



Bio-based Industrial Development in Kenya

A Roadmap Developed by a Cluster of Kenyan Bio-based Industrial Enterprises

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EXECUTIVE SUMMARY

The Roadmap Developed by a Cluster of Kenyan Bio-based Industrial Enterprises focuses on scaling bio-based industrial products in Kenya, specifically biodegradable packaging, bio-based construction materials, eco-sanitary products, waste-to-energy solutions, bioprocessing enzymes, and renewable bio-based oils. It is part of the Advancing Bioeconomy Development in Kenya (ABDK) project, led by the Stockholm Environment Institute (SEI) with support from the Swedish International Development Cooperation Agency (Sida), which aims to accelerate Kenya's bioeconomy through actor mapping, cluster roadmaps, and Kenya–Sweden business partnerships.

The roadmap positions bio-based industrial development as a key pillar of a circular, low-carbon economy that can replace imported fossil-based materials, reduce plastic pollution, improve sanitation, cut emissions, and create green jobs while valorizing agricultural residues, natural fibres, and organic waste. The Kenyan bio-based industrial enterprises already demonstrate viable solutions biodegradable packaging from banana fibre and water hyacinth, eco-sanitary products, waste-to-fuel technologies, bio-based building materials but face high production costs, slow certification processes, technology gaps, and limited access to finance that constrain scaling.

The roadmap outlines detailed scaling pathways for MSMEs across four domains: markets, certification systems, technology upgrading, and compliance. Markets need to overcome high costs, competition, and bureaucracy to reach domestic, regional, and global buyers. Technology upgrading requires major investment in machinery, R&D, and skills so firms move from artisanal to semi-industrial and export-ready production. Certification systems must be simplified and clarified so delays and unclear standards no longer block entry into premium markets. Compliance challenges around taxes, bureaucracy, corruption, and rigid procurement must be reduced through policy reform and digital processes to unlock growth and green jobs.

1. An Overview of the ABDK Project

1.1 The ABDK Project

The Advancing Bioeconomy Development in Kenya (ABDK) project, implemented by the Stockholm Environment Institute (SEI) with support from the Swedish International Development Cooperation Agency (Sida), aims to accelerate the industrialization, modernization and scaling of Kenya's bioeconomy while generating lessons for the broader East Africa region. The project focuses on three core interventions: mapping bioeconomy private-sector actors and agripreneurs in Kenya and Sweden, developing bioeconomy roadmaps for different Kenyan bioeconomy actor clusters, and promoting collaboration and technology exchange between Swedish and Kenyan bioeconomy practitioners.

A central component of ABDK is the co-creation of roadmaps with selected bioeconomy clusters and the use of these cluster platforms to catalyze business-to-business partnerships between Kenyan MSME bioeconomy enterprises and Swedish bioeconomy companies. Through these partnerships, the project seeks to unlock investment, technology transfer and market access for high-potential bio-based solutions across the East African region.

Within this framework, the ABDK initiative supports four distinct clusters. Cluster 3 focuses on enterprises producing bio-based industrial products, including biodegradable packaging from agricultural residues, bio-based construction materials, eco-sanitary products, waste-to-energy solutions, bioprocessing enzymes, and renewable bio-based oils. The roadmap for this cluster outlines priority actions to scale sustainable industrial production value chains that reduce plastic pollution, improve sanitation, strengthen climate resilience, support circular economy principles, and contribute to Kenya's green industrialization and job creation objectives.

1.2 Bio-based Industrial Products in Kenya's Emerging Bioeconomy

Bio-based industrial development represents a transformative pillar for Kenya's circular economy and green industrialization, using locally available renewable resources agricultural residues, natural fibres (banana, sisal, water hyacinth, bamboo), organic waste, and indigenous oil crops to replace costly imported fossil-based plastics, synthetic materials, and chemicals. The global shift away from fossil-based production creates space for industrial biotechnology, often referred to as the third biotechnology revolution, with developing biorefineries that convert residues into multiple high-value products central to this transformation.

Kenya's bio-based industrial opportunities span multiple domains: biodegradable packaging (driven by plastic bans, e-commerce growth, and Africa's 8% annual packaging market expansion); bioprocessing enzymes (replacing imported chemicals in leather, food, textile, and brewing sectors while reducing pollution); bio-based construction materials (bamboo composites, sawdust products, engineered bio-materials for rapid urbanization and housing demand); renewable bio-based oils and green chemicals (from indigenous crops like croton, avocado, sunflower for industrial, cosmetic, and health applications); and waste-to-energy solutions (converting organic waste and fecal sludge into biofuels and value-added products).

