# ADVANCING BIOECONOMY DEVELOPMENT IN KENYA


## THE STATE OF BIOECONOMY IN KENYA: 2025

SEI Stockholm Environment Institute

Sweden Sverige

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# LIST OF ABBREVIATIONS

| | |
|---|---|
| ABS | Access and Benefit Sharing |
| AFA | Agriculture and Food Authority |
| ASALs | Arid and Semi-Arid Lands |
| AU | African Union |
| BSF | Black Soldier Fly |
| COMESA | Common Market for Eastern and Southern Africa |
| EAC | East African Community |
| EASTECO | East African Science and Technology Commission |
| IPR | Intellectual Property Rights |
| KALRO | Kenya Agricultural and Livestock Research Organization |
| KEBS | Kenya Bureau of Standards |
| KEMRI | Kenya Medical Research Institute |
| KEPHIS | Kenya Plant Health Inspectorate Service |
| KFS | Kenya Forest Service |
| KIRDI | Kenya Industrial Research and Development Institute |
| KMFRI | Kenya Marine and Fisheries Research Institute |
| KWS | Kenya Wildlife Service |
| MECC&F | Ministry of Environment, Climate Change and Forestry |
| MoALD | Ministry of Agriculture and Livestock Development |
| MoH | Ministry of Health |
| MSMEs | Micro, Small, and Medium Enterprises |
| NACOSTI | National Commission for Science, Technology and Innovation |
| NBA | National Biosafety Authority |
| NEMA | National Environment Management Authority |
| NRF | National Research Fund |
| PPP | Public–Private Partnership |
| R&D | Research and Development |
| SDGs | Sustainable Development Goals |
| STI | Science, Technology and Innovation |

# DEFINITIONS OF KEY TERMS

**Bioeconomy:** The sustainable production, transformation, and use of biological resources, such as crops, forests, marine organisms, livestock, and organic waste, combined with science, technology, and innovation to create food, energy, materials, and services that support inclusive economic growth, environmental sustainability, and climate resilience.

**Bioprocessing:** Industrial processes that use biological systems such as microorganisms, enzymes, or plant/animal cells to produce products including biofertilizers, biochemicals, and bioplastics.

**Circular Bioeconomy:** A regenerative economic model where biological resources are reused, recycled, or converted into new products (e.g., biogas, compost, packaging), minimizing waste and environmental impact.

**Biopackaging:** Packaging materials made from renewable biological resources such as cassava starch, water hyacinth fibers, bamboo, sugarcane bagasse, or banana pseudostems, designed to replace petroleum-based plastics.

**Bioenergy:** Renewable energy derived from biological sources such as crops, residues, and organic waste, including biogas, bioethanol, biodiesel, and biomass briquettes.

**Biopharma:** The sector involving development and production of biological and pharmaceutical products such as vaccines, diagnostics, therapeutic compounds, and biologics.

**Agro-processing:** The transformation of agricultural raw materials into higher-value food, feed, industrial, or health products (e.g., avocado oil, cassava starch, herbal products).

**Value Chain:** A sequence of activities, from production and processing to distribution and consumption, that adds economic value to biological resources.

**Indigenous Knowledge:** Traditional knowledge, innovations, and practices of local communities developed over generations, forming the basis for biodiversity conservation, herbal medicine, and climate adaptation.

**Biowaste / Biomass Residues:** Organic materials from agriculture, forestry, food systems, and households that can be reused or converted into energy, soil amendments, or industrial inputs.

**Biotechnology:** Technological applications that use biological systems, organisms, or derivatives to develop or modify products for agriculture, industry, and health.

# MESSAGE FROM THE AMBASSADOR OF THE KINGDOM OF SWEDEN TO THE REPUBLIC OF KENYA

Sweden and Kenya enjoy a long-standing and constructive partnership grounded in shared commitments to sustainable development, innovation, and inclusive economic growth. Over the years, this cooperation has supported initiatives across science, technology, climate action, and green industrial development, areas that are increasingly central to Kenya's development trajectory and to global efforts toward sustainability.

The Advancing Bioeconomy Development in Kenya (ABDK) project exemplifies this partnership in action. Supported by the Swedish International Development Cooperation Agency (Sida) and implemented in collaboration with Kenyan and international partners, including the Stockholm Environment Institute (SEI) and the Kenya Private Sector Alliance (KEPSA), the project has fostered closer collaboration between Kenyan and Swedish bioeconomy actors. In particular, the Kenya–Sweden Bioeconomy Business and Innovation Fair created a valuable platform for bio-entrepreneurs, researchers, investors, and policymakers from both countries to exchange knowledge, explore business opportunities, and build partnerships aimed at scaling sustainable bio-based enterprises.

The bioeconomy presents significant opportunities to address shared global challenges such as climate change, food and energy security, and job creation, while supporting inclusive and resilient economic growth. Sweden recognises Kenya's strong potential in this area, built on its rich natural capital, growing innovation ecosystem, and vibrant entrepreneurial community. This report, *The State of the Bioeconomy in Kenya,* provides an important evidence base for understanding this potential and identifying pathways for strengthening policy coherence, innovation, and investment in the sector.

As Kenya continues to advance its bioeconomy agenda, Sweden remains committed to supporting collaborative, science-based, and market-driven approaches that promote sustainability and shared prosperity. It is my hope that this report will inform dialogue, inspire new partnerships, and contribute to deepening Kenya–Sweden cooperation in advancing a green, inclusive, and competitive bioeconomy.

**His Excellency Håkan Åkesson**
Ambassador of the Kingdom of Sweden to the Republic of Kenya

# FOREWORD

Kenya stands at a defining moment in its pursuit of inclusive, sustainable, and innovation-led economic transformation. As global economies accelerate the transition toward low-carbon, resource-efficient development pathways, the bioeconomy presents Kenya with a strategic opportunity to harness its rich biological resources, scientific capabilities, and entrepreneurial potential to drive industrial growth, job creation, and environmental sustainability.

The Ministry of Investments, Trade and Industry (MITI), through the State Department for Industry, remains firmly committed to advancing a competitive and resilient industrial economy anchored in value addition, manufacturing, and innovation. The bioeconomy is increasingly recognised as a critical pillar of Kenya's green industrialisation agenda, offering new pathways for agro-processing, bio-manufacturing, bioenergy, bio-packaging, and nature-based industries that can stimulate domestic production while expanding access to regional and global markets. This commitment is fully aligned with Kenya Vision 2030 and the Bottom-Up Economic Transformation Agenda (BETA), which prioritise industrialisation, MSME development, export diversification, and sustainable livelihoods. By shifting the economy from the export of raw biological materials toward high-value, market-ready biobased products, the bioeconomy strengthens local manufacturing, enhances competitiveness, and creates dignified employment opportunities for youth, women, and rural communities.

In addition, the State Department for Industry plays a central role in creating an enabling environment for bioeconomy advancement by supporting industrial infrastructure development, strengthening standards and quality assurance systems, facilitating investment, and promoting stronger linkages between research, innovation, and enterprise. Working in collaboration with other Ministries, Departments, Agencies, county governments, the private sector, and development partners, the Department is committed to ensuring that emerging bio-industries are commercially viable, environmentally responsible, and inclusive.

This report, *The State of the Bioeconomy in Kenya,* provides a timely and comprehensive assessment of the country's bioeconomy landscape, highlighting its economic contributions, priority value chains, policy and regulatory frameworks, and opportunities for scaling innovation and investment. It serves as both a diagnostic and a strategic guide to inform policymaking, support private sector engagement, and strengthen coordination across sectors.

As global demand for sustainable, low-carbon, and traceable products continues to grow, Kenya is well positioned to emerge as a regional leader in Africa's bioeconomy. MITI recognises the bioeconomy not only as an environmental imperative, but as a powerful industrial and trade opportunity that can enhance Kenya's competitiveness within the East African Community, the African Continental Free Trade Area, and beyond. It is our expectation that this report will stimulate dialogue, partnerships, and coordinated action to unlock the full potential of Kenya's bioeconomy as a driver of inclusive growth and sustainable industrial development.

**Dr. Juma Mukhwana, CBS**
Principal Secretary
State Department for Industry
Ministry of Investments, Trade and Industry






# EXECUTIVE SUMMARY


Kenya's bioeconomy represents one of the most promising frontiers for achieving sustainable, inclusive, and innovation-led economic development. Anchored in the country's rich biodiversity, strong agricultural foundation, expanding scientific capacity, and vibrant entrepreneurial ecosystem, the bioeconomy offers a transformative framework for linking bioinnovation with environmental stewardship and industrial growth. This report, The State of the Bioeconomy in Kenya, provides the first comprehensive national assessment of the sector, outlining its progress, opportunities, and strategic direction. It highlights how key value chains, agro-processing, aquaculture and the blue economy, natural products, bioenergy, biopackaging, and biopharma, are emerging as powerful drivers of rural livelihoods, green industrialisation, and climate resilience. Across the country, enterprises such as Limbua Avocado Oil Factory, Giraffe Bioenergy, Hydro Victoria Africa, and HyaPak Ecotech illustrate how Kenyan innovators are harnessing biological resources to redefine production systems through circularity, inclusivity, and value addition. These initiatives demonstrate the bioeconomy's potential to generate jobs, empower youth and women, reduce waste, stimulate local manufacturing, and expand economic opportunities for farmers and MSMEs.

The policy and institutional review also shows that Kenya has made significant strides in establishing a strong foundation for bioeconomic growth through frameworks such as Vision 2030, the Bottom-Up Economic Transformation Agenda (BETA), the Science, Technology and Innovation (STI) Act, the Climate Change Act, and the Sustainable Waste Management Act, complemented by regional alignment with the EAC Bioeconomy Strategy and continental priorities under the African Union.

Despite this progress, major gaps persist. Coordination across sectors remains weak, regulations and mandates are fragmented, and the absence of a dedicated national bioeconomy strategy limits coherence. Financing mechanisms for bio-based enterprises, especially early-stage innovators and rural MSMEs, are inadequate, while commercialization of research is constrained by limited incubation facilities, inadequate bioprocessing infrastructure, and insufficient industry–research linkages. The skills pipeline also remains underdeveloped, with universities and TVETs not yet fully aligned to emerging industrial and biotechnological needs. Public awareness, certification systems, and market standards for natural products and bio-based goods are still evolving, while indigenous and local knowledge, critical for biodiversity conservation and natural product development, remains insufficiently integrated and protected.

Advancing Kenya's bioeconomy will require a stronger enabling environment that brings together policy coherence, innovation capacity, finance, and human capital. Priority actions include developing a national bioeconomy strategy, establishing a coordinated governance mechanism, expanding regional bioprocessing and innovation hubs, strengthening standards and certification systems, and creating blended financing instruments that support MSMEs, youth, and women-led enterprises. Equally important are investments in skills development, circular bioeconomy models, indigenous knowledge protection, and stronger research–industry partnerships.

Addressing these gaps while leveraging Kenya's comparative advantages positions the country to lead Africa's transition toward a regenerative, knowledge-driven economy that strengthens food and nutrition security, expands rural industrialisation, accelerates climate adaptation, and enhances biodiversity conservation. Ultimately, the choices made today will determine whether the bioeconomy remains a policy aspiration or evolves into a defining pillar of Kenya's national development.

# INTRODUCTION

Kenya stands at a pivotal moment in its pursuit of sustainable, inclusive, and innovation-led economic transformation. With its rich biological diversity, expanding scientific and innovation capacity, and a rapidly growing youthful population, the country possesses the foundational assets needed to transition toward a modern, knowledge-driven economy. The bioeconomy offers Kenya a strategic pathway to harness its biological resources more intelligently by creating greater value from primary production, converting biowaste into useful products, generating green jobs, and advancing national priorities such as food and nutrition security, climate resilience, and industrial diversification.

Over the past decade, Kenya has made deliberate efforts to embed science, technology, and innovation (STI) into national development planning. Through frameworks such as Kenya Vision 2030, the Bottom-Up Economic Transformation Agenda (BETA), and the National Science, Technology and Innovation Policy, the country has positioned innovation as a central driver of economic growth and competitiveness. This national direction aligns with continental and global development agendas, including the African Union's Agenda 2063 and the United Nations Sustainable Development Goals (SDGs), where the bioeconomy is increasingly recognised as a practical pathway for achieving green growth, circularity, and sustainable livelihoods.

Kenya's emerging bioeconomy builds upon dynamic sectors that already play a central role in the economy, including agriculture, forestry, fisheries, energy, and waste management. These sectors are major contributors to gross domestic product and employment, and they hold significant potential for transformation through biobased innovation. Opportunities range from agro-processing, bioplastics, biofertilisers, and renewable bioenergy to bio-based industrial inputs and health-related products. By strengthening linkages between research, enterprise, and policy, Kenya can move from a resource-driven model toward a value-added, knowledge-based economy that competes effectively in regional and global markets.

This report, *The State of the Bioeconomy in Kenya,* presents the first comprehensive national assessment of the country's bioeconomy landscape. It maps existing assets, policies, institutions, and innovation ecosystems; examines the economic contributions and priority value chains shaping the sector; and identifies gaps and opportunities related to coordination, financing, skills development, and commercialization. Drawing on both national experiences and international lessons, the report provides an evidence-based foundation to inform policymaking, guide investment, and support coordinated action among government, industry, research institutions, and development partners.

Functioning as both a situational analysis and a policy and investment compass, this report outlines how Kenya can transform its biological wealth into sustainable economic value. By examining sectoral contributions, innovation systems, and enabling policy frameworks, it highlights practical pathways for integrating bioeconomy principles into national and county development processes. Ultimately, the report seeks to strengthen Kenya's transition toward an inclusive, resilient, and competitive bioeconomy that supports long-term economic growth while safeguarding environmental sustainability.

> **Kenya's emerging bioeconomy builds upon dynamic sectors such as agriculture, forestry, fisheries, energy, and waste management.**

# OVERVIEW OF THE KENYAN BIOECONOMY

This chapter establishes the conceptual and policy foundations of Kenya's bioeconomy. It begins by defining the bioeconomy within Kenya's context and situating it within global and regional frameworks, including the African Union's Continental Bioeconomy Strategy and the East African Community's Regional Bioeconomy Strategy. The discussion outlines the scope, guiding principles, and strategic relevance of the bioeconomy to Kenya's national priorities, particularly its contribution to sustainable agriculture, climate resilience, green industrialisation, and inclusive growth. It then examines the legislative and institutional architecture shaping Kenya's innovation landscape, anchored in the Vision 2030, and the Bottom-Up Economic Transformation Agenda (BETA). By mapping key actors across public agencies, research organisations, and private enterprises, the chapter highlights how policy, regulation, and coordination mechanisms interact to advance research, innovation, and commercialisation. It also identifies gaps and overlaps that constrain coherence and implementation, while underscoring Kenya's alignment with continental and international frameworks.

## 2.1 Definition of the Bioeconomy

The bioeconomy refers to the sustainable production and use of biological resources and the knowledge associated with them to create goods and services that promote inclusive growth, enhance food and nutrition security, and support industrial transformation. It encompasses activities that convert renewable biological resources, such as crops, livestock, forests, fisheries, and organic waste, into value-added products including food, feed, bio-based materials, pharmaceuticals, and bioenergy.

The bioeconomy represents a system where science, technology, and innovation intersect with biological resources to generate social, environmental, and economic benefits. In practice, this means leveraging research and innovation to add value to agricultural residues, biowaste, and other organic materials, transforming them into sustainable products that contribute to job creation, resource efficiency, and climate resilience. By doing so, the bioeconomy offers an integrated framework for addressing multiple development priorities, including sustainable industrialization, climate action, biodiversity conservation, and rural transformation.

## 2.2 Overview of Global and Regional Bioeconomy Trends

In recent years, the bioeconomy has emerged globally as a transformative approach to fostering economic development, sustainability, and resilience. Rooted in the sustainable management and conversion of biological resources into value-added products, it signifies a paradigm shift in how societies generate wealth, respond to environmental challenges, and meet the needs of growing populations.

Countries across the world are investing in bioeconomy strategies as part of their transition to green and circular economies. Countries in the European Union, the Americas, and Asia's have developed Bioeconomy national strategies and have integrated bioeconomy principles into industrial policy, innovation frameworks, and climate strategies. Globally, the bioeconomy is estimated to be worth over USD 4 trillion and continues to expand through innovations in biotechnology, sustainable agriculture, and renewable energy systems.

