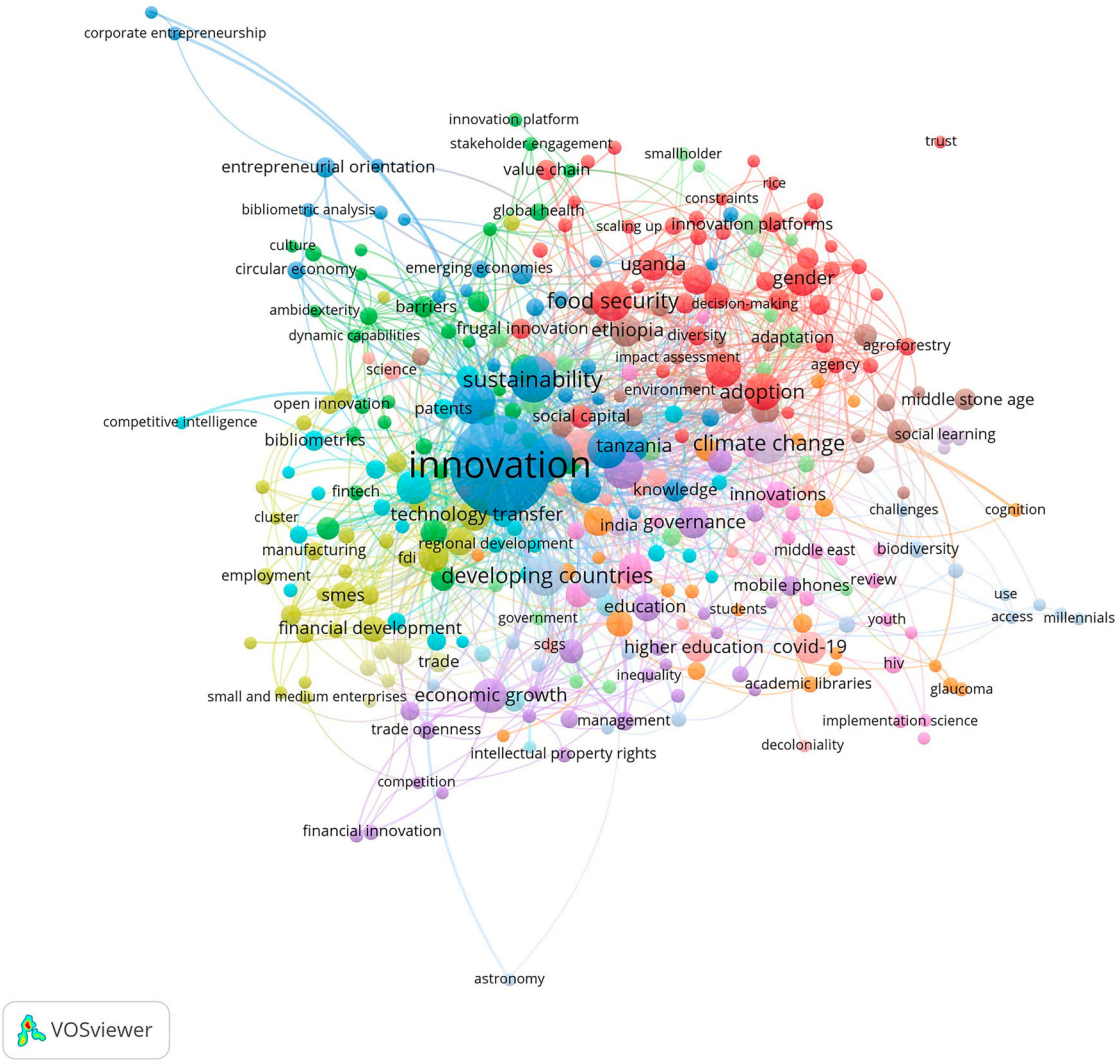

Figure 4: Topics of international peer reviewed innovation articles regarding Africa, 2015–2021. A VOSviewer analysis (n = 2,869).
***Source*:** Calculated from Web of Science (2022)

publication through the peer-review process has cemented their scientific credibility. This corpus of research represents a valuable resource, providing insights and information that can significantly inform the decision-making processes of policymakers, politicians, and the general public. However, to harness the benefits of this knowledge, it is essential for these stakeholders to have access to the articles and possess proficiency in English, along with a solid understanding of the specialized scientific terminology employed in these publications.