Existing agro-industries such as sugar mills and breweries can be upgraded into modern bioprocessing hubs, while smaller, community-based biorefineries can stimulate rural industrialization and green job creation. Kenya's diverse biological resources, entrepreneurial base, and policy momentum position it to become a regional leader in bio-based industrial development. However, targeted investments in bioprocessing technologies, modern machinery, green infrastructure, certification systems, and skills development are essential to unlock value from renewable resources and drive the country's transition toward a sustainable bioeconomy by 2030 and beyond.

2.

The Kenyan Bio-based Industrial Enterprises Cluster Roadmap

2.1 Cluster Vision

A globally competitive, innovative and sustainable bio-industrial sector that transforms Kenya's abundant biomass into high-value bio-based materials, driving green industrialization, circularity, and job creation while eliminating fossil-based pollution and waste.

Cluster 3 members and enterprises are listed in the annex.

2.2 Scaling Opportunities for Cluster Enterprises (MSMEs)

The Kenyan bio-based Micro, Small and Medium enterprise cluster include innovators producing bioplastics, alternative packaging, natural fibers, bio-based construction materials, and industrial bio-chemicals. To unlock their full potential, coordinated actions are needed across four key domains:

Markets

» **Markets are constrained by high costs, competition, and bureaucratic barriers, limiting MSMEs' ability to reach and grow domestic, regional, and international demand Scaling requires:**

- Lower transaction and distribution costs.
- Simplified market entry and export procedures.
- Strategic procurement partnerships (public and private).
- Collective/cluster branding and cooperative marketing.
- Stronger links to regional and global value chains.

Technology

» **Technology requires sustained investment in modern machinery, R&D, and skills so enterprises can move from manual or artisanal production to semi industrial and export ready operations. Scaling requires:**

Access to modern, efficient production machinery and tools.

- Dedicated R&D support for product process innovation.
- Technical training for operators, engineers, and production managers.
- Shared processing hubs or industrial parks to reduce individual capex.
- Maintenance, after-sales support, and technology-transfer partnerships.

Certification

» **Certification delays and unclear or missing standards restrict entry into premium and export markets, making faster, clearer, and more affordable approval systems a critical scaling opportunity. Scaling requires**

- Clear, specific standards for bio-based products and materials.
- Faster, predictable certification timelines and procedures.
- Affordable, accessible testing and inspection services.
- Guidance and support for MSMEs on documentation and compliance.
- Mutual recognition of standards within EAC/export markets.

Compliance

» **Compliance issues related to taxes, bureaucracy, corruption, and rigid procurement processes prevent efficient scaling, highlighting the need for more predictable, transparent, and digitally enabled regulatory frameworks. Scaling requires:**

- Simplified, transparent licensing and tax procedures (ideally digital).
- Reduced and rationalized fees, levies, and permits.
- Strong anti-corruption measures and grievance mechanisms.
- Procurement reforms that allow fair access for MSMEs and innovators.
- Consistent enforcement so compliant firms are rewarded, not penalized.

2.3. SWOT Analysis

Strengths

- *Unique Products and Innovation Capacity:* Cluster enterprises demonstrate high innovation potential with locally adapted, unique products banana fibre packaging, water hyacinth composites, waste-to-biofuel systems, bamboo construction materials designed to solve local challenges while meeting global sustainability standards.
- *Abundant and Accessible Raw Materials:* Rich agricultural residues (banana stems, rice husks, sugarcane bagasse), natural fibres (sisal, water hyacinth, bamboo hectares), organic waste streams, and indigenous oil crops provide low-cost, locally relevant feedstocks for bioprocessing and value addition.
- *Alignment with Global Sustainability Trends:* Products align with global movements away from single-use plastics, fossil-based materials, and unsustainable sanitation systems, positioning Kenyan enterprises to capture growing domestic, regional, and international markets for sustainable alternatives.
- *Strong Social Impact and Green Job Creation:* Bio-based industries offer dignified employment for youth, women, and marginalized communities, particularly in rural areas, while addressing pressing social needs menstrual dignity, improved sanitation, affordable housing materials, waste management.
- *Existing Customer Base and Market Demand:* Cluster members have demonstrated market traction with schools, institutions, conscious consumers, and corporate buyers seeking sustainable alternatives, validating demand and willingness to pay for quality bio-based products.
- *Networks of Skilled Artisans and Entrepreneurs:* Strong informal networks of weavers, natural product processors, and waste valorization innovators provide foundations for rapid scaling once financing and technology barriers are addressed.
- *Protected Intellectual Property and Trade Secrets:* Several cluster members hold patents, proprietary processes, or protected technologies that provide competitive advantages and attract potential investors and partners.
- *Investment Readiness and Entrepreneurial Energy:* Many enterprises have successfully accessed seed funding from competitions, universities, and early investors, demonstrating capacity to pitch, secure resources, and execute on business plans.