Africa has also recognised bioeconomy as a key driver of inclusive and sustainable development. For instance, The African Union (AU) is mainstreaming the bioeconomy into its development agenda, anchored in Agenda 2063 and the Malabo Declaration, by promoting investments in science, technology, and innovation (STI), strengthening regional cooperation, and advancing supportive policies and legal frameworks to sustainably harness biological resources for value addition, economic transformation, job creation, poverty reduction, food security, and environmental sustainability. In eastern Africa, the East African Community (EAC) has a Regional Bioeconomy Strategy, developed in collaboration with stakeholders including the East African Science and Technology Commission (EASTECO) and approved in 2022. The EAC Regional Strategy provides a framework for harnessing the region's rich biological resources to drive sustainable and inclusive economic growth while addressing key challenges such as food security and climate change. These frameworks promote cross-border collaboration, harmonization of policies, and market integration, creating an enabling environment for countries to align national strategies with continental goals. Through its active participation in these initiatives, Kenya is positioning itself as an emerging leader and a potential regional knowledge hub for biobased innovation, not only in East Africa, but increasingly across the wider Sub-Saharan African region. At the same time, regional institutions such as the East African Science and Technology Commission (EASTECO) continue to support the harmonization of science, technology, and innovation policies, encouraging the integration of biotechnology, renewable energy, and circular economy approaches into national development plans. This regional and global alignment provides the policy foundation upon which Kenya's bioeconomy can thrive.

## 2.3 What can the Bioeconomy Deliver to Kenya?

For Kenya, bioeconomy is more than an emerging economic trend. It is a transformative pathway for inclusive, sustainable, and innovation-led growth. The country's diverse biological resources, robust agricultural base, renewable energy potential, and dynamic innovation ecosystem form a strong foundation for developing a thriving bio-based economy.

Through bioeconomic development, Kenya can achieve multiple objectives: diversify its industrial base, enhance rural livelihoods, create green jobs for youth and women, strengthen food and nutrition security, and accelerate the shift toward climate resilience and environmental sustainability. By integrating biotechnology, life sciences, and circular economy principles into agriculture, health, energy, and manufacturing, Kenya can reduce reliance on imports, enhance competitiveness, and stimulate new industries driven by bio-based solutions.

These transformations align with the goals of Kenya Vision 2030, the Bottom-Up Economic Transformation Agenda (BETA), and the country's commitments under the Sustainable Development Goals (SDGs) and the Paris Agreement. The bioeconomy, therefore, is not a new economic frontier but a vehicle for realizing existing national aspirations through innovation and sustainable use of natural resources.

## 2.4 Kenya's Bioeconomy Potential and Comparative Advantages

While the concept of the bioeconomy is still evolving within Kenya's policy landscape, its foundational sectors, agriculture, forestry, fisheries, bioenergy, waste management, and emerging life sciences, already contribute significantly to national development and livelihoods. This positions the bioeconomy not as a distant aspiration, but as a central pillar of Kenya's socio-economic transformation.

Kenya's diverse and resource-rich environment provides a strong foundation for bioeconomic expansion. Fertile arable land, extensive forests, rich biodiversity, and substantial biomass from agriculture, forestry, and organic waste offer vast potential for innovation and value addition. Coastal and freshwater ecosystems further create opportunities for a growing blue bioeconomy, particularly in aquaculture, marine biotechnology, and algae-based products. As global demand for sustainable and bio-based goods increases, these natural endowments can be repositioned as strategic assets through targeted investments in bioprocessing, certification, and export readiness. Moreover, Kenya's leadership in renewable energy strengthens this foundation. Over 90% of the country's electricity is generated from clean sources, including geothermal, wind, hydro, and solar—providing a reliable and sustainable energy base for green industrialisation and bio-based manufacturing.

Kenya's youthful and increasingly tech-savvy population is another key driver of bioeconomic growth. With more than 70% of the population under the age of 35, the country has a strong demographic advantage to power innovation in digital agriculture, biotechnology, circular economy enterprises, and sustainable energy solutions. Targeted investments in technical skills development, incubation programmes, and appropriate financing mechanisms can unlock a new generation of bioeconomy entrepreneurs and green jobs, particularly in rural and peri-urban areas.

**90%**

of Kenya's electricity is generated from clean sources, geothermal, wind, hydro, and solar

**70%**

of Kenya's population is under the age of 35

The agriculture sector contributes

**23%**

of GDP and another

**27%**

indirectly through linkages to manufacturing, logistics, and services.

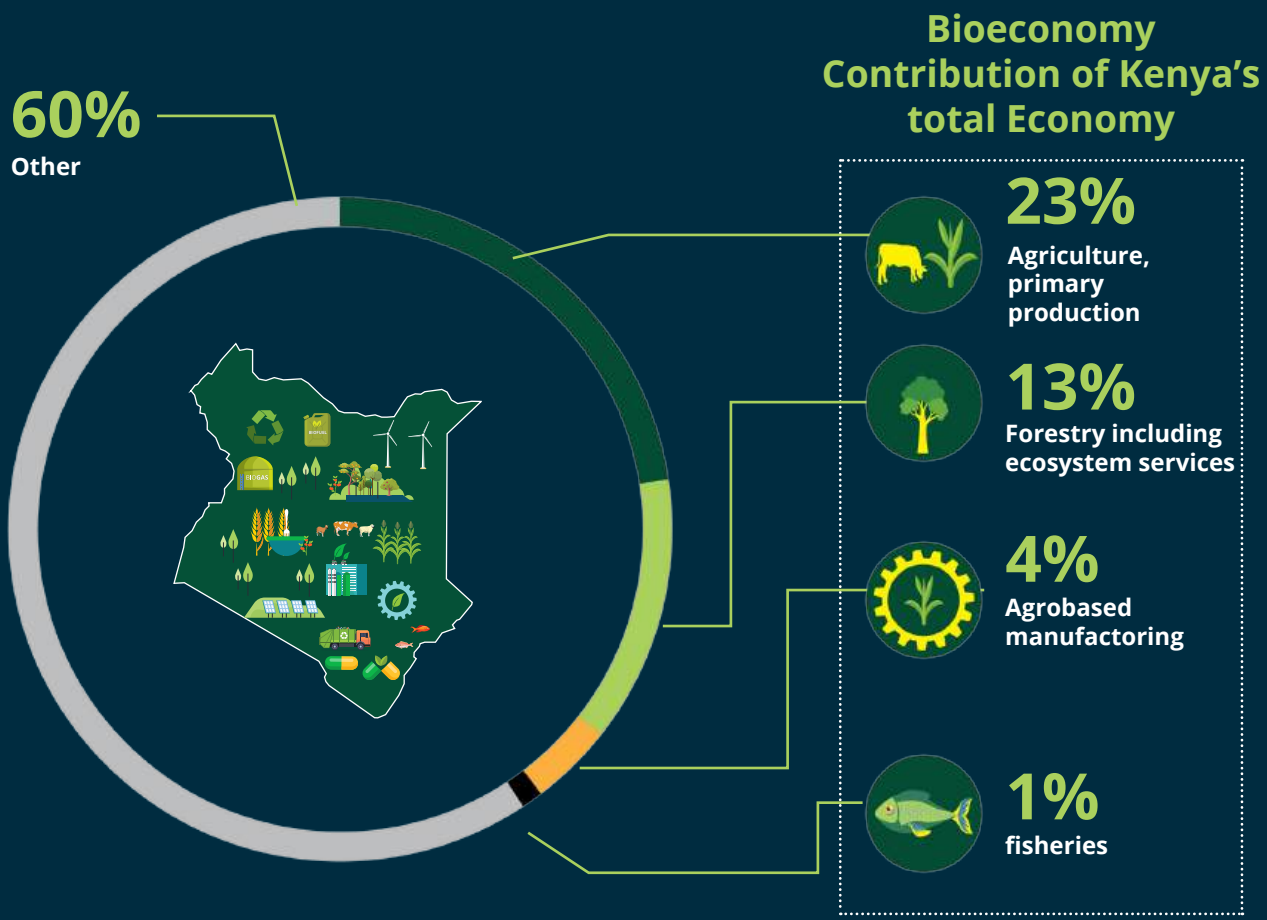
The agriculture sector remains the backbone of Kenya's bioeconomy, contributing approximately 23% of national GDP directly, alongside substantial indirect contributions through linkages with manufacturing, logistics, and services. Major exports such as tea, coffee, flowers, avocados, and macadamia nuts highlight Kenya's biological productivity, while bioeconomy approaches enable deeper value addition by transforming residues into bioenergy, biofertilisers, and bioplastics, and by shifting agriculture toward more knowledge- and innovation-driven production models.

Beyond agriculture, sectors such as manufacturing, ICT, tourism, and energy are increasingly integrating bio-based innovations. Green technologies and circular production models are improving efficiency and resource use in manufacturing, while sustainable tourism and biodiversity conservation are reinforcing nature-based economies. Kenya's advanced digital ecosystem which is anchored in mobile technologies and emerging artificial intelligence applications, supports traceability, precision agriculture, and efficient resource management, thereby strengthening linkages across bioeconomy value chains.

Despite persistent challenges, including policy fragmentation, infrastructure gaps, and limited access to finance, Kenya's biodiversity wealth, renewable energy leadership, and youthful population provide a strong platform for sustained bioeconomic growth. With continued investment in research, innovation, and enabling policy frameworks, Kenya is well positioned to emerge as a regional and global leader in sustainable, inclusive, and circular bioeconomic transformation—turning its biological wealth into long-term prosperity.

## Current Contribution of the Bioeconomy to Kenya's Economy

Kenya's bioeconomy already makes a measurable and multifaceted contribution to national development. Spanning primary production, ecosystem services, and high-value bio-innovations, the bioeconomy accounts for an estimated 30–40% of the national GDP. Agriculture remains the dominant contributor at approximately 22.5%, followed by agro-based manufacturing (4.1%), forestry (3.6% directly and up to 13% when ecosystem services are included), and fisheries (0.7%). In addition, other emerging sub-sectors such as biotechnology, bioenergy, and circular economy activities, add further value, underscoring the bioeconomy's role as a cross-sectoral driver of growth. Collectively, bioeconomy-related activities support over 70% of Kenya's workforce, particularly in rural and informal economies, and underpin livelihoods, energy access, and food systems resilience.



## 2.5 Mapping Kenya's Bioeconomy Ecosystem: Key Actors and Institutions Driving Transformation

Kenya's bioeconomy is powered by a diverse ecosystem of actors, including government ministries and agencies, research institutions, private innovators, civil society, and development partners, working across the value chain from research to commercialization. Together, these actors form the backbone of Kenya's transition toward a green, knowledge-driven, and inclusive economy.

At the policy and regulatory level, the Ministry of Investments, Trade and Industry (MITI)—particularly the State Department for Industry which plays a central role in advancing value addition, industrialisation, and manufacturing linked to bio-based resources. Through its mandate on industrial development, standards, investment promotion, and MSME growth, the State Department for Industry supports the scaling of bio-based manufacturing, agro-processing, biopackaging, bioenergy, and other emerging bio-industries. This role complements that of key science and innovation institutions such as the National Commission for Science, Technology and Innovation (NACOSTI), the Kenya National Innovation Agency (KeNIA), and the National Research Fund (NRF), which coordinate policy implementation, support innovation, and fund research. Collectively, these institutions operationalise national frameworks such as the Science, Technology and Innovation (STI) Policy (2020–2030), Kenya Vision 2030, and the Bottom-Up Economic Transformation Agenda (BETA), aligning science, innovation, and industrial development with national priorities.

In agriculture and food systems, the Kenya Agricultural and Livestock Research Organization (KALRO) leads research on improved crop and livestock varieties, bio-inputs, and agricultural biotechnology. Oversight bodies such as the Agriculture and Food Authority (AFA), the Kenya Plant Health Inspectorate Service (KePHIS), the Pest Control Products Board (PCPB), and the National Biosafety Authority (NBA) ensure quality control, biosafety, and regulation of agricultural innovations. Industry and market-oriented partners such as the African Agricultural Technology Foundation (AATF), the Alliance for a Green Revolution in Africa (AGRA), the Kenya Seed Company, and farmer cooperatives bridge science and practice by supporting commercialization, input supply, and sustainable production systems.

In health biotechnology and life sciences, institutions such as the Kenya Medical Research Institute (KEMRI), the Kenya BioVax Institute, and the International Centre of Insect Physiology and Ecology (ICIPE) are driving innovation in vaccines, diagnostics, biopharmaceuticals, and bio-based pest control. In industrial biotechnology and manufacturing, the Kenya Industrial Research and Development Institute (KIRDI) plays a critical role in advancing bioprocessing, product development, standards testing, and bio-based manufacturing. In addition, startups such as HyaPak and HuskiPlast are pioneering biodegradable packaging solutions derived from agricultural and industrial waste streams, demonstrating the strong link between industrial biotechnology and circular economy principles. Regional and continental platforms such as BioInnovate Africa and the Open Forum on Agricultural Biotechnology (OFAB) Kenya Chapter further foster collaboration in biosciences, capacity building, and policy engagement across Eastern Africa.

The energy and environment sectors are equally active in Kenya's bioeconomy ecosystem. Actors such as BURN Manufacturing, PowerGen, SNV Netherlands Development Organisation (SNV), Sistema.bio, and the Kenya Biogas Program are scaling clean and bio-based energy solutions, including biogas systems, bio-briquettes, ethanol fuels, and efficient cookstoves. These efforts are guided by policy oversight from the Ministry of Energy and Petroleum and regulation by the Energy and Petroleum Regulatory Authority (EPRA). Meanwhile, institutions including the Kenya Forest Service (KFS), the Kenya Wildlife Service (KWS), the National Environment Management Authority (NEMA), the Kenya Marine and Fisheries Research Institute (KMFRI), and county governments manage Kenya's natural capital and ecosystems, linking conservation, sustainable resource use, and bio-based economic opportunities.

Universities and research centres such as the University of Nairobi, Jomo Kenyatta University of Agriculture and Technology (JKUAT), Egerton University, Masinde Muliro University of Science and Technology (MMUST), Kenyatta University, and Pwani University anchor bioeconomy education, research, and innovation through their biotechnology programmes and international research partnerships. In parallel, international organisations and development partners—including the United Nations Environment Programme (UNEP), the Center for International Forestry Research–World Agroforestry (CIFOR–ICRAF), the Stockholm Environment Institute (SEI), BioInnovate Africa, UNIDO, FAO, and research centres of the Consultative Group on International Agricultural Research (CGIAR), provide technical expertise, financing, and policy support. These partnerships help ensure that Kenya's bioeconomy development aligns with the African Union (AU) Continental Bioeconomy Strategy and global frameworks such as the Sustainable Development Goals (SDGs).

As Kenya accelerates its bioeconomic transition, stronger coordination among these diverse actors is essential. A unified, multi-stakeholder platform linking MITI and the State Department for Industry, science and innovation agencies, sector ministries, county governments, academia, the private sector, and civil society would strengthen policy coherence, encourage co-investment, and accelerate the uptake of bio-based innovation. Such integration is critical to ensuring that Kenya's bioeconomy remains inclusive, climate-resilient, industrially competitive, and well positioned to contribute to national development and regional leadership.

## 2.6 Policy and Regulatory Framework of Kenya's Bioeconomy

Creating consistency across diverse policy domains is critical for the successful advancement of the bioeconomy, given the wide-ranging influence of agriculture, environment, industry, energy, trade, and innovation policies on bioeconomic initiatives. Further, developing a coherent and unified bioeconomy policy framework requires extensive intersectoral deliberation and iterative refinement. In East Africa, the evolution of the bioeconomy is strongly shaped by political commitment and economic priorities, which together determine the pace and direction of sustainable growth. Kenya, in alignment with other East African countries, has demonstrated political will by embedding bioeconomy-relevant objectives within national strategies and sectoral action plans.

Despite this progress, Kenya continues to face notable challenges in establishing a comprehensive and coordinated bioeconomy policy framework. Existing national policies governing biomass utilisation, biotechnology, agriculture, environment, and industrial development exhibit gaps in coherence and limited cross-sectoral integration. While the Government of Kenya has made significant efforts to promote biomass use, particularly in the energy sector, political support and financial incentive mechanisms for industrial and manufacturing applications of biomass remain insufficient. This imbalance constrains the scaling of bio-based manufacturing and value-added bioprocessing.

