**Enhancing Technology Development and Transfer in Africa for Sustainability**

**Kariuki Muigua**

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**Enhancing Technology Development and Transfer in Africa for Sustainability**

**Kariuki Muigua[[1]](#footnote-1)\***

# ***Abstract***

*This paper critically discusses the need to enhance technology development and transfer in Africa. It argues that technology development and transfer is key in accelerating the Sustainable Development agenda in Africa. The paper defines technology development and transfer. It also examines the achievements made and setbacks facing technology development and transfer in Africa. The paper further offers ideas towards enhancing technology development and transfer in Africa for sustainability.*

# **1.0 Introduction**

Technology plays a key role in sustainability[[2]](#footnote-2). Technology is deemed vital to catalyzing innovation; promoting industrial and economic growth; and effecting social changes and human development to improve lives[[3]](#footnote-3). Access to technology is directly correlated with economic, social, and environmental productivity[[4]](#footnote-4). Eco-friendly technologies have a significant impact on the environment, as well as the economy[[5]](#footnote-5). Such technologies can aid in reducing greenhouse gas emissions, the amount of waste produced and the amount of money spend[[6]](#footnote-6). Technology is also a major enabler of competitiveness in almost all sectors[[7]](#footnote-7). Advances in technology often open up new opportunities that drive innovation, emergence of new companies, and improvement in the productivity and efficiency of existing ones[[8]](#footnote-8).

Most countries are now using science and technology to identify the answers to achieving a sustainable future and solving the environmental problems that they are facing[[9]](#footnote-9). The United Nations *2030 Agenda for Sustainable Development[[10]](#footnote-10)* recognizes the role of technology in realizing the Sustainable Development Goals (SDGs) including achieving food security; promoting good health and well-being; fostering access to affordable and clean energy; building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation and combating climate change[[11]](#footnote-11). It has been noted that achieving the SDGs requires action on a number of fronts, including harnessing and maximizing the potential of science and technological innovation for Sustainable Development[[12]](#footnote-12). These technologies include carbon capture and storage systems, more efficient irrigation methods, essential medicines, household water purification devices, and manufacturing processes that minimize waste and pollution[[13]](#footnote-13).

Due to the importance of technology in sustainability, there has been an increasing attention in recent years towards transfer of green technologies to developing countries[[14]](#footnote-14). It has been argued that African countries need to make presence, acquire and absorb relevant eco-friendly technologies in order to meet their various social-economic development imperatives as outlined in Africa Union’s Agenda 2063 and the Sustainable Development agenda[[15]](#footnote-15). Enhancing technology development and transfer is therefore key in fostering sustainability in Africa.

This paper critically discusses the need to enhance technology development and transfer in Africa. It argues that technology development and transfer is key in accelerating the Sustainable Development agenda in Africa. The paper defines technology development and transfer. It also examines the achievements made and setbacks facing technology development and transfer in Africa. The paper further offers ideas towards enhancing technology development and transfer in Africa for sustainability.

# **2.0 Technology Development and Transfer: Definition and Elements**

Technology development and transfer has been defined as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to climate change amongst different stakeholders including governments, private sector entities, financial institutions, non-governmental organization (NGOs), and research/education institutions[[16]](#footnote-16). Technology development and transfer encompasses diffusion of technologies and technology cooperation across and within countries[[17]](#footnote-17). It also entails the process of learning to understand, utilize and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies[[18]](#footnote-18). Technology development and transfer can also be understood as a planned and deliberate movement of a specific technology between two or more entities, in which the transferor and the recipient are identifiable, and their respective motives and purposes can be comprehended in most cases[[19]](#footnote-19).

Technology development and transfer therefore involves processes that distribute technology from its place of origin to more people and places[[20]](#footnote-20). It comprises not only the movement of tangible goods and services but also the exchange of ideas and concepts[[21]](#footnote-21). It has been pointed out that technology development and transfer must be aligned to the goal of Sustainable Development when being utilized as a sustainability tool[[22]](#footnote-22).

Technology development and transfer requires meaningful and effective actions including technology needs and needs assessments; technology information; enabling environment; capacity building; and mechanisms for technology transfer[[23]](#footnote-23). In addition, it has been pointed out that technology transfer capacity must recognize and must be pegged on certain criteria including: the ability to utilize/man/manage imported propriatory hardware[[24]](#footnote-24); the comprehensive understanding of imported propriatory technology involving the ability to alter, improve or otherwise retrofit the technology for local conditions or to bypass a problem without recourse to the supplier[[25]](#footnote-25); the ability to originate technology at all levels including research and development, bench scaling, piloting and commercial transfer[[26]](#footnote-26); and the ability to influence global thinking on local technology and foreign technology development programmes[[27]](#footnote-27).

It has been noted that technology development and transfer can help sustain natural resources and improve the livelihoods of people who depend on those resources[[28]](#footnote-28). Further, it has been argued that increasing water scarcity and the attendant unreliability of water supply coupled with competition for land arising from other non-agricultural demands necessitate the need for technology development and transfer[[29]](#footnote-29). When properly sourced and managed, technology development and transfer can enhance land productivity and tackle problems of food and water insecurity[[30]](#footnote-30).