Weaknesses

- *Limited Research and Development Facilitation:* Insufficient public and private investment in R&D, product development, efficacy testing, and innovation means that many promising technologies remain at pilot stage without pathways to commercialization and upscaling.
- *High Machinery Costs and Technology Gaps:* Modern bioprocessing equipment—industrial dryers, automated extraction systems, moulding presses, biogas digesters—remains prohibitively expensive, forcing MSMEs to rely on manual or semi-automated processes that limit efficiency, quality, and scale.
- *Scaling and Industrialization Challenges:* Enterprises struggle to scale beyond break-even or small-batch production due to capital constraints, infrastructure gaps, and inability to achieve economies of scale individually.
- *Long and Unclear Certification Processes:* Current certification pathways take 12+ months, lack clear standards for novel bio-based products, involve high costs, and create uncertainty that blocks market entry, especially for export and institutional procurement.
- *Technology Dependency and Lack of Local Adaptation:* Heavy reliance on imported technologies, foreign expertise, and international R&D partnerships creates sustainability challenges, increases costs, and limits local capacity development.
- *Talent Acquisition and Skills Gaps:* Severe shortages of trained bioprocess technicians, chemical engineers, quality assurance specialists, and skilled operators; professionals are expensive while young workers lack adequate training, creating workforce bottlenecks.
- *Limited Access to Capital and Public Funding:* Banks view bio-based MSMEs as high-risk; venture capital is scarce; public funding is inadequate or inaccessible; lack of working capital constrains production, inventory, and market expansion.
- *Weak Public Procurement Support for Private Innovators:* Government procurement processes favor established suppliers, involve political interference and corruption, and lack frameworks to support private sector bio-based innovators, limiting access to large, stable institutional demand.
- *High Licensing, Permit, and Compliance Costs:* Multiple licenses, permits, and regulatory fees from national and county governments, combined with bureaucratic delays, impose significant cash burden on cash-constrained MSMEs.
- *Marketing Challenges and Limited Brand Recognition:* High marketing costs, weak brand visibility, consumer unfamiliarity with bio-based products, and competition from established conventional products constrain demand generation and market penetration.
- *Lack of Technical Capacity for Business Operations:* Many enterprises lack capacity in financial management, supply chain optimization, quality control systems, export procedures, and regulatory compliance, limiting professionalization and growth.
- *Inconsistent Product Quality and Standardization:* Absence of industry-wide quality standards, process controls, and quality assurance systems leads to variable product performance, undermining customer trust and repeat purchases.