One of the earliest policy instruments explicitly addressing the bioeconomy is the National Biotechnology Development Policy (2006), which sought to transition Kenya toward a knowledge-based economy by promoting research, development, and commercialisation of biotechnology products. Complementary sectoral initiatives include the National Root and Tuber Crops Development Strategy (2019–2022), which aimed to enhance productivity, strengthen market linkages, and promote private sector investment across the value chain, thereby transforming smallholder agriculture from subsistence to a more commercial, innovation-driven model. The Agricultural Sector Development Strategy (ASDS) 2019–2029 provides a broader policy framework for agricultural transformation, emphasising value addition, agro-processing, and reduced biowaste generation. In addition, commodity-specific policies, such as those targeting cassava and other strategic crops, seek to strengthen production, research, marketing, and regulation to build resilient and competitive value chains. Environmental sustainability policies further advocate prudent resource utilisation, biodiversity conservation, and ecosystem stewardship through investments in research infrastructure, biodiversity monitoring, public awareness, and resource mobilisation.

Kenya's commitment to renewable energy development, including bioenergy, geothermal, wind, hydro, and solar power, underscores the country's broader transition toward green growth. However, current policy instruments remain insufficient in supporting accelerated growth of productive bioeconomy sectors, particularly Micro, Small, and Medium Enterprises (MSMEs) and informal enterprises that dominate bioprocessing and value addition. Limited access to finance, markets, and incentives continues to constrain innovation and scale-up, especially in rural and peri-urban areas.

At the constitutional level, the Constitution of Kenya (2010) establishes the right to a clean and healthy environment and mandates sustainable utilisation of natural resources (Articles 42 and 69), forming the legal foundation for bioeconomy governance. This foundation is reinforced by Kenya Vision 2030 and its Medium-Term Plans, which advance industrialisation, innovation, and green growth, principles central to bioeconomy development.

Several sectoral laws further support bioeconomy-related objectives, including:

- The **Agriculture and Food Authority Act (2013)** and **Crops Act (2013),** which streamline agricultural regulation and promote value addition.
- The **Environmental Management and Coordination Act (1999, revised 2015)** and the **Forest Conservation and Management Act (2016)**, which provide safeguards for sustainable environmental stewardship.
- The **Climate Change Act (2016)** and the **Bioenergy Strategy (2020–2027)**, which support low-carbon development and circular energy transitions.

- The **Science, Technology and Innovation Act (2013),** which established the National Commission for Science, Technology and Innovation (NACOSTI), the National Research Fund (NRF), and the Kenya National Innovation Agency (KeNIA) to anchor research coordination, innovation funding, and commercialisation.

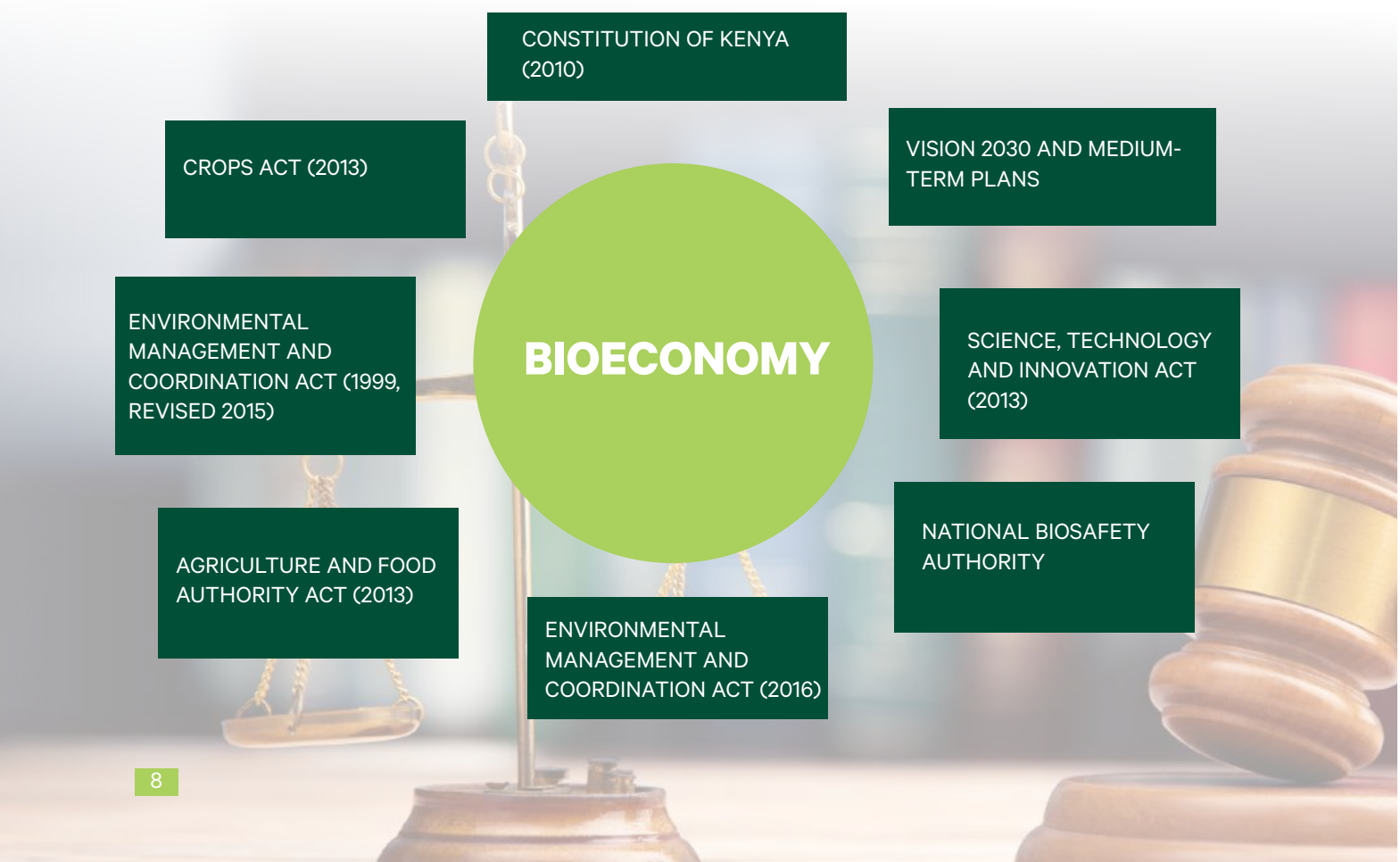
From an industrial and trade perspective, the Ministry of Investments, Trade and Industry (MITI), particularly the State Department for Industry, plays a critical role in translating bioeconomy potential into manufacturing, value addition, and market competitiveness. Key institutions under MITI that are central to bioeconomy development include:

- The **Kenya Bureau of Standards (KEBS),** which sets and enforces standards critical for bio-based products, certification, and export readiness.
- The **Kenya Industrial Property Institute (KIPI),** which safeguards intellectual property rights essential for bio-innovation and biotechnology commercialization.
- The **Export Processing Zones Authority (EPZA)** and the **Special Economic Zones Authority (SEZA),** which provide industrial infrastructure and incentives for bio-based manufacturing and agro-processing.
- The **Micro and Small Enterprises Authority (MSEA),** which supports MSMEs engaged in bio-based value chains.

Despite the breadth of this institutional landscape, policy fragmentation and overlapping mandates remain significant challenges. Agencies such as the Agriculture and Food Authority (AFA), Kenya Plant Health Inspectorate Service (KEPHIS), National Environment Management Authority (NEMA), NACOSTI, KeNIA, and MITI-linked regulators often operate in silos, leading to duplication, regulatory inefficiencies, and weak coordination across agriculture, environment, industry, and innovation domains. The absence of a dedicated national bioeconomy policy and coordination framework further limits synergy.

Devolution adds another layer of complexity. While county governments are well positioned to drive localised bioeconomy innovation based on comparative advantage, weak vertical integration between national and county levels often undermines coherence and scale. Strengthening coordination across governance levels is therefore essential to ensure alignment with national development priorities.

Furthermore, existing policies inadequately recognise and protect indigenous and traditional knowledge systems, despite their critical role in biodiversity conservation, ecosystem management, food security, and health. Mechanisms to safeguard benefit-sharing, support community enterprises, and integrate indigenous knowledge, particularly the role of indigenous women—remain limited. Addressing these gaps is essential for ensuring inclusivity and equity in Kenya's bioeconomy.



## Tropical Leadership in the Bioeconomy: Brazil as a Case Study for Kenya's Transition

Brazil offers valuable lessons for Kenya as both countries share biodiversity richness, strong agricultural bases, and the challenge of balancing development with environmental stewardship. Brazil demonstrates how a developing economy can transform its biological wealth into inclusive, innovation-driven growth through a coherent policy and regulatory framework. Its experience shows that a legally anchored and socially inclusive bioeconomy can thrive even in complex governance settings, an approach Kenya can adapt in building its own coordinated and sustainable bioeconomy model.

Brazil has positioned itself as a global leader in advancing a sustainable bioeconomy through a regulatory framework that integrates environmental preservation, innovation, and local development. Recognizing the immense potential of its biodiversity, particularly within the Amazon region, the country launched its National Bioeconomy Strategy (Decree No. 12,044/2024), outlining priorities around biodiversity-based value chains, regenerative agriculture, climate action, and green job creation. Complementing this, Law 15.070/2024 established a legal foundation for the production and commercialization of bio inputs such as biopesticides, biofertilizers, and bio stimulants, fostering innovation in sustainable farming. A National Secretariat for Bioeconomy under the Ministry of Environment now leads coordination, oversight, and public-private partnerships, ensuring alignment across sectors.

A defining feature of Brazil's bioeconomy is its strong social dimension, often referred to as the social bioeconomy. This model emphasizes community participation, traditional knowledge, and equitable benefit-sharing, particularly within The Amazon. Through initiatives such as the Bioeconomy of the Amazon Programme and the Socio-biodiversity Product Chains Programme (PNPSB), local cooperatives process non-timber forest products like açaí, Brazil nuts, and natural resins into high-value goods for food, cosmetics, and pharmaceuticals. These efforts link conservation with livelihood generation, turning standing forests into economic assets and reducing pressure on deforestation. Brazil has shown that biodiversity conservation and economic growth can reinforce one another by integrating environmental protection with inclusive enterprise.

For Kenya, Brazil's experience underscores the value of legal clarity, centralized coordination, and investment in community-driven innovation. Therefore, developing a national bioeconomy policy, strengthening cross-sectoral institutions, protecting indigenous knowledge, and supporting county-level green enterprises would greatly advance Kenya's transition toward an inclusive, circular, and innovation-based bioeconomy. Lastly, Brazil's successes demonstrate that when ecological sustainability and social inclusion are embedded in policy, biodiversity-rich nations can lead the global shift toward resilient, green growth.

# 2.7 Unpacking Kenya's Bioeconomy Landscape: A PESTEL Analysis

Kenya's bioeconomy is advancing within a complex and evolving macro-environment. This Political, Economic, Social, Technological, Environmental, and Legal dimension (PESTEL) analysis provides a structured overview of the external factors influencing the development of Kenya's bioeconomy. A PESTEL analysis identifies key enablers, challenges, and trends shaping bio-based innovation and value chain development. It offers a holistic lens through which policymakers, investors, and stakeholders can better understand the broader system dynamics at play. This insight is crucial for designing coordinated policy responses, aligning sectoral strategies, and leveraging opportunities for sustainable and inclusive bioeconomic growth.

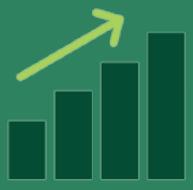
## A PESTEL table on Kenya's Bioeconomy Landscape

### Political

Kenya demonstrates strong political will toward sustainable development through national blueprints such as Vision 2030, the Bottom-Up Economic Transformation Agenda (BETA), and strategic commitments under regional blocs like the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA). These frameworks underscore Kenya's ambition to transition to a more inclusive, innovation-led, and resource-efficient economy, ideals that are central to the bioeconomy. Policies supporting agriculture, health, renewable energy, and science, technology, and innovation (STI) all provide entry points for mainstreaming bioeconomy principles. However, despite this enabling policy environment, the sector faces challenges due to weak inter-ministerial coordination, sectoral silos, and fragmented regulatory frameworks that hinder cross-sector integration. A coherent, whole-of-government approach is urgently needed to unlock synergies between policies in agriculture, environment, industry, health, and research to fully harness the transformative potential of the bioeconomy

Developing a national bioeconomy strategy and policies and strengthening measurement frameworks and will also enable Kenya to quantify progress more accurately and attract greater investment into its growing bio-based sectors..

### Economic



The bioeconomy is a foundational pillar of Kenya's national development, supporting nearly 70 % of the workforce—particularly through traditional sectors such as agriculture, forestry, livestock, and fisheries. Together, these sectors ensure food security, sustain rural livelihoods, and anchor value chains critical to industrial growth. Kenya's bioeconomy already makes a measurable and multifaceted contribution to national development, accounting for an estimated 30–40 % of the national GDP. Agriculture remains the dominant contributor at approximately 22.5 %, followed by agro-based manufacturing (4.1 %), forestry (3.6 % directly and up to 13 % when ecosystem services are included), and fisheries (0.7 %). Emerging sub-sectors, including biotechnology, bioenergy, circular economy enterprises, and industrial bioprocessing, are rapidly expanding, further enhancing value addition and resilience.

In recent years, innovations in biopharmaceuticals, bioplastics and biodegradable packaging, biopesticides, and clean bioenergy have begun to reshape Kenya's industrial and innovation landscape, offering new pathways for green jobs and industrial diversification. The country's rising middle class, expanding urban markets, and improved infrastructure in energy, transport, and digital systems are stimulating demand for bio-based goods and services. Yet, despite this momentum, the sector's full potential remains underutilized due to limited investment in research and development (R&D), slow uptake of advanced biotechnologies, and inadequate local capacity for value addition and commercialization.

Bridging these gaps, particularly through enhanced public–private partnerships, increased funding for innovation, increased access to venture capital for Kenyan SMEs to grow and upscale and targeted skills development, will be critical to advance the Kenyan bioeconomy.

## Social

With over 70% of its population under the age of 35, Kenya possesses a vibrant and youthful demographic that holds immense potential to drive innovation across bioeconomy frontiers such as agri-tech, biotechnology, circular bio-manufacturing, and green enterprises. This demographic advantage is further amplified by growing societal awareness of sustainability, health, and demand for natural, locally sourced products, which aligns closely with the goals of a bio-based economy. However, low public awareness of bio-based innovations, coupled with insufficient technical training and limited integration of bioeconomy concepts into education and vocational systems, continues to constrain meaningful youth participation and broader societal engagement. Unlocking this potential will require targeted investment in skills development, innovation hubs, and entrepreneurship support, especially tailored toward youth and women. Value addition infrastructure, such as biorefineries, agro- and bioprocessing also need to be developed and adapted for rural communities. Such community based biorefinery structures with local value addition would generate incomes and livelihoods to rural communities

## Technological

Kenya, often dubbed the “Silicon Savannah,” is gaining traction as a hub for innovation, particularly in mobile tech, fintech, and agritech. However, bioprocessing industrial and environmental biotechnology skills and infrastructure, crucial parts of a modern bioeconomy, remain significantly underdeveloped. Much of the country’s biotechnology policy has historically focused on agricultural and pharmaceutical domains, with minimal attention to the potential of industrial biotechnology, which uses sustainable biomass as a substitute for fossil-based raw materials. This gap is further compounded by limited technological capacity, weak inter-sectoral coordination, and insufficient value addition, a trend seen across East Africa. The consumption preference for raw goods and lack of advanced processing facilities limit the growth of bio-based manufacturing.

Despite these constraints, Kenya holds strong potential to scale up its bioeconomy through value addition and waste valorisation. For example, advances in converting cassava into bioplastics, sweeteners, and fibres could economically empower smallholder farmers and introduce new export commodities. Agricultural residues and food waste, often discarded, can be transformed into fuels, fertilizers, and high value biochemicals using microbes and enzymes. This presents an opportunity for inclusive green growth, particularly in rural and urban informal settlements. Tuber crops like cassava and sweet potato, with their increasing yields, could soon surpass cereals in production, positioning Kenya as a leader in tuber-based bio-industrial innovation.

To realize these prospects, targeted interventions are needed. Kenya must strengthen intellectual property rights (IPR) frameworks to support innovation, enhance technology transfer mechanisms, and promote cleaner production technologies through tax incentives and R&D funding. The country is still in the early stages of acquiring technical capabilities, making it essential to establish an enabling policy environment that supports industrial biotech adoption, bio-manufacturing, and circular economy models. By addressing these gaps, Kenya can catalyse a new era of sustainable industrialization rooted in its biological resources and youthful innovation base.