Technology transfer plays an increasingly critical role in the global response to the challenges of climate change and of the global environment[[31]](#footnote-31). According to the Intergovernmental Panel on Climate Change (IPCC), technology development including improvement and reassessment of existing technologies, is urgently needed to: limit or reduce anthropogenic greenhouse gas emissions; absorb greenhouse gases by protecting and increasing greenhouse gas sinks; adapt human activities to the impacts of climate change; and monitor, detect, and predict climate change and its impacts[[32]](#footnote-32). It further notes that as the greenhouse gas emissions in developing countries are increasing with their population and economic growth, rapid transfer, on a preferential basis, to developing countries, of technologies that help to monitor, limit, or adapt to climate change, without hindering their economic development, is an urgent requirement for sustainability[[33]](#footnote-33).

The role of technology development and transfer in sustainability is acknowledged by the *United Nations Framework Convention on Climate Change (UNFCCC)[[34]](#footnote-34)*. The Convention requires states to promote and cooperate in the development, application and diffusion, including transfer, of technologies, practices and processes that control, reduce or prevent anthropogenic greenhouse gas emissions[[35]](#footnote-35). It also requires developed countries to take all practicable steps to promote, facilitate and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and knowhow to other parties, particularly developing country parties, to enable them to implement their climate change goals[[36]](#footnote-36). UNFCCC therefore envisions technology development and transfer between developed and developing countries in order to strengthen the global response towards climate change.

Similarly, the *Paris Agreement[[37]](#footnote-37)* recognizes the role of technology development and transfer in sustainability. The Paris Agreement acknowledges the specific needs and special situations of the least developed countries with regard to funding and transfer of technology[[38]](#footnote-38). Parties to the Paris Agreement share a long-term vision on the importance of fully realizing technology development and transfer in order to improve resilience to climate change and to reduce greenhouse gas emissions[[39]](#footnote-39). It requires states to strengthen cooperative action on technology development and transfer with developed countries being at the forefront in promoting technology development and transfer to developing countries[[40]](#footnote-40).

 Technology development and transfer is therefore vital for sustainability.

# **3.0 Technology Development and Transfer in Africa: Opportunities and Challenges**

According to IPCC, technology development and transfer is particularly important to developing countries[[41]](#footnote-41). As a result, there has been an increasing attention in recent years towards transfer of green technologies to developing countries[[42]](#footnote-42). Technology development and transfer has been associated with decreased inputs of water, energy, fertilizer and pesticides and increased crop yields[[43]](#footnote-43). Technology development and transfer in Africa has the potential to enhance agricultural practices through improved irrigation and soil management techniques[[44]](#footnote-44). Further, it has been noted that technology development and transfer in Africa can improve the sustainability of water supply and sewerage services[[45]](#footnote-45).

Technology development and transfer has been identified as one of the levers through which African products and markets can gain competitiveness[[46]](#footnote-46). This process can enhance the transfer of technical information, tacit know-how and performance skills, technical materials or equipment, jointly or as individual elements, with the intent of enabling the technological or manufacturing capacity African countries[[47]](#footnote-47). For example, technology development and transfer has been identified as a possible solution in accelerating development of Africa’s pharmaceutical production base[[48]](#footnote-48). Therefore, African countries can leverage on the substantial potential of technology development and transfer to drive socio-economic growth and development in the continent[[49]](#footnote-49).

The need for technology development and transfer is recognized under the United Nations *2030 Agenda for Sustainable Development[[50]](#footnote-50)*. SDG 17 recognizes that the Sustainable Development agenda can only be realized through strong global partnerships and cooperation on a number of areas including technology development and transfer[[51]](#footnote-51). It encourages states to enhance North-South, South-South and triangular regional and international cooperation on and access to science, technology and innovation and enhance knowledge sharing on mutually agreed terms[[52]](#footnote-52). It also urges developed countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed[[53]](#footnote-53). Realizing the targets of SDG 17 is key in enhancing technology development and transfer in Africa for sustainability.

Africa Union’s *Agenda 2063[[54]](#footnote-54)* also recognizes the role of technology development and transfer for sustainability. Agenda 2063 acknowledges the role of science and technology in achieving the aspiration of a prosperous Africa based on inclusive growth and Sustainable Development[[55]](#footnote-55). It further acknowledges that well educated citizens and skills revolution underpinned by science, technology and innovation is a vital priority for Sustainable Development in Africa[[56]](#footnote-56). According to Agenda 2063, Africa’s partners have a crucial role to play in supporting the continent’s development efforts through technology development and transfer in accordance with national needs and interests[[57]](#footnote-57). Enhancing technology development and transfer in Africa is therefore vital in achieving the vision, aspirations, and goals of Agenda 2063 towards sustainability.