Opportunities

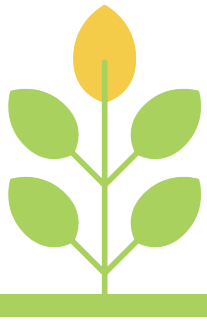
- *Urgent Sanitation Needs Across Kenya and Africa:* Massive unmet demand for improved sanitation solutions, eco-toilets, fecal sludge treatment, and waste-to-energy systems in urban slums, rural areas, schools, and public facilities creates immediate market opportunities.
- *New Sanitation Policies and Frameworks:* Kenya's emerging sanitation policy, county sanitation strategies, and regional commitments to SDG 6 (clean water and sanitation) create enabling policy environments and potential public financing.
- *Ready Markets for Bio-based Industrial Products:* Rapid urbanization, e-commerce growth (driving packaging demand), plastic bans, green building codes, and corporate sustainability commitments create expanding domestic and export markets.
- *Room for Geographic Expansion and Scaling:* Proven business models can be replicated across Kenya and expanded regionally to Uganda, Tanzania, Rwanda, and beyond, multiplying impact and revenues.
- *Access to International Clients and Export Markets:* Growing global demand for certified sustainable products, particularly in EU, Middle East, and North American markets, offers premium pricing and large-volume opportunities for export-ready enterprises.
- *Carbon Credits and Climate Finance:* Waste-to-energy projects, plastic substitution, and circular economy innovations qualify for carbon finance, green bonds, and climate funds, unlocking non-traditional capital sources.
- *Immense Funding Opportunities:* Proliferation of impact investment funds, green financing mechanisms, development partner programs, and innovation challenges targeting sustainable enterprises creates unprecedented capital availability for bankable projects.
- *Policy Support and Enabling Legislation:* Start-Up Bill, green industrialization policies, Buy Kenya Build Kenya campaigns, and plastic ban enforcement create favorable policy momentum for bio-based enterprises.
- *Innovation Partnerships Opening Up:* Growing interest from international companies, research institutions, and technology providers in co-development, licensing, and joint ventures with Kenyan bio-based innovators.
- *Modern Bioprocessing Technologies Becoming Increasingly Accessible:* Declining costs and increasing availability of enzymatic processing, mechanical sorting, controlled fermentation, and digital production management systems lower barriers to industrial-scale production.
- *Easy Raw Material Access and Processing:* Abundant agricultural residues, organic waste, and natural fibres remain underutilized, offering low-cost, secure feedstock supply for scaling without competing with food production.
- *Youth and Women Entrepreneurship Momentum:* Growing numbers of young, educated, and motivated entrepreneurs entering bio-based sectors bring energy, innovation, digital literacy, and commitment to social and environmental impact.

Threats

- *Consumer Price Sensitivity and Affordability Barriers:* Bio-based products often cost more than conventional alternatives; low-income consumers (students, smallholders, budget-conscious households) struggle to afford premium prices, limiting market penetration.
- *Policy Shifts and Government Unpredictability:* Changes in government priorities, political leadership transitions, or fiscal pressures can reverse supportive policies, eliminate incentives, or redirect budgets away from bioeconomy support.
- *Competition from Cheap Imported Goods and Petrochemical Plastics:* Heavily subsidized fossil-based plastics, imported synthetic materials, and established multinational brands compete aggressively on price, convenience, and distribution reach, making market entry difficult.
- *Government Interference and Bureaucratic Bottlenecks:* Excessive bureaucracy, slow approvals, arbitrary enforcement, multiple and contradictory regulations across counties, and political interference in procurement undermine business predictability and growth.
- *Corruption and Rent-Seeking:* Systemic corruption bribes for licenses, favoritism in tenders, extortion by officials increases costs, blocks fair market access, and discourages honest entrepreneurs from entering or scaling.
- *Consumer Behavior Inertia and Resistance to Change:* People are accustomed to conventional products (plastic bags, synthetic sanitary pads, cement blocks); shifting mindsets, building trust, and changing purchasing habits requires sustained education and demonstration.
- *Land Conflicts and Insecure Tenure:* Unclear land ownership records, ancestral land disputes, fraudulent land sales, and squatters create risks for enterprises requiring land for production facilities, feedstock cultivation, or infrastructure projects.
- *Funding Uncertainty and Capital Flight:* Economic instability, currency volatility, or investor risk aversion can reduce access to capital, increase financing costs, or trigger withdrawal of committed funds.
- *Ease of Market Entry Attracting Opportunistic Competitors:* Low initial barriers in some segments (small-scale fibre products, basic packaging) attract fly-by-night operators who produce low-quality goods, undercut prices, and damage sector reputation.
- *Availability and Cost of Specific Raw Materials:* While overall feedstock is abundant, specific high-quality inputs (certain fibre varieties, specialized enzymes, clean organic waste) may become scarce or expensive as demand grows, threatening supply chain stability.
- *Competition from Government-Owned Enterprises:* State-owned companies in related sectors may receive preferential treatment, subsidies, or market protection, creating uneven playing field for private bio-based innovators.
- *Marketing Costs and Challenges:* High costs of advertising, brand building, distribution, and customer education in fragmented markets with low consumer awareness create cash drain that many MSMEs cannot sustain.
- *Experience vs. Qualification Gaps:* Tension between experienced artisans/innovators (who lack formal credentials) and formally educated professionals (who lack practical experience) can create hiring challenges, wage disputes, and operational inefficiencies.