## Legal

Kenya's legal landscape for the bioeconomy is evolving but remains fragmented across sectors, with overlapping mandates and regulatory gaps. While key frameworks such as the Biosafety Act, the Seed and Plant Varieties Act, the Environmental Management and Coordination Act (EMCA), and emerging intellectual property (IP) regimes provide a foundation for bio-innovation, they often operate in silos, leading to inefficiencies and regulatory uncertainty. There is an urgent need for harmonization and coordination across these instruments to support integrated development of the bioeconomy. Furthermore, robust legal protections around access to genetic resources, traditional knowledge, indigenous rights, and fair benefit-sharing are critical. Aligning national laws with international agreements like the Nagoya Protocol and ensuring participatory governance will help build trust, attract investment, and promote equitable, inclusive, and responsible growth of the bioeconomy.

## Environmental

Climate change, land degradation, and biodiversity loss are among Kenya's most urgent environmental challenges, threatening food security, water availability, and ecosystem health in Kenya. For instance, accelerated land degradation, which is often driven by unsustainable farming, deforestation, overgrazing, and extractive practices, has led to declining soil fertility and reduced productivity across large swaths of arable land. At the same time, rapid land use changes, including urban sprawl, infrastructure expansion, and the conversion of natural ecosystems into agricultural land, are eroding Kenya's ecological resilience.

However, these challenges also present critical entry points for bioeconomy-based interventions. In particular, nature-based and bio-based solutions such as climate-smart agriculture, agroforestry, soil regeneration using biofertilizers, and restoration of degraded lands through indigenous species offer pathways to reverse environmental decline while enhancing rural livelihoods. Furthermore, biopesticides, drought-tolerant crops, and sustainable rangeland management can increase productivity without compromising environmental health. The transition to a sustainable bioeconomy aligns with Kenya's commitments under the Paris Agreement, Sustainable Development Goals (SDGs), and national policies like the Climate Change Act and National Land Use Policy. By embedding environmental sustainability at the heart of its bioeconomy strategy, Kenya can position itself as a regional leader in leveraging biological innovation

# 2.8 Kenya's Bioeconomy: Strengths, Weaknesses, Opportunities & Threats (SWOT)

Kenya's bioeconomy operates within a complex national and regional environment that presents a blend of opportunities and risks. This SWOT analysis distils key strengths, weaknesses, opportunities, and threats shaping the growth and sustainability of bio-based sectors in Kenya. It reflects structural factors, innovation trends, environmental pressures, and institutional dynamics drawn from national assessments and policy analyses. This analysis will further identify priority areas for investment, reform, and strategic coordination SWOT Analysis.

## Strengths

- Strong contribution to economy and employment: The bioeconomy supports ~70% of the workforce, particularly through agriculture, forestry, and fisheries.
- Political will and strategic alignment: Anchored in Vision 2030, BETA, and aligned with regional strategies (EAC, COMESA), providing long-term direction for green growth and industrialization.
- Youth-driven innovation potential: A young, tech-savvy population (70% under 35) driving innovation in agritech, biotech, and mobile applications.
- Natural resource base: Rich biodiversity, vast arable land, and abundant agricultural and forest biomass support diverse bio-based value chains.
- Emerging bio-innovations: Advancements in biopharmaceuticals, biopesticides, biodegradable packaging, and climate-smart agriculture supported by institutions like KEMRI, ICIPE, and Kenya BioVax.
- Established biosafety and IP frameworks: Existing laws such as the Biosafety Act and Seed and Plant Varieties Act provide foundational legal support for biotechnology development.

## Weaknesses

- Low level of value addition to primary biomass produce. Inefficient biomass value chains. limited use of ag/bio waste and biomass residues
- Fragmented legal and policy landscape: Sectoral regulations and strategies remain uncoordinated, especially across agriculture, energy, health, and environment.
- Underinvestment in R&D and value addition: Low public and private R&D spending, minimal investment in industrial biotech, and weak tech transfer systems.
- Insufficient infrastructure for processing and storage: Limited facilities for bioprocessing, cold chains, and waste valorisation hinder expansion of high-value chains.
- Skills gaps and low public awareness: Inadequate training in bio-innovation and limited societal understanding of bio-based products and technologies.
- Neglect of industrial and environmental biotech: Existing biotechnology-based policies emphasis remains largely on agriculture and health, sidelining industrial biotech and its climate and circular economy benefits.

## Opportunities

- Regional market integration: EAC, COMESA, and AfCFTA provide expanded markets, harmonized standards, and trade incentives for bio-based goods and services.
- Climate change response and green jobs: Bioeconomy solutions (e.g. bioenergy, biopesticides, carbon farming) offer tools to address land degradation, biodiversity loss, and rural unemployment.
- Growing consumer demand for sustainability: Rise in middle-class purchasing power, awareness of organic and bio-based products, and global sustainability standards.
- Agrowaste valorization and circular economy: Potential to transform cassava, sugarcane, and food waste into packaging, bioplastics, biofertilizers, and fuels.
- Youth entrepreneurship and tech ecosystems: Kenya's "Silicon Savannah" presents an opportunity to digitize bioresource management, foster youth-led startups, and incubate green innovations.
- Global partnerships and green finance: Climate finance, green investment platforms, and innovation hubs are increasingly accessible to support bio-based SMEs and community-led projects.

## Threats

- Climate-related risks: Land degradation, erratic rainfall, water scarcity, and biodiversity loss may disrupt primary bio-based production systems.
- Policy and regulatory uncertainty: Inconsistent implementation, outdated laws, and lack of incentives for bio-innovation discourage investment and long-term planning.
- Technology lock-ins and IPR barriers: Dependence on imported patented technologies, limited access to open-source innovation, and weak IPR enforcement can hinder local industrialization.
- Competing land use and urbanization: Rising demand for housing and infrastructure threatens availability of arable land for sustainable biomass production.
- Market access challenges: Non-tariff barriers, low standardization, and limited certification systems affect Kenya's competitiveness in exporting high-value bio-based products.
- Resistance to new technologies: Cultural preferences and public skepticism toward GMOs or synthetic biology may slow the adoption of critical innovations.

# ECONOMIC CONTRIBUTIONS, STRATEGIC VALUE CHAINS, AND MARKET DYNAMICS

Kenya's bioeconomy is anchored in the productive use of its rich biological resources, from agriculture, forestry, and fisheries to energy, manufacturing, and emerging biotechnologies. These sectors collectively illustrate how innovation, circularity, and ecosystem stewardship can drive inclusive growth, restore ecosystems, and build a sustainable, competitive national economy. This chapter explores tangible opportunities across key value chains, showing how biological resources are being transformed into high-value products and services that enhance food security, green industrialization, and livelihoods. Through selected case studies, such as millet and sorghum value addition and revitalization, leather processing, seaweed farming, and bioenergy innovation, it demonstrates how enterprises and communities are translating science and innovation into practical bio-based solutions that strengthen resilience and sustainability.

## 3.1 Bioeconomy in Action: Unlocking Kenya's Biological Wealth

To unlock Kenya's biobased wealth, the focus must shift from primary production toward smarter, value-adding, and regenerative use of resources. In agriculture, this means investing in local production of bio-inputs such as biofertilizers and biopesticides, encouraging on-farm waste recovery for compost and biogas, and supporting farmer cooperatives to process and brand natural products for niche markets. Strengthening linkages between research institutions, extension services, and small enterprises can accelerate the adoption of bio-based innovations and improve productivity without degrading ecosystems. Similarly, the fisheries and aquaculture sectors can increase their bioeconomy contribution by promoting sustainable aquaculture, improving feed production using algae and crop by-products, and supporting small processors to add value through fish drying, smoking, and packaging technologies. On the other hand, the forestry sector in the country offers unique opportunities to expand sustainable value chains through bamboo cultivation, wood product innovation, and commercialization of non-timber forest products such as honey, resins, and medicinal plants. At the same time, strengthening community forest associations and providing incentives for private tree farming can enhance both forest cover and rural incomes.

In the energy sector, expanding access to affordable biogas systems, promoting bioethanol for clean cooking, and developing waste-to-energy projects in urban areas can reduce dependence on charcoal while creating local jobs. These initiatives require targeted financing, supportive regulation, and technical training for communities and small businesses. Meanwhile, Kenya's growing network of universities and innovation hubs provides a platform for emerging bio-based industries, such as biodegradable materials, biopharmaceuticals, and natural product chemistry, to move from research to commercialization. Strengthening partnerships between science and industry, establishing clear standards, and protecting intellectual property will be essential for these innovations to scale.

Therefore, by intentionally building capacity along these value chains, through targeted training, accessible financing, and supportive policy, Kenya can transform its biological wealth into engines of inclusive, low-carbon growth. The task ahead is not only to conserve what nature provides, but to use it wisely, regeneratively, and profitably for both current and future generations. This transition calls for identifying and prioritizing the value chains with the greatest potential for innovation, investment, and sustainable impact and is explored in the next chapter

## 3.2 Prioritized Value Chains and Sector Opportunities

Kenya's agro-processing sector stands at the heart of its transition toward a sustainable and innovation-driven bioeconomy. By bridging agriculture, industry, and technology, agro processing creates value-added products from the country's diverse biological resources while addressing key development priorities such as food security, employment, rural industrialization, and environmental sustainability. With strategic development and investment in modern technology and value chains it is possible convert raw materials into high-value bioproducts ranging from oils, starches, nutraceuticals, and animal feed to bioplastics, bioenergy, and health product. In addition, enterprises such as Limbua Avocado Oil Factory, Giraffe Bioenergy, EABL's Senator Keg initiative, and the Leather Capacity Building Project illustrate practical pathways through which inclusive innovation, circular resource use, and policy support can unlock local and global market opportunities. Collectively, these case studies underscore the transformative role of agro-processing in catalysing a circular bioeconomy that integrates smallholder farmers, youth, and MSMEs into value-added production systems—laying the foundation for Kenya's broader vision of green, resilient, and inclusive industrial development.

## 3.2.1 Agro processing for Food and Industrial Transformation

Agricultural processing plays a pivotal role in Kenya's emerging bioeconomy, serving as a bridge between primary production and value-added innovation. Most of the food produced in Kenya, and the broader Eastern African region is currently marketed in minimally processed forms, grains milled into flour, fruits dried, or tubers sold fresh. This pattern constrains the full economic, nutritional, and environmental value that biological resources can offer. Agriprocessing offers a powerful opportunity to address post-harvest losses, stimulate rural industrialization, diversify exports, and unlock new bio-based product streams from both primary crops and side-streams. In this section, we focus on four key value chains, millet, cassava, avocado, and leather as strategic entry points for expanding agroprocessing within the Kenyan bioeconomy. These commodities are chosen based on their climate resilience, economic relevance, and strong potential for value addition across food, health, energy, and material sectors. The section outlines opportunities not only for food transformation but also for bioproducts such as bioplastics, animal feed, nutraceuticals, and bio-based packaging, demonstrating how Kenya can transition from raw commodity exports to circular, innovation-led bio-industrial development.

### Avocado: A Growing Bioeconomy Frontier

Kenya's avocado sector has rapidly emerged as one of the country's most dynamic bioeconomy value chains. Annual production has grown from about 264,000 tonnes in 2019 to over 417,000 tonnes in 2024, positioning Kenya as Africa's leading exporter and the world's third-largest producer. With nearly 70% of production coming from smallholder farmers, the crop provides both livelihood security and a platform for rural enterprise. Yet, most exports still consist of raw fruit, limiting value capture and leaving significant potential untapped.

Expanding domestic processing and innovation can unlock high-value product streams such as cold-pressed avocado oil for food, cosmetics, and health applications; purees and pastes for regional and global markets; and functional foods for the growing health-conscious consumer base. The cosmetics industry also offers major opportunities through avocado-based skincare and haircare formulations, while side streams such as skins and seeds can be converted into biochar, animal feed, fertilizer, or biodegradable materials, supporting circular production.

To realize this potential, Kenya must invest in county-level processing clusters, improved cold chain infrastructure, and concessional financing for SMEs engaged in value addition. Strengthening certification, digital traceability, and climate-smart production will improve market access and consumer confidence. With coordinated policy support and targeted investment, the avocado sector can serve as a flagship example of how Kenya's biological resources can power inclusive, innovation-led, and sustainable growth.

## Limbua Avocado Oil Factory: Transforming Kenya's Avocado Sector through Organic Innovation and Inclusive Value Addition

Limbua Avocado Oil Factory is a pioneering enterprise in Kenya that has redefined how value is added to avocados by integrating sustainability, technology, and social impact into every stage of its operations. A division of LIMBUA Group Limited which was established in 2009, the factory is located near Ena village in Embu County, strategically positioned close to its primary suppliers: smallholder farmers. Limbua works with over 7,000 organically certified farmers who grow avocados, macadamia nuts, and other crops in mixed agroforestry systems. By sourcing directly from these farmers, the company ensures fair pricing, eliminates middlemen, and strengthens traceability. Payments are made digitally via mobile money, guaranteeing transparency and timely compensation.

The factory uses advanced cold-pressing technology that preserves the nutritional integrity, rich flavour, and deep green hue of the oil, without chemicals or excessive heat. Fruits are carefully sorted by hand to ensure only optimally ripened avocados are processed. This meticulous approach, coupled with mechanical extraction, results in a premium, extra-virgin avocado oil that meets the highest international standards. Limbua's oil is certified under USDA Organic, EU Organic, Bio Suisse, Fair-for-Life, and other globally recognized quality seals, opening doors to health-conscious markets in Europe, the U.S., and beyond. Limbua is also deeply committed to environmental stewardship. Its decentralized processing model reduces transport emissions, while renewable energy systems such as solar and biogas power its facilities. The company also utilizes waste from macadamia shells as a local energy source, embodying principles of the circular economy. Socially, Limbua employs over 700 local workers, most of them women and youth, contributing significantly to rural employment and community resilience.

The company's model has earned recognition from global partners, including Germany's DEG and cosmetic brands like Dr. Hauschka, which use Limbua's avocado oil in premium skincare. Revenues generated also support local development projects such as schoolbook provision and organic seedling distribution. By blending inclusive development with global competitiveness, Limbua Avocado Oil Factory showcases how Kenyan enterprises can deliver high-value, ethical products while empowering smallholders and protecting the environment.

## Cassava: An emerging Industrial Bioeconomy Crop

Cassava, long regarded as an underexploited but resilient crop, is increasingly recognized as a cornerstone of Kenya's emerging bioeconomy. Grown widely in the Coastal, Eastern, and Western regions, it serves as both a staple food and a strategic livelihood source for drought-prone communities. The annual production of the crop stands at roughly one million tonnes 1, and with investment in improved varieties and value chain infrastructure, national output could exceed three million tonnes, transforming cassava into a key driver of rural growth and agro-industrial development.

Its bioeconomy potential lies in its versatility. Cassava is not only a food and feed crop but also a valuable industrial raw material for starch, ethanol, bioplastics, adhesives, and bio-based composites. In recent times, high-yielding, early-maturing, and pest-resistant varieties that have been developed by the Kenya Agriculture and Livestock Organisation (KALRO) can thrive in semi-arid environments, making cassava a climate-smart solution for food and energy security. Locally, cassava flour is increasingly used in composite baking and gluten-free products, while industrial starch applications in paper, textile, and pharmaceutical sectors present major expansion opportunities.

However, realizing this potential requires tackling long-standing challenges such as weak aggregation systems, limited processing capacity, and post-harvest losses due to cassava's perishability. Most importantly, strengthening rural processing through decentralized grating and drying units, expanding cold storage, and improving rural roads can drastically reduce losses and create new market opportunities for farmers. Furthermore, cassava by-products also hold untapped promise. Biproducts such as peels, skins, and wastewater can be converted into livestock feed, biogas substrates, organic compost, and biodegradable materials, turning waste into value while reducing environmental impact. Kenya can draw lessons from Nigeria and Ghana, where cooperatives and SMEs are successfully transforming cassava waste into energy and feed products, offering replicable models for Kenya 2.

To fully harness cassava's bioeconomy potential however, Kenya should prioritize: (i) access to improved planting material and climate-smart agronomic support, (ii) financing and training for women- and youth-led value addition enterprises, (iii) public–private partnerships for ethanol and starch-based industries, and (iv) sustained investment in applied research for advanced derivatives such as modified starches, ethanol gels, and bio-based packaging. Ultimately, with coordinated policy and investment, cassava can evolve from a food security crop into a climate-resilient industrial resource that anchors Kenya's transition to a regenerative bioeconomy.