In the past, many journals imposed temporal restrictions or geographical limitations on access to research articles. However, in recent times, open access publishing has gained increasing prominence due to its ability to provide broader access to research findings, making them readily and globally available. In this scenario, individuals with an interest need only an internet connection to search for, locate, and read articles published through open-access procedures. Of all the articles related to innovation in Africa from 2015 to 2021, approximately half (49.2%, totalling 1,411 articles) were published with at least some open-access practices, and more than one-fifth (22.3%, equal to 640 articles) were fully accessible (Gold Access) on the Internet. On the other hand, nearly half (50.8%) of the articles had some level of accessibility restrictions (Table 3).

There was a small variation in open-access publishing practices among the organizations contributing to these articles. Articles authored exclusively by scholars in Africa had the lowest share of open-access publications. This can be attributed to the relatively limited financial resources of their organizations, making it challenging to cover the article processing charges (APCs) required for open-access publication. Certain innovation-focused journals are exclusively published via open access. However, these journals often necessitate the payment of APCs. Notably, '*Sustainability*' and '*Plos One*,' the second and third most common venues for publishing international peer-reviewed innovation articles related to Africa, fell into this category. Financial constraints posed a significant hurdle for many African scholars and organizations, hindering their ability to publish their innovation-related research in APC-based journals.

Research on innovation in the context of Africa has been disseminated across a multitude of peer-reviewed international academic journals. In total, these articles

Table 3: Open access in international peer reviewed innovation articles regarding Africa, 2015–2021.

	All articles		Articles by only African organizations		Articles without African organizations	
	Number	%	Number	%	Number	%
Open Access	1,411	49.2	314	38.2	634	47.7
Gold	640	22.3	240	29.2	240	18.1
Gold-Hybrid	296	10.3	25	3.0	135	10.2
Free to Read	131	4.6	15	1.8	74	5.6
Green Published	526	18.3	70	8.5	229	17.2
Green Accepted	267	9.3	4	0.5	142	10.7
Green Submitted	389	13.6	100	12.2	162	12.2
Not Open Access	1,458	50.8	506	61.8	686	52.3
All	2,869	100	820	100	1,320	100

***Source*:** Calculated from Web of Science (2022)

were published in 199 different journals during the period spanning 2015–2021. On average, approximately one article per year pertaining to this topic was featured in 60 different journals. However, this figure drops significantly when considering articles solely authored by scholars based in Africa, which appeared in 15 journals on average. Among these, the top three publication venues for innovation articles by scholars exclusively affiliated with African organizations were the '*African Journal of Science, Technology, Innovation and Development*'; '*Technological Forecasting and Social Change'*; and '*Sustainability*' (Table 4).

The '*African Journal of Science, Technology, Innovation and Development'* emerged as the most frequent venue for articles authored exclusively by Africans, often originating from South Africa. On the other hand, '*Sustainability*' and '*Technological Forecasting and Social Change*' stood out as the two leading publication platforms for innovation-related articles about Africa that lacked African authorship. Notably, the '*African Journal of Science, Technology, Innovation and Development'* held the fourth position in this ranking. Within its publications, 70.8% of articles were the work of exclusively African scholars, while 11.4% were co-authored by scholars from both African and non-African organizations, and 17.8% were devoid of any African organization's participation. Furthermore, individuals with African backgrounds contributed to 86.7% of the articles published in this journal, affirming its significance as a robust platform for African scholars to disseminate innovation articles related to Africa.

In contrast, '*Technological Forecasting and Social Change*' presented a significantly different profile. A mere 2.3% of its Africa and innovation related articles were authored exclusively by scholars based in Africa, while a substantial 75.0% of articles lacked contributions from any organization in Africa. These publication trends highlighted the issue of brain drain, as a considerable 56.8% of articles were composed by individuals with African backgrounds, yet organizations from Africa were involved in merely 25.0% of the articles.

In the case of innovation articles related to Africa published in '*Sustainability*', a distinct pattern emerged: 60.3% of the articles were published without contributions from scholars based in Africa, while 19.2% were the result of collaboration between scholars from African and non-African organizations. The remaining 20.5% were authored by scholars solely affiliated with organizations in Africa, with a notable emphasis on South Africa. Notably, 58.7% of all articles had authors with African backgrounds, indicating a significant presence of scholars with African heritage, surpassing the representation of those currently affiliated with organizations in Africa.

A key indicator of an article's academic impact is its citation count. A substantial increase in an article's citation count typically occurs a few years after publication. Since many of the articles under investigation were

Table 4: Most common international journals of peer reviewed innovation articles regarding Africa, 2015–2021.