The *Digital Transformation Strategy for Africa[[58]](#footnote-58)* also sets out the need for technology development and transfer in Africa for sustainability. It recognizes that technology is key in transforming traditional socioeconomic sectors in Africa[[59]](#footnote-59). The Strategy seeks to harness digital technologies and innovation to transform African societies and economies to promote Africa's integration, generate inclusive economic growth, stimulate job creation, break the digital divide, and eradicate poverty for the continent’s socio-economic development and ensure Africa’s ownership of modern tools of digital management[[60]](#footnote-60). It also urges African countries to leverage national and international technology development and transfer processes in order to achieve digital transformation in the continent[[61]](#footnote-61). Digital transformation has been identified as an essential driver for development in Africa[[62]](#footnote-62). The availability and use of digital technologies is strongly linked to economic growth, innovation, job creation, and inclusion, at both the national and regional levels[[63]](#footnote-63). It is therefore necessary for African countries to enhance technology development and transfer in order to realize the digital transformation agenda in the continent for sustainability[[64]](#footnote-64).

Technology development and transfer is therefore a key priority in Africa. It has been noted that since Africa’s share of the world’s research and development output remains low and most African countries are marginal producers of new technologies, domestic as well as international technology development, acquisitions and transfers can serve as a critical means to help narrow technology gaps and accelerate technological advances in African countries towards socio-economic development[[65]](#footnote-65). In addition, it has been observed that the technology development and transfer landscape in Africa has undergone dynamic change and development in recent years driven by improvement in related policy framework, rapid technological changes, and the development of technology sectors and markets in African countries[[66]](#footnote-66). However, the ability to effectively embrace technology development and transfer in Africa is hindered by challenges such as inadequate human and institutional capacity, social factors that inhibit change, inadequate financial resources to purchase, operate, and maintain new technologies, and higher initial capital costs in the case of some technology options[[67]](#footnote-67). It is vital to address these challenges in order to enhance technology development and transfer n Africa for sustainability.

# **4.0 Conclusion**

Technology is vital for development in Africa. It can catalyze innovation, promote industrial and economic growth, and effect social changes and human development to improve lives[[68]](#footnote-68). Technology can also help to sustain natural resources and improve livelihoods for people who depend on such resources[[69]](#footnote-69). Leveraging on technology can also help countries tackle the environmental problems that they are facing including climate change, biodiversity loss, and pollution[[70]](#footnote-70). It is therefore necessary to enhance technology development and transfer in Africa for sustainability.

In order to enhance technology development and transfer in Africa, it is vital for countries to adopt appropriate policies that will foster this process including those on intellectual property rights[[71]](#footnote-71). These rights are an important instrument at the research and development level. They help assure the ownership over intellectual findings and the capacity to control the use of intellectual property in line with an institution's mission and core values[[72]](#footnote-72). They are also a powerful business tool to gain position on the market and exclusivity over a new product or process[[73]](#footnote-73). Intellectual property rights can therefore influence technology development and transfer. It has been noted that stronger protection of intellectual property rights can encourage innovation, technology development, and transfer[[74]](#footnote-74). It is therefore key for African countries to adopt effective policies with regard to protection of intellectual property rights in order to enhance technology development and transfer in the continent for sustainability.

Technology development and transfer in Africa can also be enhanced by strengthening research and development in the continent[[75]](#footnote-75). It has been noted that governments in Africa need to put in place the necessary support policies and legal frameworks that will encourage both academia and industry to collaborate in technology development and transfer initiatives[[76]](#footnote-76). These measures include competitive funding that requires collaboration between academia and industry, regulation that encourage the development and adoption of clean technologies by firms, the appropriate intellectual property rights that balance the interests of technology developers and users and a common platform for sharing and exchanging knowledge and best practices on technology development and transfer[[77]](#footnote-77). It is also necessary for African countries to establish or expand regional or national technology research centers to develop technologies for basic infrastructure, energy efficiency, and alternative energy sources, agriculture, forestry, and water resources among other key sectors that are vital for sustainability[[78]](#footnote-78).

In addition, it is imperative to enhance knowledge flows, innovation, and capacity building in Africa[[79]](#footnote-79). Technology development and transfer not only comprises of hardware but also encompasses the flow of knowledge[[80]](#footnote-80). It has been noted that knowledge, expertise and experience for generating, managing, utilizing, and maintaining technology are key for effective technology development and transfer[[81]](#footnote-81).

Developed countries, and international institutions can also support technology development and transfer initiatives in Africa through funding[[82]](#footnote-82). Funding is key in supporting the costs associated with technology development and transfer activities[[83]](#footnote-83). It has been noted that these costs may include training and any royalties and licensing fees where the owners of the technologies may not be willing to waive the costs associated with clean technology transfer[[84]](#footnote-84). Further, consideration should also be given to opportunities for regional cooperation around green technology and knowledge-based initiatives in order to enhance technology development and transfer in Africa for sustainability[[85]](#footnote-85).

Enhancing technology development and transfer in Africa for sustainability is a goal that is achievable and therefore should be pursued.

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