## Giraffe Bioenergy: Unlocking Clean Energy and Rural Prosperity through Cassava

Giraffe Bioenergy is a Kenyan-based clean energy enterprise that is pioneering the production of ethanol cooking fuel derived from cassava. Recognizing both the climate-resilient properties of cassava and the persistent challenge of unsustainable biomass use for household energy, the company has positioned itself at the intersection of agriculture, rural development, and green innovation. Its model centres on sourcing cassava from underutilized semi-arid regions, particularly areas affected by low agricultural production due to unreliable rainfall attributed to climate change, and converting it into affordable, locally manufactured ethanol fuel.

The company's mission is to enhance rural livelihoods, particularly for smallholder women farmers, by creating reliable market demand for cassava. By 2030, Giraffe Bioenergy aims to produce up to 75 million litres of ethanol annually, enough to meet the clean cooking needs of hundreds of thousands of households, while simultaneously displacing charcoal, which remain dominant in low-income urban and peri-urban settings.

Importantly, the initiative has become a proof of concept for how climate-resilient crops like cassava can be used to drive decentralized clean energy solutions and agro-industrial development in rural Kenya. Giraffe Bioenergy's model aligns strongly with bioeconomy principles as it leverages local biological resources, adds value through green technologies, creates rural employment, and supports climate mitigation. As such, it serves as an illustrative example of how targeted innovation in the cassava value chain can advance Kenya's sustainable development and bioenergy goals simultaneously.

## Millet and Sorghum: Indigenous Cereals for Climate Resilience and Innovation

Millet and sorghum, just like Cassava, are among Kenya's most resilient and culturally significant cereals, thriving in arid and semi-arid lands where other staples often fail. Grown across Eastern, Northeastern, Rift Valley, and parts of Western Kenya, these grains are naturally adapted to drought, heat, and poor soils, making them vital to food security under a changing climate. Despite their potential, millet and sorghum remain underutilized in Kenya's formal food and industrial systems, with production and consumption constrained by limited processing infrastructure and shifting dietary preferences.

Renewed interest in these crops is being driven by rising demand for nutritious, gluten-free, and low-glycaemic foods. Rich in iron, calcium, fibre, and antioxidants, millet and sorghum are increasingly being used in infant foods, health snacks, breakfast cereals, and fortified beverages. Local enterprises and cooperatives are also tapping into new opportunities in composite flours, bakery mixes, and craft beverages, illustrating the growing appeal of these grains among health-conscious and urban consumers.

From a bioeconomy perspective, millet and sorghum offer diverse opportunities for value addition and circular use. Sorghum stalks and husks can be processed into animal feed, paper pulp, or biodegradable packaging materials, while millet flour can be extruded into instant noodles, snack bars, and gluten-free mixes. Their compatibility with low-input, mixed-farming systems also enhances soil health and biodiversity, supporting sustainable agricultural intensification in drylands.

To unlock their full potential therefore, Kenya must strengthen seed systems for improved and biofortified varieties, expand mechanization and storage infrastructure, and incentivize private investment in processing and product development. Integrating millet and sorghum into school feeding, health nutrition, and public procurement programmes would further stimulate demand and normalize their consumption. Finally, embedding these indigenous cereals within climate adaptation and green industrial strategies can position them as flagship crops for resilience, nutrition, and inclusive bioeconomic transformation in the ASAL regions.

## East African Breweries Limited "Senator Keg" Initiative: Reviving Sorghum Through Inclusive Farmer Partnerships

The East African Breweries Limited (EABL), through its Senator Keg brand, has cultivated one of Kenya's most successful examples of an inclusive and market-driven agricultural value chain. By working closely with smallholder farmers across counties such as Kisumu, Busia, Tharaka Nithi, Kitui, Homa Bay, Siaya, Meru, and Migori, the company has repositioned sorghum from a largely neglected crop into a dependable commercial commodity that supports rural livelihoods and stimulates local economies.

Introduced in 2004 through a partnership with the Government of Kenya, Senator Keg was designed as a safe, high-quality, affordable alternative to illicit brews, aligning with national priorities on public health and consumer protection. The subsequent introduction of excise tax remission in 2006 for beers brewed using sorghum, millet, or cassava further incentivized local production, helping spur the expansion of sorghum farming across Kenya's semi-arid regions. Therefore, with a stable market guaranteed, EABL began to contract farmers and support them with certified seed varieties, agronomic guidance, and predictable procurement arrangements. The company's engagement enabled farmers to access improved seed types such as Gadam and Silla sorghum, increase their productivity, and benefit from timely payments. For many households, this reduced the risks associated with farming and provided a path from subsistence production to more commercially focused agriculture.

The impact of this intervention has been far-reaching. EABL now works with more than 45,000 sorghum farmers and pays out over KSh 1.1 billion annually, creating consistent income streams for rural households. Farmer testimonies have also reflected significant improvements in yields, often surpassing those of maize and other common crops, as well as increased abilities to lease additional land, invest in small businesses, educate children, and improve housing. These outcomes illustrate the transformative potential of stable markets for climate-resilient crops.

Beyond individual livelihoods, EABL's investments have contributed to broader regional development. The reopening and major expansion of the Kisumu brewery, a KSh 14 billion investment, has created a reliable processing hub for locally sourced sorghum and is projected to support more than 100,000 direct and indirect jobs across the value chain. The presence of this facility has further motivated county governments and local actors to increase farmer mobilization, enhance supply networks, and participate more actively in the structured value chain. This initiative demonstrates how private–public collaboration can catalyze rural industrialization and stimulate economic growth in regions frequently left behind.

In addition, this model highlights the strategic importance of climate-resilient crops such as sorghum in advancing Kenya's food security and adaptation agenda. Given that arid and semi-arid lands make up 84 percent of the country's landmass, scaling such value chains offers a practical pathway for enhancing both productivity and resilience. When supported by consistent demand, fair pricing, agronomic support, and local value addition, sorghum can serve as a cornerstone of sustainable rural transformation.

***Source: Kenya Breweries Limited. (2019). Celebrating 15 Years of Senator Keg. Nairobi: KBL.***

## Leather Value Chains

Kenya's leather sector is widely recognised as one of the country's most underexploited industrial assets. With an annual potential to process over 2.5 million hides and 10 million skins from cattle, goats, and sheep, the country holds a significant comparative advantage in livestock-based bioresources. However, despite this natural endowment, the leather industry continues to face challenges in unlocking higher-value opportunities across the value chain, from raw hides to finished goods.

At present, the majority of Kenya's hides and skins are exported in raw or semi-processed form (wet blue), with limited local processing into finished leather products. This not only results in missed opportunities for value addition and employment creation but also contributes to revenue loss through the export of low-value commodities. In addition, existing tannery capacities remains underutilised, while domestic leather goods manufacturing, such as footwear, bags, belts, and upholstery, struggle with issues of scale, design, quality standards, and access to technology

Despite these challenges, the sector is gaining momentum. Government initiatives, including the Leather Value Chain Strategy (2018–2022) and the establishment of Kenya Leather Development Council (KLDC), have aimed to stimulate investment in local tanning and manufacturing. In line with Kenya's Bottom-Up Economic Transformation Agenda (BETA), leather has been identified as a strategic sector for micro, small and medium enterprise (MSME) development, particularly in counties like Kajiado, Narok, Isiolo, and Garissa where livestock production is a way of life. The revitalisation of leather is seen as a means to support rural industrialisation, local job creation, and the emergence of bio-based cottage industries.

The few value addition opportunities existing, span several domains. In the upstream segment, improved livestock husbandry and slaughterhouse practices can enhance the quality of hides and skins, which are often degraded due to poor handling and diseases. In the midstream, tannery waste valorisation presents significant bioeconomy potential, transforming offcuts, shavings, and fleshing waste into inputs for biogas, organic fertilisers, and gelatin-based products. Downstream, innovations in leathercraft and design, particularly among youth and artisans are already beginning to reshape perceptions of Kenyan-made leather goods for both local and export markets. A successful example includes the Athi River Leather Industrial Park, which aims to cluster tanneries, manufacturers, and training institutions into a special economic zone to spur integrated value chain development. In addition, the Kenya Leather Apex Society, composed of local artisans and MSMEs, continues to advocate for skills upgrading, market linkages, and access to affordable processing facilities.

As the global leather market shifts toward sustainable and traceable materials, Kenya has an opportunity to position its leather sector within green branding frameworks, and emphasising ethical sourcing, reduced chemical use, and circular practices. An additional area of focus is also the growing global interest in bio-leather alternatives (e.g., from cactus, mushroom, or fish skins). Here, Kenyan entrepreneurs and researchers could explore hybrid models that blend traditional leather processing with bio-based innovations aligned with circular economy goals.

## Capacity Building for Job Creation and Growth of Leather Goods and Leather Footwear Manufacturing Enterprises project

The transformation of Kenya's leather industry offers a compelling illustration of how capacity building, innovation, and sustainability can accelerate the country's bioeconomy. Through the Capacity Building for Job Creation and Growth of Leather Goods and Leather Footwear Manufacturing Enterprises project, the National Research Fund (NRF), in partnership with Dedan Kimathi University of Technology (DeKUT), is equipping artisans and small enterprises with the technical and entrepreneurial capabilities needed to harness the full value of livestock-based bioresources. Led by Dr. Paul Tanui, the initiative demonstrates how targeted research funding can translate into meaningful economic and social outcomes by connecting academic expertise with local enterprise development.At the core of Dr. Tanui's work is a focus on enhancing the competitiveness of MSMEs, promoting value addition, and advancing sustainable leather processing technologies. Through hands-on training, product prototyping, and structured capacity-building programmes, the project has strengthened the skills of youth, women, and community-based enterprises. These interventions have supported MSMEs in adopting cleaner production methods, improving product quality, and transitioning into higher-value market segments, directly contributing to job creation and local economic growth.

The results are visible on the ground. Graduates of the programme now produce higher-quality leather goods, including shoes, bags, and accessories, with greater efficiency and reduced waste. In the case of footwear production, individual artisans have increased their output from an average of ten pairs per day to as many as fifteen pairs following the training. Many participants have since established or expanded their own enterprises, while others have become trainers themselves, passing on their expertise and fostering a self-sustaining cycle of skill transfer and enterprise growth. Training materials developed under the project further ensure that this knowledge continues to circulate and strengthen technical capacity across the sector. Additionally, a distinctive aspect of the initiative is its emphasis on circular production. Participants now repurpose leather offcuts into smaller items such as keyholders and belts, maximizing raw material utilization and minimizing environmental impact. This approach reflects core bioeconomy principles that prioritize resource efficiency, waste valorisation, and sustainable manufacturing practices.

The broader significance of this project lies in how it repositions Kenya's leather sector within the bioeconomy framework. By integrating research, innovation, and enterprise development, it demonstrates how biological resources, often exported in low-value forms, can drive inclusive industrialization when supported by skills, technology, and sustainable production systems. The initiative provides a clear pathway toward a regenerative economy where craftsmanship, circular innovation, and community empowerment converge to create jobs, boost competitiveness, and reduce environmental pressure.

A notable outcome has been the ripple effect of empowerment across participating communities. Several graduates have transitioned into trainers at institutions such as the Rukira Vocational Training Centre, ensuring continuous knowledge transfer and community-led skills expansion. Others are now working with the project's industry partner, Yallo Leather, as subcontractors

during periods of high demand, further embedding local enterprises within the national leather value chain. This multiplier effect expands the project's reach, generating a growing network of skilled artisans who contribute to local economies, strengthen small manufacturing enterprises, and model principles of circular production.

Building on this progress, the project team has secured a new competitive award from the National Research Fund to scale up capacity-building initiatives across the leather value chain. This milestone reinforces their leadership in advancing innovation, skills development, and enterprise transformation within Kenya's leather sector, demonstrating how strategic investment in people, technology, and sustainable practices can reshape the country's bioeconomy.

## 3.2.2 Aquaculture and the Blue Bioeconomy

Kenya's blue economy holds a great, yet underutilised, potential to drive sustainable development through innovations in aquaculture, marine biotechnology, and aquatic resource valorisation. As pressures on land-based food systems intensify, inland and coastal waters are increasingly being recognised not only as ecological assets but as engines of economic resilience, livelihood diversification, and bio-based industrial growth. In this context, aquaculture and marine bioproducts represent critical frontiers for advancing Kenya's bioeconomy agenda.

**Potential for New Aquaculture and Novel Feeding Systems**

Kenya's aquaculture sector has grown steadily over the past two decades, emerging as a critical component of the country's blue bioeconomy and food security agenda. The reactivation of fish farming under the Economic Stimulus Programme (ESP) led to the expansion of inland ponds in counties such as Kisumu, Homa Bay, Siaya, Kakamega, and Nyeri, while recent developments have seen a rapid uptake of cage aquaculture in Lake Victoria. Private investors, cooperatives, and youth groups are increasingly adopting floating cage systems to rear species like tilapia and catfish, attracted by their higher feed efficiency, faster growth rates, and year-round production potential.

Despite this progress, the sector faces persistent challenges including high feed costs, limited access to quality fingerlings, weak extension services, and localized environmental impacts from unregulated cage clusters. Addressing these issues will be essential for sustainable expansion and value creation. The next frontier for Kenya's aquaculture bioeconomy lies in developing novel and sustainable feed systems that reduce dependence on costly imported feeds. Opportunities exist in using locally available ingredients, such as algae, black soldier fly larvae, duckweed, and crop by-products to produce high-protein, low-cost feeds while reducing waste and pressure on wild fish stocks. Complementary innovations in genetic improvement, water quality monitoring, and ecosystem-based management can further enhance productivity and resilience.

By investing in research, local feed formulation, and aquaculture engineering, Kenya can establish a more circular, self-reliant aquaculture system that not only meets growing domestic demand for fish but also strengthens rural livelihoods and environmental sustainability. In doing so, aquaculture can evolve from a supplementary activity into a core pillar of Kenya's blue bioeconomy, linking food production, innovation, and ecological stewardship..

## Hydro Victoria Africa: Pioneering Circular Bioeconomy Solutions in Kenya's Blue Economy

Hydro Victoria Africa, based in Busia County with operations in Kakamega, Homabay, Siaya, Kisumu, and Kilifi, is a social enterprise and living laboratory advancing regenerative agri-aquaculture within Kenya's Blue Economy. Since 2018, the enterprise has pioneered the use of the black soldier fly (BSF) to tackle feed insecurity, organic waste management, and youth unemployment.

By partnering with over 2,000 smallholder farmers, Hydro Victoria collects more than 50 tons of organic waste monthly, producing about 5 tons of BSF larvae for poultry and fish feed. This approach not only reduces landfill waste but also provides affordable, protein-rich alternatives to fishmeal and soy while generating fertilizer that boosts soil health.

As a key implementing partner in the Mastercard Foundation's Youth in Sustainable Aquaculture (YISA) program, Hydro Victoria trains young people, with about 70% of them being women, with an aim to establish BSF ventures across six counties. Beyond breeding and larvae production, participants learn value addition and market integration, creating dignified jobs and new local service networks. So far, more than 3,000 youth have been trained, with a target of 6,000 by 2026.

The regional context further underscores the urgency of this model. Kenya's demand for animal feed is projected to hit 3 million metric tons by 2025, with heavy reliance on costly imports. BSF, at 40% protein and with strong climate credentials, offers a sustainable, locally available solution. Hydro Victoria already offsets over 1,000 tons of waste annually and produces more than 50 tons of larvae, demonstrating the scalability of circular bioeconomy innovations. By linking waste-to-value systems with youth empowerment and inclusive markets, the enterprise illustrates how Kenya's bioeconomy can grow into a nature-positive and resilient food system for East Africa.

*Photo credit: Hydrovictoria Farms, Kenya*

## Potential for Algae and Seaweed Production

Beyond finfish aquaculture, Kenya's blue bioeconomy holds vast untapped potential from aquatic plants, algae, and marine organisms. Algae, in particular, represent a high-value bioresource with applications in nutraceuticals, cosmetics, animal feed, fertilizers, and biofuels. Kenya's diverse aquatic ecosystems, including Lake Victoria, the Indian Ocean, and coastal mangrove lagoons provide ideal conditions for cultivating microalgae and macroalgae species such as Spirulina, Chlorella, and Ulva. These species are rich in protein, omega-3 fatty acids, antioxidants, and pigments, making them valuable in food and health industries.

Small-scale Spirulina production initiatives in regions such as Kisumu and Kilifi have already demonstrated the feasibility of community-based algae farming for dietary supplements and improved nutrition. However, algae cultivation in Kenya remains largely informal, constrained by limited research infrastructure, processing facilities, and regulatory frameworks. Establishing stronger linkages between marine science institutions, local innovators, and investors could catalyse a new wave of bio-based enterprises focused on algae processing, bio-product development, and export-oriented marine biotechnology.