Name	Number	Share	IF	Name	Number	Share	IF
All articles (n = 2,869)				Top-300 most cited articles (n = 300)			
African J of STI Development	99	3.5	–	Tech Forecasting and Soc Change	15	5.0	8.593
Sustainability	72	2.5	3.251	World Development	11	3.7	5.278
Plos One	44	1.5	3.240	Energy Research Social Science	9	3.0	6.834
Tech Forecasting and Soc Change	44	1.5	8.593	Agricultural Systems	8	2.7	5.370
World Development	34	1.2	5.278	Journal of Cleaner Productions	7	2.3	9.297
Agricultural Systems	31	1.1	5.370	Proc of the Nat Acad Sci USA	6	2.0	11.205
Only African organizations (n = 821)				Without African organizations (n = 1,328)			
African J of STI Development	68	8.3	–	Sustainability	40	3.1	3.251
South African Journal of Science	19	2.3	2.197	Tech Forecasting and Soc Change	30	2.3	8.593
Sustainability	18	2.2	3.251	World Development	26	2.0	5.278
SA J of Human Resource Manag	16	1.9	–	African J of STI Development	18	1.4	–
Scientific Africa	13	1.6	–	Energy Research Social Science	16	1.2	6.834
Development Southern Africa	12	1.5	1.442	Journal of Cleaner Production	16	1.2	9.297

***Source*:** Calculated from Web of Science (2022)

Table 5: Citations in international peer reviewed innovation articles and those regarding Africa.

	most cited	10th most cited	100th most cited	median
All articles	2,501	1,052	380	5
All social science articles	2,094	606	208	5
All African topic articles	248	109	49	3
Africa-only articles	108	36	10	2
Africa-only without South Africa	72	28	4	2

***Source*:** Calculated from Web of Science (2022).

relatively new, they had not yet accumulated significant citations. When examining the citations of the most influential innovation articles related to Africa, it was found that articles published in '*Technological Forecasting and Social Change*' were the most frequently cited among the top 300 articles. Notably, the '*African Journal of Science, Technology, Innovation and Development*' and '*Sustainability*' did not appear in the list of the most scientifically influential journals.

In general, the most highly cited articles tended to be published in journals with higher impact factors. Articles that lacked affiliations with African organizations were more likely to appear in journals with higher impact factors compared to articles exclusively authored by scholars affiliated with African organizations. Publishing an article in a high-impact factor journal is considered a notable achievement for authors, and authors from outside of Africa appeared to have an advantage in achieving this distinction.

Innovation articles related to Africa received fewer citations compared to general innovation articles, and social science articles on innovations received fewer citations than those from the natural sciences (Table 5). The top 10 most cited articles within this context explored a range of topics, including the role of knowledge and attitudes in agricultural and agroforestry innovations, the impact of green innovation on organizational performance, the use of mobile phones in knowledge diffusion, broader issues related to the knowledge economy in African business, and sustainability in project management. Furthermore, these articles delved into environmental themes, such as postharvest losses and fish passages, as well as specific issues pertaining to human history in Africa.

In general, articles that were the result of collaboration between African and non-African organizations received more citations than articles that did not involve any African organizations or articles authored exclusively by scholars in Africa. Interestingly, even the most cited article with solely African authorship received substantially fewer citations (Table 5).

The top 10 most cited innovation articles authored exclusively by scholars in organizations in Africa covered a range of topics, including general aspects of innovation in Africa, the knowledge economy gaps and knowledge management, mobile marketing and mobile financial services, climate-smart technologies, underutilized crops and biorefineries, and conservation agriculture. Additionally, these articles explored specific subjects such as the ancient human impact in Africa and human–elephant conflict mitigation. Many of these articles were case studies focusing on South Africa or southern Africa. The citation numbers within Africa were even smaller when excluding South Africa from the analysis.

Conclusion

This article analyzed 2,869 peer-reviewed, research-based articles on innovation in Africa from 2015 to 2021 from the Web of Science database, but did not address applied research published outside international academic journals or articles published without a peer-review process. A compelling need exists for scholarly knowledge and research-based insights into innovations and innovation processes within the African context. International peer-reviewed journals serve as pivotal repositories for this essential knowledge. This pursuit is accompanied by significant challenges and opportunities that are intrinsically linked to the endeavour.