At the coast, seaweed farming is gaining traction in Kwale, Kilifi, and Lamu, where community-based projects supported by NGOs and research institutions are piloting the cultivation of Eucheuma and Kappaphycus species. These seaweeds are commercially valuable for carrageenan extraction, widely used in food, pharmaceuticals, and biodegradable materials. The emerging seaweed sector is creating new livelihood opportunities, particularly for women and youth, while promoting sustainable marine resource management and conservation. Scaling up these early models through improved farming technology, quality assurance, and market access could anchor inclusive and climate-resilient coastal value chains.

To fully realize the potential of algae and seaweed within the blue bioeconomy, Kenya needs coordinated policy and institutional support. National initiatives such as the Blue Economy Implementation Plan, Kenya Marine Fisheries and Socio-Economic Development Project (KEMFSED), and the Aquaculture Business Development Programme (ABDP) have laid an important foundation. Building on these efforts will require targeted investment in research commercialization, enterprise incubation, and marine bioprocessing infrastructure, including cold chains, coastal innovation labs, and algae-processing hubs. Such investments would transform aquatic biomass into value-added products for domestic use and export, positioning Kenya as a regional leader in sustainable marine biotechnology and blue growth

## East Africa Seaweeds Limited: Catalysing Kenya's Coastal Blue Bioeconomy

Seaweed farming is fast emerging as a cornerstone of Kenya's blue bioeconomy, offering a sustainable alternative livelihood for coastal communities while contributing to marine ecosystem restoration. At the forefront of this transformation is East Africa Seaweeds Limited (EASL), a pioneering enterprise based in Shimoni, Kwale County, that has successfully built a scalable model linking marine biodiversity with inclusive economic development.

EASL partners with over a thousand small-scale farmers, predominantly women and youth in coastal villages such as Kibuyuni, Mkwiro, Funzi, and Gazi. Through training, provision of quality Eucheuma and Kappaphycus seedlings, and guaranteed markets, the company has enabled coastal households to diversify their income and strengthen resilience against declining fisheries. The enterprise aggregates and processes more than 100 tonnes of dried seaweed annually, supplying both local and export markets for carrageenan, a natural polymer used in food additives, pharmaceuticals, and eco-friendly packaging.

Beyond direct income generation, EASL's work illustrates the broader bioeconomy potential of marine biomass. The seaweed can be converted into biofertilizers, animal feed supplements, cosmetics, and bioplastics, presenting multiple value chains for Kenya's emerging blue economy. Moreover, seaweed cultivation supports carbon sequestration, coastal protection, and nutrient cycling, directly aligning with Kenya's climate adaptation and sustainable ocean management goals.

Nevertheless, the sector remains nascent as factors such as limited processing infrastructure, lack of research–industry linkages, and regulatory gaps continue to constrain large-scale growth. Strengthening partnerships among marine science institutions, private investors, and county governments will be key to expanding production capacity, developing value-added products, and positioning Kenya as a competitive regional producer of sustainable marine bioproducts. EASL's experience demonstrates how targeted investment in local enterprise, research, and community capacity can transform coastal livelihoods into drivers of innovation and sustainability, anchoring Kenya's transition toward an inclusive, circular, and resilient blue bioeconomy.

*Source: East African Seaweed Company Website*

## 3.2.3 Bioenergy production in Kenya

The bioenergy sector represents one of Kenya's most promising yet under-leveraged bioeconomy frontiers. By transforming agricultural, forestry, and industrial residues into clean, renewable energy, bioenergy directly links climate action with rural development and circular value creation. With nearly 70% of households still dependent on firewood and charcoal for cooking, scaling sustainable bio-based energy alternatives offers immense potential for improving livelihoods, reducing emissions, and conserving forests.

Currently, biogas, bio-briquettes, and ethanol are at the centre of this transition. Therefore, expanding biogas systems, particularly through cooperative models, pay-as-you-go technologies, and institutional installations, can reduce methane emissions while providing affordable energy and organic fertiliser. Bio-briquettes, produced from agricultural and sawmill waste, present a scalable substitute for charcoal, creating green jobs and reducing deforestation. Meanwhile, ethanol from sugarcane molasses and cassava offers a viable clean-cooking and industrial fuel alternative, cutting fossil fuel imports and stimulating rural agro-industrial growth. Despite this momentum, Kenya's bioenergy landscape remains fragmented, with weak coordination, limited infrastructure, and underdeveloped consumer markets.

Therefore, strengthening feedstock supply chains through organized farmer aggregation, residue collection networks, and regional biomass inventories will ensure consistent input for energy production. Expanding financing options for local enterprises, including concessional credit, green bonds, and results-based incentives, can help small and medium producers scale up affordable technologies for biogas, briquettes, and biofuels. Equally, integrating bioenergy into county development plans and national frameworks, such as Kenya's Bioenergy Policy, Energy Act (2019), and Nationally Determined Contributions (NDCs), will further anchor the sector within broader climate and energy transitions. This alignment should be complemented by clear standards, certification systems, and inter-agency coordination mechanisms to enhance investor confidence, market development, and policy coherence.

### Biojoule Kenya Ltd: Powering Kenya's Bioeconomy Through Agricultural Waste

Located at Gorge Farm in Naivasha, Nakuru County, Biojoule Kenya Ltd operates one of Africa's first grid-connected biogas power plants, demonstrating how agricultural residues can be transformed into clean, affordable energy. The facility, situated within an 800-hectare vegetable farm owned by Veg Pro Group, processes approximately 150 tonnes of crop residues and organic waste daily through anaerobic digestion. The resulting biogas powers high-efficiency engines that generate 2.4 MW of electricity, supplying both the national grid and the farm's operations.

By converting farm waste into energy, Biojoule reduces reliance on diesel and cuts an estimated 7,000 tonnes of $CO_2$ emissions annually, while the nutrient-rich digestate from the process replaces around 20% of the farm's synthetic fertiliser use. This closed-loop system embodies the principles of the circular bioeconomy, turning waste into value and linking agriculture, renewable energy, and sustainable production in one integrated model.

The success of Biojoule highlights bioenergy's potential as a driver of Kenya's low-carbon transition. The project demonstrates how reliable feedstock supply, smart technology, and favourable power purchase agreements can make bioenergy commercially viable. It also shows that agricultural enterprises can become energy producers, not just consumers, improving their competitiveness and resilience while contributing to national energy security. Scaling this model across Kenya's agro-industrial landscape, especially in sugarcane, dairy, horticulture, and cassava clusters that could unlock significant renewable energy capacity and rural industrialisation. However, replication will depend on improving feedstock logistics, strengthening bioenergy financing mechanisms, and ensuring policy.

## 3.2.4 Bio-packaging in Kenya: Turning Waste into Sustainable Packaging Solutions

Kenya's bio-packaging sector is rapidly emerging as a compelling illustration of circular bioeconomy in action, that is transforming organic residues into biodegradable, locally produced packaging alternatives that meet environmental, economic, and social objectives. This sector was boosted by the country's 2017 ban on single-use plastics and a growing policy focus on sustainable waste management, innovative companies are forging diverse pathways to replace plastic packaging with compostable, plant-based solutions.

Kenya's emerging biopackaging sector is being shaped by a wave of innovative enterprises that are transforming local biomass into sustainable, biodegradable alternatives to plastic. HyaPak Ecotech7, based near Lake Naivasha, exemplifies this shift by partnering with local fishermen to harvest invasive water hyacinth, which it processes into compostable seedling bags and eco-packaging materials. These biodegradable wrappers decompose naturally within a few months, enhance soil moisture retention, and contribute to decongesting Lake Naivasha's ecosystem from invasive biomass. Similarly, Zuripacks is advancing a banana-fibre packaging model that converts banana pseudostems, which are typically discarded agricultural waste and turns them into durable, plant-based packaging. This innovation not only reduces plastic dependency but also adds value to farm residues and creates jobs across the supply chain, from slicing to final product packaging. Complementing these efforts are enterprises like Terra Safi Eco Products, which produce compostable packaging and green solutions tailored to the hospitality industry. Together, these enterprises and many more, are not only reducing plastic pollution but also anchoring a thriving, waste-to-wealth bio packaging economy rooted in Kenya's own agro-ecological resources. Nonetheless, the bio-packaging landscape in Kenya faces challenges that limit scaling i.e., inconsistent quality standards, feedstock supply variability, research gaps in material science, and limited consumer awareness and market acceptance. Addressing these requires coordinated efforts to develop industrial composting infrastructure, improve regulatory clarity, and support research-industry linkage. Therefore, with better access to finance, technical capacity, and policy support, such as eco-labeling incentives and public procurement targets, Kenya's biopackaging sector can evolve from niche innovation into a mainstream bio-based industry

## HyaPak Ecotech Ltd: Transforming Water Hyacinth into Biodegradable Packaging

HyaPak Ecotech Ltd, founded in 2022 and based in Nakuru County, is pioneering the conversion of the invasive water hyacinth into fully biodegradable packaging materials. By transforming an environmental menace into a renewable industrial resource, HyaPak demonstrates how innovation can transform ecological challenges into opportunities for sustainable growth. The company produces biodegradable seedling bags, food containers, and wrappers that decompose within months, offering a green alternative to single-use plastics.

The company's operations are anchored in a circular bioeconomy model that connects ecosystem restoration, waste valorisation, and green manufacturing. Water hyacinth harvested from Lake Naivasha and other infested water bodies is processed into bio-based materials, helping clear waterways, restore aquatic biodiversity, and support local livelihoods. The initiative engages local youth and fisher communities in weed harvesting and processing, creating jobs while improving lake ecosystem health.

HyaPak's products are gaining recognition both locally and internationally, with growing demand from the agriculture and packaging sectors and pilot exports to European markets. The company's biodegradable seedling bags are already being used in reforestation and horticultural projects, reducing plastic pollution and improving soil quality as the materials naturally decompose. This innovation illustrates Kenya's potential to lead in bio-based materials that substitute fossil-derived plastics, supporting green manufacturing and environmental protection.

HyaPak's model captures the essence of Kenya's emerging bioeconomy: transforming local biodiversity challenges into inclusive economic opportunities. By valorising invasive species, creating circular industries, and contributing to global sustainability goals, enterprises like HyaPak are redefining how Kenya can build a regenerative, innovation-driven economy from its natural resources.

*Source: Hyapac*

## 3.2.5 Natural Products and Biopharma: Health and Wellness as Pillars of Kenya's Bioeconomy

Kenya's natural products and biopharmaceutical (biopharma) sectors are rapidly emerging as high-potential pillars of the national bioeconomy. Both sectors leverage Kenya's rich biodiversity, traditional knowledge systems, and growing scientific capacity to create value-added health and wellness solutions that address local needs while tapping into global demand for natural, organic, and biologically derived products.

The natural products sector, which encompasses essential oils, herbal cosmetics, and traditional medicines, has seen significant growth over the past decade. Essential oils such as tea tree, eucalyptus, lavender, chamomile, and frankincense are among Kenya's top horticultural exports, contributing nearly 10% of the sector's export value (KSh 9.8 billion in 2015, ). By 2023, Kenya exported $10.7 million worth of essential oils, ranking 42nd globally, reflecting growing global demand for plant-based wellness ingredients. This reflects the rising global demand for organic and plant-based ingredients and the country's growing footprint in the natural products market.

The herbal cosmetics segment is also rapidly expanding, as consumers increasingly prefer natural skincare. However, challenges still persist in terms of inconsistent quality standards, limited regulatory oversight, and consumer scepticism about efficacy compared to synthetic products. Addressing these bottlenecks through laboratory testing, branding education, and policy support from the Pharmacy and Poisons Board (PPB) and Kenya Bureau of Standards (KEBS) is critical to building trust and scale in the sector.

Reliance on herbal medicine remains widespread in Kenya, particularly in rural areas where over 70% of the population depends on herbal remedies for primary healthcare, with women making up the majority of traditional medicine practitioners, playing a crucial role in community health delivery. While formal healthcare systems have historically been sceptical of traditional healing, the Ministry of Health acknowledges the important role traditional healers play in underserved and remote regions. However, significant regulatory gaps persist, especially regarding standardized practices, practitioner licensing, and the integration of traditional medicine into mainstream health systems. These challenges hinder efforts to ensure the safety, efficacy, and quality of herbal treatments, and underscore the need for a more coherent and enforceable legal framework.

The natural products sector, when viewed through a bioeconomy lens, offers multiple co-benefits as it supports rural livelihoods, enhances the value of biological resources, fosters local innovation, and contributes to broader policy goals such as job creation, health access, and environmental sustainability. To fully harness its potential, Kenya must invest in vertical integration, linking the formal and informal sectors, including farmers, processors, laboratories, and markets. Strategic actions to improve the sector include establishing regional extraction and formulation hubs, building export-ready branding, strengthening regulatory infrastructure, and supporting MSMEs with training and finance. Linking herbal medicine producer cooperatives to cosmetics labs and export platforms can further localize value addition and diversify income streams.

Complementing this is Kenya's growing biopharma sector, which includes vaccines, diagnostics, and plant-based therapeutics. This sector is central to Kenya's ambition to transition toward a knowledge-based bioeconomy, and it exemplifies how biological resources and innovations can be applied not only for commercial benefit but also for national health security and resilience. The establishment of the Kenya Biovax Institute marks a significant step in building local vaccine manufacturing capacity, reducing dependency on imports, and strengthening health sovereignty. Additionally, development of innovations in diagnostics, often led by institutions like the Kenya Medical Research Institute (KEMRI), have also demonstrated the potential of domestic research to deliver cost-effective, scalable health technologies that respond to national disease burdens while opening opportunities for bio-based enterprise growth. Furthermore, plant-based therapeutics represent a natural point of convergence between the natural products and biopharma sectors. Kenya's abundant medicinal flora and traditional healing knowledge provide an untapped source of bioactive compounds with pharmaceutical potential. If properly researched, standardised, and regulated, these resources can support new value chains that benefit rural communities, promote biodiversity conservation, and position Kenya as a regional hub for nature-based health innovations.

## Super Moringa Supplies: Unlocking Kenya's Bioeconomy Through Natural Wellness Innovation

Super Moringa Supplies exemplifies how Kenya's rich biodiversity can fuel a modern and inclusive bioeconomy. Founded by Judy and Martin Salano, the enterprise grew from a personal discovery of moringa's healing potential into a purpose-driven African wellness brand. Over 11 years, it has expanded from a small family venture into an internationally recognised enterprise, demonstrating the transformative power of Kenya's natural products sector.

At the heart of the enterprise is an integrated farmer-to-market system that engages more than 600 smallholder farmers, predominantly women and youth, who cultivate moringa using climate-smart and regenerative practices. Through farmer training, fair pricing, and the creation of over 25 local jobs, Super Moringa Supplies has built a resilient and inclusive value chain aligned with Kenya's bioeconomy ambitions. Its zero-waste processing ensures complete utilization of the moringa tree into teas, powders, skincare products, cold-pressed oils, herbal hair food, and multi-purpose petroleum jelly, demonstrating how SMEs can embed circularity and value addition within bio-based production.

These products complement a growing national market that reflects rising consumer interest in moringa's nutritional and medicinal properties. The plant is rich in vitamins A, C, and E, calcium, and iron, and is valued for boosting immunity, managing chronic conditions, and supporting skin and hair health. The crop itself thrives in Kenya's arid and semi-arid areas, in areas such as Machakos thereby offering livelihood opportunities for farmers and significant scope for rural bio-based enterprises. Super Moringa Supplies has strengthened its market position despite challenges common to bio-based enterprises, including limited capital, certification barriers, and gender biases in agribusiness. Through reinvestment, strategic partnerships, and consistent product quality, the company has built credibility across domestic and export markets. Its journey mirrors broader needs within Kenya's bioeconomy—such as supportive regulatory frameworks, accessible financing, stronger research–industry linkages, and continued investment in high-value natural products.

Ultimately, Super Moringa Supplies is more than a successful enterprise: it is a living example of Kenya's bioeconomy potential. By combining indigenous biological resources, community empowerment, and sustainable production systems, the company demonstrates how nature-based innovation can drive economic opportunity, promote public health, create green jobs, and strengthen climate resilience, offering a clear pathway for inclusive, value-added growth as Kenya advances its bioeconomy agenda.


# CREATING AN ENABLING ENVIRONMENT FOR BIOECONOMY ADVANCEMENT IN KENYA

Kenya's transition to a sustainable bioeconomy depends on an enabling environment where innovation, investment, and human capital work together to transform biological resources into inclusive economic opportunities. The country's success in this transformation relies not only on advances in science and technology but also a vibrant and innovative an entrepreneurial private sector, functional financing systems, effective institutions , and a skilled, adaptive workforce. This chapter examines how Kenya's innovation and financing architecture, anchored in public budgets, research grants, development partnerships, and private investment supports the growth of the bioeconomy. It explores how state-led programmes, development partners, and emerging private-sector initiatives mobilise resources for research, entrepreneurship, and commercialization. At the same time, it analyses the human capital foundations of the bioeconomy, highlighting the roles of universities, TVETs, research institutes, and indigenous knowledge systems in developing the skills and creativity needed to drive innovation.

# 4.1 National Innovation and Research Framework

Kenya has deliberately built a national innovation and research framework to harness science, technology, and innovation (STI) as drivers of economic transformation. Anchored in law and guided by the Kenyan Science, Technology and Innovation (STI) Act of 2013, this framework connects research to enterprise, enabling the conversion of Kenya's biological wealth into high-value, globally competitive products and services. It aligns with Vision 2030, the Bottom-Up Economic Transformation Agenda (BETA), and the African Union's Agenda 2063, placing innovation at the heart of sustainable and inclusive growth.

At its core this system has a coordinated triad of agencies. The National Commission for Science, Technology and Innovation (NACOSTI) provides regulation, coordination, and policy oversight to ensure that research is ethical, relevant, and development oriented. The Kenya National Innovation Agency (KeNIA) drives commercialization, bridging researchers and entrepreneurs through initiatives like the Research-to-Commercialisation (R2C), Accelerator and national innovation challenges and the National Research Fund (NRF) complements these functions by financing applied research and innovation infrastructure in priority fields such as agricultural biotechnology, renewable energy, health innovation, and industrial processing. Together, these institutions form a cohesive ecosystem where NACOSTI regulates, KeNIA connects innovation to markets, and NRF fuels the system with funding.

Beyond this institutional architecture, Kenya's innovation ecosystem is supported by a growing network of specialized hubs, research centres, and industry linkages. For instance, Konza Technopolis, a flagship Vision 2030 project, serves as the nation's emerging "Silicon Savannah," offering infrastructure for ICT and biotechnology, including the Kenya Advanced Institute of Science and Technology (KAIST-Kenya) to promote advanced research in biosciences and industrial innovation. The Kenya Industrial Research and Development Institute (KIRDI) strengthens industrial R&D through pilot plants and prototyping facilities, supporting agro-processing and bio-based manufacturing. Complementing these are public universities and research institutions such as Jomo Kenyatta University of Agriculture and Technology (JKUAT), the University of Nairobi, Egerton University, Masinde Muliro University of Science and Technology (MMUST), the Kenya Agricultural and Livestock Research Organization (KALRO), and the Kenya Medical Research Institute (KEMRI), which remain essential for knowledge generation, human capital development, and applied innovation.

Kenya's innovation system has also benefited from dynamic collaborations with international and private partners. The International Centre of Insect Physiology and Ecology (ICIPE) hosts BioInnovate Africa, a SIDA-funded regional platform that supports bio-based innovations in agro-biotechnology, waste valorisation, and climate-smart technologies across Eastern Africa. Similarly, the Stockholm Environment Institute (SEI) and its Africa Center strengthens research–enterprise linkages through bioeconomy innovation analysis and its Advancing Bioeconomy Development in Kenya (ABDK) initiative, promoting innovation and business partnerships between Kenyan and Swedish bioeconomy actors. In parallel, a vibrant private incubation ecosystem, led by platforms like iHub, Nairobi Garage, and MEST Africa, provides mentorship, workspace, and investment readiness support for bio-entrepreneurs and startups.

Another sign of Kenya being a regional bioeconomy innovation Hub, was the organisation of the The Fourth Global Bioeconomy Summit (GBS) held from 23-24 October, 2024 in Nairobi, Kenya in East Africa, which marked a historic chapter in the advancement of the global bioeconomy. It was the first time the Global Bioeconomy Summit (GBS) was held outside Germany since the beginning of the biennial GBS series in 2015.With a spotlight on Africa and the global south, GBS 2024 presented unprecedented opportunities to engage global leaders, innovators, and experts in a collaborative effort to explore bioeconomy solutions that drive positive, lasting change in countries and regions around the world.

Within Kenya counties are now emerging as critical nodes in decentralizing innovation. Through devolved planning, county governments are integrating STI into agriculture, waste management, renewable energy, and enterprise incubation. Examples include the Lake Region Economic Bloc's climate-smart agriculture programs and coastal counties' blue bioeconomy initiatives in seaweed farming and sustainable fisheries. Counties like Nairobi, Mombasa, and Kisumu have invested in innovation hubs linking youth and SMEs to finance and mentorship. While disparities in capacity and funding persist, such initiatives bring innovation closer to communities and stimulate locally adapted bioeconomy models that enhance regional equity and resilience.

Overall, Kenya's innovation and research framework has institutionalized STI as a national development priority, fostering collaboration across public agencies, academia, private sector, and international partners. Yet, challenges remain i.e., fragmentation, weak coordination, lack of harmonised standards for biobased products, limited financing for commercialization, and uneven county capacities continue to slow momentum. Strengthening inter-agency

coordination, improving intellectual property and creating supportive regulations and policies for Micro, Small and Medium Enterprises and expanding access to early-stage funding will be vital for scaling innovations. Therefore, by consolidating its innovation infrastructure, diversifying financing mechanisms, and deepening collaboration between science and enterprise, Kenya can transform its research and innovation ecosystem into a powerful launchpad for bio-based industrialization, inclusive green growth, and sustainable development, cementing its leadership in Africa's emerging bioeconomy.

## 4.2 Financing Bioeconomy in Kenya

Kenya's bioeconomy financing landscape is a layered, multi-actor system that blends public resources, donor and multilateral funds, research grants, private investment, and emerging green finance mechanisms. Together, these funding streams underpin the country's transition from a resource-based to an innovation-driven economy, grounded in the sustainable use of biological assets. The national exchequer remains the backbone of bioeconomy financing. Each year, the Treasury allocates funds to key ministries, Agriculture and Livestock Development, Environment, Energy, and Industrialisation and to state corporations such as KALRO, KEMRI, and KIRDI. These allocations sustain laboratories, pilot plants, and applied research programmes across biotechnology, renewable energy, and climate adaptation. County governments are also increasingly directing devolved funds to agricultural innovation, waste management, and renewable energy initiatives, embedding bioeconomy activities within local planning. Despite their fragmentation, these allocations anchor the bioeconomy within Kenya's formal public finance framework.

Complementing domestic resources are bilateral and multilateral development funds, which provide catalytic support to national programmes. The World Bank and African Development Bank (AfDB) finance agricultural transformation and industrial value addition under the Agricultural Sector Transformation and Growth Strategy (ASTGS) and Bottom-Up Economic Transformation Agenda (BETA). Similarly, the European Union (EU), USAID, and IFAD have supported food systems, forestry, and fisheries projects aligned with bioeconomy priorities. These partnerships bring not only funding but also technical expertise and co-financing that strengthen the national innovation and sustainability agenda. On the other hand, the National Research Fund (NRF) provides a crucial bridge between research and innovation by issuing competitive grants for applied research in agriculture, health, energy, and industrial biotechnology. A notable example is the KES 45 million grant to Pwani University, which strengthened the Pwani University Biosciences Research Centre (PUBReC), which is now a regional hub for research in marine biotechnology, crop genetics, and biosafety. Complementary funding from bilateral agencies such as Sida, DAAD, and UKRI further supports scholarships, institutional strengthening, and cross-border collaborations. For instance, the BioInnovate Africa programme, hosted by ICIPE and funded by Sida, exemplifies how regional donor-supported platforms can link science, enterprise, and commercialization across Eastern Africa, demonstrating the multiplier effect of coordinated research investment.

Kenya has also become a major beneficiary of global climate and environmental finance. Facilities such as the Green Climate Fund (GCF), Global Environment Facility (GEF), and Adaptation Fund have supported climate-smart agriculture, renewable energy, and biodiversity conservation. For instance, the GCF-backed Lake Region Economic Bloc climate-smart agriculture programme and the Kasigau REDD+ carbon offset scheme illustrate how global funds can align with local development and conservation goals.

Beyond the public and donor domain, private capital is increasingly driving Kenya's bioeconomy, particularly in renewable energy, agritech, and circular economy ventures. Venture and impact investors have backed companies such as Twiga Foods (agri-supply chains), M-KOPA Solar (off-grid energy), TakaTaka Solutions (waste recycling), and Sistema.bio (biogas systems), the latter leveraging results-based financing from international facilities. Public–private partnerships (PPPs) have also mobilized billions into large-scale projects, including the Lake Turkana Wind Power Project (310 MW, €620 million) and Olkaria IV Geothermal Plant (140 MW), showing how blended financing can deliver sustainable infrastructure.

Collectively, these funding mechanisms form a complementary financing ecosystem: exchequer allocations ensure predictable baseline funding; development partners bring catalytic and concessional resources; research grants sustain knowledge creation; and private capital drives commercialization and scaling. However, despite the recent inflow of venture capital, the limited availability of risk and early-stage capital continues to be a significant barrier to the commercialisation of bioeconomy innovation in Kenya. Thus, significant challenges persist and financing flows

remain fragmented and poorly coordinated. Private investment is concentrated in Nairobi and fast-return sectors, and early-stage bio-innovations, especially in biotechnology and rural enterprises, remain underfunded. Additionally, existing regulatory uncertainties around biosafety, intellectual property, and startup incentives further constrains investor confidence.

## 4.3 Business Upscaling & Commercialization: Value Chains and Market Linkages

Kenya's bioeconomy is entering a new phase of growth, driven by rising opportunities for business upscaling, commercialization, and enterprise partnerships. Innovations across agriculture, bioenergy, and bioproducts are gaining traction, yet many businesses remain stuck at micro or pilot stage. Growth is often held back by structural constraints, limited access to finance, fragmented policies, weak market linkages, and underdeveloped value chains. Most enterprises operate in rural or informal settings where infrastructure for storage, transport, water, and energy is often inadequate. As a result, scaling up production or meeting formal market standards becomes a major challenge. Commercialization pathways also remain narrow; local research outputs often lack support for incubation, intellectual property protection, or market-ready packaging that could attract buyers and investors.

At the same time, clear opportunities are emerging. County-level efforts to promote industrialization, through agro-processing parks and decentralized green energy hubs, are creating a foundation for rural bioeconomy enterprises to scale and formalize. Kenya's growing demand for certified organic, climate-smart, and traceable products is also opening premium markets for businesses that invest in compliance and quality. In addition, circular bioeconomy models, such as converting agricultural waste into energy or packaging, are becoming commercially viable, especially for micro and small enterprises located near production zones. Digital technologies in logistics and e-commerce are also helping rural producers reach broader markets while reducing inefficiencies and post-harvest losses.

Stronger business-to-business (B2B) collaboration is central to unlocking scale in the bioeconomy. Strategic partnerships, particularly across public and private actors, can bridge the gap between research and commercialization, reduce risk, and open new markets. Agritech firms, for example, are partnering with cooperatives to streamline aggregation, improve compliance, and strengthen supply logistics. In sectors like bio-inputs and sustainable forestry, private companies are sharing research costs, leveraging blended finance, and jointly scaling new solutions. Further, County Governments and innovation hubs are building networks that link startups, SMEs, and larger firms through shared infrastructure and procurement systems. Internationally, B2B partnerships, such as buyer-supplier contracts and technology transfer agreements are helping Kenyan producers integrate into global bio-based value chains.

However, many enterprises still struggle to attract investment. Factors such as investor readiness remains a key gap, with limited business development support available to help entrepreneurs formalize, scale, or meet investor expectations. Financing solutions also remain poorly matched to the realities of bio-based businesses, which often operate on long product cycles and decentralized models. Addressing this requires more tailored investment vehicles, alongside capacity building and advisory services to prepare businesses for growth. As Kenya strengthens linkages across businesses and aligns capital flows with sustainability goals, the potential of the bioeconomy will become clearer. With a supportive environment grounded in B2B collaboration and innovation, the sector can become a major driver of inclusive industrialization, expanded trade, and green job creation.

## B2B Collaboration in Action: Advancing Bioeconomy Development in Kenya (ABDK)

The Advancing Bioeconomy Development in Kenya (ABDK) project represents a forward-looking model for fostering bioeconomy growth through international business-to-business (B2B) collaboration. Led by the Stockholm Environment Institute (SEI), the project is designed to build structured linkages between Kenyan and Swedish bioeconomy actors thereby mobilizing private sector expertise to accelerate inclusive, sustainable industrialization in Kenya. Sweden's bioeconomy already contributes more than 8% of total national value added, 12% of total turnover, and over 20% of the country's exports, underscoring the potential of bio-based industries to drive national prosperity. ABDK seeks to leverage this experience to support Kenya's growing bioeconomy sector through structured cooperation, technology transfer, and shared market development.

At its core, ABDK is structured around three interventions: developing bioeconomy pathways for different sectors through Kenya–Sweden partnerships; generating evidence of viable business opportunities targeting Kenya's micro, small, and medium-sized enterprises (MSMEs); and promoting national and international policy engagement to align regulations and create enabling conditions for growth. This approach aligns with Kenya's Vision 2030 and the Bottom-Up Economic Transformation Agenda (BETA), particularly its focus on job creation, zero hunger, and inclusive growth. In addition, ABDK's emphasis on agriculture and MSMEs directly supports the creation of 1.2 million new jobs annually, especially in rural areas, and complements broader national strategies on climate change, biodiversity, and pollution management. Importantly, the project recognizes the transformative role of MSMEs and community-based enterprises in building a bio-based economy. Across Kenya, these actors are increasingly engaged in value-added processing of agricultural, forestry, marine, and biowaste resources. However, many remain constrained by limited access to technology, finance, and markets. Through B2B exchanges with Swedish companies and institutions, ABDK offers a platform for knowledge transfer, innovation sharing, and enhanced market access, ensuring that Kenya's bioeconomy players can plug into regional and global value chains.

The project also supports policy coherence by working alongside existing national frameworks such as the Green Economy Strategy and Implementation Plan (GESIP), the National Climate Change Action Plan (NCCAP 2023–2027), the STI Policy (2020–2030), and the Sustainable Waste Management Policy. These frameworks are increasingly recognizing bioeconomy as a cross-cutting enabler of sustainability and economic transformation. ABDK strengthens this positioning by demonstrating how B2B-driven collaborations can translate policy goals into tangible economic outcomes, such as increased productivity, reduced emissions, and localized manufacturing. As implementation progresses through 2025, ABDK serves as a template for structured international collaboration, showing how targeted B2B partnerships can unlock innovation, scale local enterprises, and enhance Kenya's competitiveness in emerging green markets.

## 4.4 Building a Future-Ready Bioeconomy Workforce

Kenya's bioeconomy will only thrive if its people have the skills and capacity to translate ideas into market-ready innovations. While policies, infrastructure, and finance are essential, it is the depth, diversity, and adaptability of human capital that ultimately determine success. The country already produces a growing number of graduates in agriculture and biosciences, yet few are trained in frontier domains such as industrial biotechnology, bioenergy engineering, or bioprocess scale-up. Weak industry linkages, insufficient hands-on training, and limited access to research and pilot-scale technical facilities leave many graduates academically qualified but without the technical and practical skills required for successful commercialization.

To close these gaps, Kenya must reimagine its education and training ecosystem. Universities, TVET institutions, and research centres such as the Kenya Agricultural and Livestock Research Organization (KALRO), the Kenya Medical Research Institute (KEMRI), should act as interconnected innovation anchors, linking theory with practice through co-supervised internships, shared pilot plants, and applied research partnerships with industry. Embedding entrepreneurship, regulatory literacy, and intellectual property management within curricula would also help students translate research into viable enterprises. A strong focus on technical and vocational education is equally critical, as TVETs are well placed to produce mid-level technicians skilled in agro-processing, bioenergy systems, and quality assurance, roles that directly support rural industrialization and green job creation.