The first issue pertains to the establishment of up-to-date knowledge concerning innovation research in Africa. Currently, there is no ongoing systematic analysis dedicated to peer-reviewed innovation research within the African context. Each year, over 500 articles – albeit fewer than two per day – are published in international peer-reviewed journals indexed in the Web of Science, addressing the intersection of Africa and innovations. Instituting a consistent mechanism for tracking the latest developments in the international scholarly discourse related to innovation activities, innovation systems, and innovations in the African context is an achievable endeavour. Building and maintaining such an ever-evolving database, coupled with accessible information, would prove valuable to both researchers and policymakers across the African continent.

The second issue revolves around the notably limited participation of African scholars in the sphere of international innovation research related to Africa. Currently, nearly half of the body of international scientific knowledge concerning innovation issues in Africa is devoid of contributions from universities, research institutes, or other organizations within the African continent. These articles are often crafted by and intended for scholars hailing from the Global North, who subsequently read and reference them. With the notable exception of South Africa, scholars and researchers from African universities have maintained a relatively modest presence within the international scientific dialogue on innovation in Africa and the associated body of scientifically recognized knowledge. In fact, researchers in South Africa played a significant role in nearly one-third of all innovation articles pertaining to Africa and were involved in two-thirds of intra-African articles. Furthermore, South Africa

emerges as the most extensively researched country concerning innovations in the African context.

However, within the field of innovation research, the considerable influence of non-African scholars persists, significantly shaping the scholarly discourse and determining what is considered significant and noteworthy in the domain of innovations and their research within Africa. This perpetuates the dominance of Eurocentric epistemology and the transfer of conceptual frameworks that may pose challenges when directly applied to diverse African contexts. Consequently, there arises a pressing need for methodologies and knowledge that are context-specific and emerge from within the African settings.

A valuable lesson in innovation research promotion can be gleaned from South Africa. The robust support for research, including well-established funding opportunities and research grants provided by entities like the National Research Foundation (NRF), the Technology Innovation Agency (TIA), and the National Advisory Council on Innovation (NACI), has significantly contributed to the impressive performance of South African researchers and organizations in the field of innovation research. South African universities emerge as highly sought-after partners for collaboration in innovation research, particularly among leading institutions in the United States, the United Kingdom, various EU member states, and scholars from diverse regions. Encouraging greater participation from African scholars in research and publications on innovations offers the potential to provide an authentic, contextually informed perspective on innovation activities, innovation systems, and innovations in Africa, thereby unlocking their capacity to benefit the continent more profoundly.

The third issue pertains to the choice of publication venues and the escalating costs associated with open-access publishing. During the period from 2015 to 2021, over 10 African innovation-related articles per year were published in a total of 29 publication series. The principal channels for authors to disseminate their research findings in international journals included the '*African Journal for Science, Technology, Innovation and Development*,' '*Technological Forecasting and Social Change'*, and '*Sustainability'*. Notably, a substantial portion of international peer-reviewed innovation articles with an intra-African focus found their home in South African academic peer-reviewed journals.

The articles lacking contributions from scholars or organizations in Africa were typically published in journals boasting higher impact factors, resulting in increased citation rates when compared to those involving African scholars or organizations. Consequently, approximately half of international peer-reviewed innovation articles concerning Africa were not accessible via open access, meaning they were not immediately available to all interested parties. Simultaneously, open-access publishing is witnessing a notable surge in popularity. Many publishing venues impose Article Processing Charges (APCs) that can be financially burdensome for African scholars, universities, and research institutes. A potential solution lies in negotiating collective agreements aimed at reducing publishing fees for scholars from Africa.

The fourth issue pertains to the future themes within the domain of innovation research. Up to this point, the majority of peer-reviewed international articles have revolved around fairly conventional innovation subjects linked to business, management, the environment, and technology. Research addressing the intersection of sustainability and innovation remains limited in many African countries, and studies investigating indigenous knowledge and local innovation activities are rare.

As digitalization, including the Metaverse and generative AI, gains ground, its implications for Africa must be a focal point, especially given the continent's rapid population growth and urbanization. It is imperative for Africa to transcend its current status as a mere empirical field for the application of general innovation theories and concepts. To achieve this, a broader spectrum of African nations should be included in innovation research, with a stronger representation of authors from these nations. Contextualizing general innovation concepts to suit Africa's unique conditions is essential, and the promotion of innovation research methodologies, practices, and concepts originating from Africa can enhance the global landscape of innovation research.

Realizing these objectives will necessitate financial support from African governments and organizations to steer innovation research on the continent. Additionally, African policymakers and researchers should articulate their demands for innovation research that is directly relevant to African policy and developmental contexts, ensuring the alignment of research endeavours with the specific needs and aspirations of the continent.

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