At the same time, a national workforce strategy for the bioeconomy should prioritise inclusivity and regional equity. Establishing county-level training hubs and shared facilities for specific sectors such as fermentation, extraction, and quality testing would extend access to rural innovators, youth, and SMEs. Structured apprenticeships and short professional courses can build continuous learning pathways, ensuring that both new graduates and mid-career professionals stay abreast of fast-evolving technologies. By fostering a "T-shaped" talent base, deep specialists who also understand adjacent disciplines, markets, and regulation, Kenya can cultivate a workforce capable of driving innovation from the lab to the marketplace. Such an approach would not only strengthen productivity and competitiveness but also position Kenya as a continental leader in bio-based industrialization.

> Kenya's bioeconomy will only thrive if its **people have the skills and capacity** to translate ideas into market-ready innovations.

## Bio-KE as a Blueprint for Kenya's Bioeconomy Education and Policy Transformation

The Bio-KE Project (Boosting Education, Research and Innovation in the Bioeconomy in Kenya) is a newly funded initiative supported by the European Commission, which has awarded approximately €900,000 through its research and innovation funding mechanisms linked to the Horizon 2020/ Horizon Europe family of programmes. The project is coordinated by Pwani University and brings together a consortium that includes the National Commission for Science, Technology and Innovation (NACOSTI), the Commission for University Education (CUE), Egerton University's Centre of Excellence in Livestock Innovation and Business (CoELIB), Chuka University, and international partners such as the Technical University of Denmark (DTU) and the University of Hohenheim. Bio-KE's overarching aim is to support the development of a coordinated National Bioeconomy Education and Policy Framework by strengthening institutional capacity, modernising curricula, promoting research–industry collaboration, and expanding public engagement on the bioeconomy.

At its core, Bio-KE will focus on aligning Kenya's education and training systems with the needs of emerging bio-based sectors. Participating universities and TVET institutions will integrate competency-based learning, expand practical and laboratory training, and embed bioeconomy concepts across academic programmes. This work will be reinforced by the creation of Bioeconomy Living Labs, envisioned as shared learning and experimentation spaces where students, researchers, county actors, and enterprises can test technologies, explore bioprocessing options, and co-develop solutions linked to local value chains. These activities will help strengthen education–industry linkages and establish clearer pathways for developing a workforce that can support rural industrialisation, circular production, and bio-based enterprise growth.

Alongside skills development, Bio-KE will play an important role in improving policy coordination and governance. Through targeted support to institutions such as NACOSTI and CUE, the project will help clarify mandates, enhance regulatory capacity, and promote the integration of bioeconomy priorities into national and county planning processes. Collaboration with European partners will facilitate technical exchange, curriculum benchmarking, and knowledge-sharing on policy design, while ensuring that all adaptations remain grounded in Kenyan contexts and priorities.

A further dimension of the project will involve public engagement and awareness-building. The planned Virtual Bioeconomy Museum will use interactive tools to communicate bioeconomy concepts to schools, communities, and the general public, helping broaden understanding of how bio-based solutions relate to everyday life. This complements the project's education and governance work by fostering wider societal participation and interest. In the long term, Bio-KE will be significant for Kenya's bioeconomy because it lays the essential institutional and human-capital foundations required for a coherent national transition.

Bio-KE
Catalysing the Bioeconomy

## 4.5. Integrating Indigenous and Local Knowledge into the Bioeconomy

Kenya's bioeconomy cannot reach its full potential without recognizing and integrating indigenous and local knowledge systems that have long sustained its biodiversity and ecosystems. Across the country, traditional practices, from pastoralists' rotational grazing in the ASALs and seed-saving networks in Western Kenya, to women-led seaweed farming cooperatives along the Coast already embody adaptive, bio-based innovations. These community practices enhance ecosystem resilience, promote sustainable livelihoods, and contribute to food, feed, and industrial value chains. Yet, they remain largely undervalued and poorly represented in formal bioeconomy frameworks.

Creating an enabling environment means placing traditional knowledge on equal footing with scientific research and enterprise development. This requires three deliberate steps. First, recognition and integration, ensuring that indigenous knowledge is incorporated into national and county bioeconomy strategies, curricula, and value chain roadmaps. Second, protection and benefit-sharing, by operationalising Kenya's Access and Benefit Sharing (ABS) regulations and aligning intellectual property laws with the Nagoya Protocol to prevent biopiracy and guarantee fair returns to knowledge custodians. Third, resourcing and scaling, particularly through tailored financing and incubation for community-based enterprises producing herbal products, indigenous foods, natural fibres, and marine bioproducts. Ultimately, bridging traditional wisdom and modern science offers Kenya a distinct comparative advantage. It grounds the bioeconomy in local legitimacy while opening new frontiers in nutraceuticals, green chemistry, and sustainable agriculture. When indigenous innovators, youth, and researchers co-create solutions, Kenya's bioeconomy becomes not just a scientific or industrial project, but a truly inclusive national transformation—rooted in its people, culture, and environment.

*Table 1: Creating an Enabling Environment for Bioeconomy Advancement in Kenya*

| Pillar | Key Actors / Institutions | Core Functions | Contribution to the Bioeconomy | Key Gaps / Challenges |
|---|---|---|---|---|
| Legislative & Policy Anchors | Constitution of Kenya (2010); STI Act (2013); Vision 2030; Bottom-Up Economic Transformation Agenda (BETA); National Climate Change Action Plan (NCCAP); Green Economy Strategy & Implementation Plan (GESIP); AU Agenda 2063 | Establish legal, policy, and institutional foundations for innovation, sustainability, and economic transformation | Anchor bioeconomy principles in national development, climate action, and green growth agendas; align Kenya with regional and global frameworks | Policy coherence still evolving; bioeconomy treated implicitly rather than through a dedicated framework; fragmented implementation |
| Policy Coordination & Oversight | National Commission for Science, Technology and Innovation (NACOSTI); Ministry of Education (State Department for STI); Ministry of Environment, Climate Change & Forestry | Coordinate STI activities, regulate research ethics and licensing, integrate science into national and county planning | Ensure bioeconomy research and innovation are ethical, relevant, and aligned with development priorities | Overlapping mandates; limited enforcement capacity; weak coordination across ministries and counties |

| | | | | |
|---|---|---|---|---|
| Industry, Trade & Standards (Value Addition) | Ministry of Investments, Trade and Industry (MITI) – State Department for Industry; Kenya Bureau of Standards (KEBS); Kenya Industrial Property Institute (KIPI); Export Processing Zones Authority (EPZA); Special Economic Zones Authority (SEZA); Micro and Small Enterprises Authority (MSEA) | Promote industrialisation, standards, IP protection, MSME growth, and export competitiveness | Translate bioeconomy potential into manufacturing, agro-processing, bioproducts, and trade; support scaling and market access | Limited incentives for bio-based manufacturing; weak integration with STI actors; uneven MSME support |
| Research & Innovation Financing | National Research Fund (NRF); Sida; DAAD; UKRI; World Bank; AfDB; BioInnovate Africa | Provide grants for applied research, innovation infrastructure, and collaborative R&D | Enable biotechnology, renewable energy, health innovation, and industrial research; foster regional collaboration | Insufficient public funding; heavy donor dependence; weak alignment between research and market needs |
| Commercialisation & Enterprise Linkages | Kenya National Innovation Agency (KeNIA); BioInnovate Africa; Stockholm Environment Institute (SEI); innovation hubs (iHub, Nairobi Garage, MEST Africa); ABDK project | Support technology transfer, incubation, accelerators, and entrepreneurship | Bridge research and enterprise; nurture startups, MSMEs, and youth-led bio-innovations | Early-stage financing gaps; weak IP management; limited outreach beyond urban centres |
| Knowledge & Research Nodes | Universities (UoN, JKUAT, Egerton, MMUST, Kenyatta, Pwani); Research Institutes (KALRO, KEMRI, KIRDI, KMFRI) | Generate knowledge, train human capital, provide laboratories and pilot facilities | Anchor skills development, applied research, and sectoral innovation | Weak industry linkages; underfunded laboratories; limited regional specialisation |
| Innovation Infrastructure & Platforms | Konza Technopolis; KAIST–Kenya; county innovation centres; TVET institutions | Provide incubation, prototyping, pilot plants, and digital platforms | Enable digital–bio convergence; decentralise innovation ecosystems | Concentrated in urban areas; limited sustainability of funding models |
| Private Sector & Development Partners | BioInnovate Africa; SEI; World Bank; AfDB; EU; USAID; IFAD; private accelerators | Fund and facilitate innovation ecosystems, technology transfer, and market development | Bring global expertise, capital, and scalable models | Donor-driven sustainability risks; limited long-term private sector anchoring |
| County-Level Integration & Devolution | County Governments; Lake Region Economic Bloc; coastal counties (Kwale, Kilifi, Lamu) | Integrate bioeconomy priorities into devolved planning and service delivery | Promote place-based innovation, inclusivity, and indigenous knowledge | Capacity constraints; uneven uptake; weak vertical coordination |
| Public Finance & Budgetary Support | National Treasury; sector ministries; state corporations (KALRO, KEMRI, KIRDI); county budgets | Allocate public funds for programmes, infrastructure, and R&D | Anchor bioeconomy activities in public expenditure frameworks | Limited fiscal space; fragmented budget lines; short funding cycles |

| | | | | |
|---|---|---|---|---|
| Private Finance & PPPs | Venture capital and impact investors; angel networks; Acorn Green Bond; carbon markets; PPPs (Olkaria, Lake Turkana Wind Power) | Provide equity, debt, blended finance, and infrastructure investment | Scale renewable energy, agritech, and circular economy solutions | Early-stage bio-ventures underfunded; regulatory uncertainty for biotech and IP |
| Business Upscaling & Market Linkages | MSMEs; cooperatives; county industrial parks; ABDK B2B platforms | Aggregate production, support partnerships, and link enterprises to markets | Formalise enterprises, create jobs, integrate rural producers into value chains | Poor infrastructure; limited investor readiness; weak business advisory services |
| Skills, Capacity & Workforce Development | Universities; TVETs; KIRDI; KALRO; industry associations; youth innovation hubs | Train workforce in bioprocessing, quality systems, entrepreneurship, and regulation | Build skilled labour force for a competitive bioeconomy | Skills mismatch; limited hands-on training; Nairobi-centric infrastructure |
| Indigenous & Local Knowledge Systems | Community seed banks; pastoral associations; women's cooperatives; ABS focal points | Preserve and integrate traditional ecological knowledge | Enhance inclusivity, biodiversity management, and cultural legitimacy | Weak protection of traditional knowledge; limited benefit-sharing mechanisms |
| International Partnerships & Technology Transfer | UNIDO; FAO; UNEP; SEI; BioInnovate Africa; ABDK | Facilitate technology exchange, policy alignment, and global cooperation | Accelerate innovation diffusion and market access | Post-project sustainability; limited domestic absorptive capacity |

# CONCLUSIONS, STRATEGIC PRIORITIES, AND OUTLOOK

This concluding chapter synthesizes the key findings of the report, outlining Kenya's current position, strategic direction, and priority actions for advancing a sustainable bioeconomy. It integrates insights from preceding chapters, spanning policy, innovation, value chains, finance, and human capacity, to present a coherent pathway for translating biological resources into economic, social, and environmental gains. The chapter is structured into three parts: a conclusion summarizing the state of Kenya's bioeconomy, strategic recommendations to guide decision-makers, and a forward-looking outlook that envisions Kenya's bioeconomy trajectory to 2030 and beyond.

## 5.1 Conclusion

Kenya's bioeconomy stands at a defining moment. The country possesses the biological wealth, institutional framework, and innovation culture needed to lead Africa's transition toward sustainable, inclusive growth. However, realizing this potential depends on deliberate investments, effective governance, and equitable participation. Without a coordinated and well-financed strategy, Kenya risks fragmented progress that falls short of its ambitions.

This report underscores that the building blocks are already in place including, progressive policies, capable research institutions, entrepreneurial talent, and growing regional collaboration. Yet, these strengths must now be consolidated into a unified national approach. By harmonizing policies, empowering counties, integrating indigenous knowledge, and mobilizing blended finance, Kenya can transform its bioresources into engines of industrial growth, environmental regeneration, and job creation. The choices made today will determine whether the bioeconomy remains a policy aspiration or evolves into a defining pillar of national development.

## 5.2 Future Outlook

The years leading to 2030 will be critical for laying the foundations of a coherent and inclusive system, while the decades beyond will determine whether the country emerges as a continental leader in sustainable innovation. In the short term, the priority is to build a strong enabling environment through policy coherence, regulatory clarity, and institutional coordination. Therefore, financing mechanisms must be strengthened to support small enterprises and community-based innovators, while universities and TVET institutions must be retooled to produce a skilled workforce that is fit for purpose. Investments in pilot projects, rural processing hubs, and circular economy practices in agriculture and waste management can demonstrate quick wins, building momentum and trust among stakeholders. By 2030, Kenya should aim to have a functioning bioeconomy ecosystem with clear governance, vibrant innovation hubs, and visible success stories that show the viability of bio-based solutions.

Looking further ahead, the horizon beyond 2040 offers the opportunity to consolidate these early gains into a globally competitive bioeconomy. Kenya will need to scale up industrial biorefineries, establish advanced biotechnology industries, and integrate into international value chains. A fully circular economy, where biowaste is valorised, biodiversity conserved, and use of biological resources optimized, should become the norm. Long-term success will also require embedding indigenous knowledge into science, policy, and innovation systems, ensuring equitable participation and benefit-sharing across society. At this stage, Kenya can position itself as a regional hub for bioeconomy research, innovation, and trade, actively shaping continental and global dialogues on sustainability and green growth.

This trajectory underlines the urgency of decisive action today. The milestones to 2030 should be seen not as final achievements, but as stepping stones toward a resilient and competitive bioeconomy that will shape Kenya's economic and environmental landscape well beyond 2040. Therefore, with consistency, ambition, and inclusive participation, Kenya can move from laying foundations to shaping outcomes, emerging not merely as a participant but as a continental leader and global contributor in the transition to sustainable, bio-based economies.

## 5.3 Recommendations

Kenya's bioeconomy has the potential to transform livelihoods, drive industrial growth, and embed sustainability into national development. However, the challenges outlined in this report, ranging from fragmented policies and limited financing to weak industry linkages, skills gaps, and underutilization of indigenous knowledge, underscore the urgency of coordinated action. Addressing these gaps requires targeted, actionable steps that can unlock the sector's full potential and ensure inclusive, sustainable growth. The following recommendations provide a roadmap for decision-makers:

- Establish a national bioeconomy strategy and coordination mechanism to harmonize sectoral policies, eliminate overlaps, and provide a clear governance framework. This strategy should be housed within a strong coordinating body to ensure alignment across ministries and agencies, with clear monitoring and evaluation mechanisms.
- Develop enabling legislation and regulatory clarity for emerging areas such as biotechnology, bioenergy, and bio-based products, ensuring safety while reducing bureaucratic bottlenecks that stifle innovation and commercialization.
- Increase investment in research, development and innovation(RDI) allocating dedicated public funds, incentivizing private sector R&D, and fostering partnerships with international research institutions to accelerate the translation of knowledge into market-ready innovations.
- Create blended financing mechanisms and green investment platforms to mobilize resources from public budgets, development partners, and venture capital from private investors. Special attention should be given to de-risking investments in early-stage enterprises and supporting SMEs that form the backbone of bio-based value chains.
- Expand infrastructure for bio-based industries including laboratories, testing facilities, biorefineries, and rural agro and bioprocessing plants, with an emphasis on decentralized infrastructure that can serve county-level innovation, production and value addition hubs.
- Strengthen skills development and vocational training by reforming curricula in universities and TVET institutions to align with industry needs, expanding apprenticeship programs, and ensuring training incorporates digital skills and bio-entrepreneurship.
- Integrate indigenous and local knowledge systems into formal innovation ecosystems, recognizing communities as custodians of biological resources. Mechanisms for equitable benefit-sharing, intellectual property protection, and gender-responsive policies must be prioritized.
- Promote regional and cross-border collaboration by aligning with the Eastern Africa Bioeconomy Strategy, strengthening trade in bio-based products, and fostering regional centres of excellence that can serve as innovation hubs for East Africa.
- Mainstream circular economy practices across agriculture, energy, waste management, and industry by incentivizing recycling, bio-based packaging, and waste-to-energy solutions that create value while reducing environmental footprints.
- Raise public awareness and engagement through outreach campaigns, citizen science initiatives, and community-based platforms that build trust, demystify new technologies, and encourage uptake of bio-based solutions.
- Position Kenya as a continental leader in the bioeconomy by actively seeking strategic partnerships, south–south cooperation, and participation in global bioeconomy dialogues, thereby expanding market access and securing long-term financing.

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