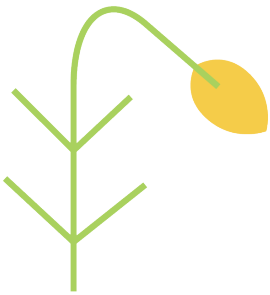
2.4 Key Opportunities for Expansion

- **Funding:** Mobilize diverse financing (blended funds, credit guarantees, green bonds, development banks, venture capital, impact investment, carbon finance) tailored to bio-based industrial MSMEs' equipment and working capital needs. Overcome high capital costs for machinery and infrastructure that constrain growth.
- **Markets:** Expand domestic, regional, and international access through plastic bans, government procurement, cooperative marketing, cluster branding, export channels to EAC and premium markets, integration into government social programs, and participation in trade fairs. Unlock revenue growth and economies of scale.
- **Empowerment through Capacity Building :** Strengthen workforce capabilities through training, apprenticeships, university partnerships, market-aligned curricula, professional development for technicians and managers, youth/women entrepreneurship support, and peer learning. Professionalize the sector and enable dignified livelihoods.



2.5 Key Barriers for Growth:

- **Access to Capital (High Cost of Initial Capital):** Prohibitive machinery, equipment, infrastructure, and input costs collide with severely limited affordable financing (banks view sector as high-risk, venture capital is scarce, public funding inadequate). Enterprises trapped at break-even, unable to scale. This is the foundation barrier underlying all other challenges.
- **Bureaucracy and Corruption:** Complex regulatory environments, multiple overlapping agencies, slow certification (12+ months), customs misclassification, bureaucratic delays, routine bribery demands, opaque procurement, paper-based systems. Regulatory maze and corruption inflate costs 10-30%, delay market entry by months, punish quality while rewarding non-compliance.
- **Social Change and Perception:** Deep consumer attachment to conventional products due to decades of familiarity, brand marketing, subsidized pricing. Low awareness of bio-based alternatives, skepticism, unwillingness to pay premiums (especially low-income segments). "People are used to one product and changing their mind is hard." Market penetration remains slow without coordinated sector-wide awareness and behavior change efforts that cash-constrained MSMEs cannot afford.



2.6. Creating an enabling environment for Agro-Food Value Addition

In the ideal situation, The Kenyan bio-based enterprises have expanded their presence across Africa and into global markets, recognized as leading providers of sustainable, bio-based products. They operate at scale, with upgraded infrastructure, multiple treatment plants, and diversified product lines delivering broader social and environmental impact. Enterprises actively pioneer social change, for example, by improving menstrual health, reducing period poverty, and strengthening public hygiene in schools and communities. Their growth creates large numbers of decent jobs while shifting major supply chains especially away from single-use plastics towards sustainable alternatives. As a result, the cluster achieves strong export performance, innovation leadership, and is seen as a valued contributor to global sustainable development agendas.

A table on Enablers, Lead Institutions, and Policy Actions

ISSUE	INSTITUTIONS	POLICY ACTIONS
Expansion / Scaling (Difficulty growing beyond local markets; high costs, fragmented logistics, limited stable buyers)	Finance institutions, R&D actors, marketing experts, Government, Private sector / KEPSA	• Subsidies, tax breaks and waivers, flexible energy tariffs, access to public finance, • Buy Kenya and build Kenya market protection.
Decision making (Policies and priorities set without sufficient MSME, youth, women, or R&D input)	Government, universities and R&D institutions, finance actors, private sector representatives (incl. youth and women)	• Embed R&D and bioeconomy content in university institutions • Ensure inclusive of MSME participation in policy and investment decisions.
Technology (Limited access to modern machinery, processing tech, and applied R&D; low productivity and quality)	Government, finance institutions, R&D organizations, capacity-building providers, AI and digital innovators	• Tax relief and policy support to keep critical equipment and inputs affordable and accessible, • support for technology transfer and modernisation.

Policy and regulations (Cumbersome, unclear, and conflicting rules; slow certification; rigid procurement)	National and county governments, relevant ministries, private sector platforms, development partners	• Reduce bureaucracy via digital licensing • Clear implementation frameworks; operationalize enabling policies (e.g. developing a Start-Up Bill).
Finance (High capital costs, limited access to affordable loans, grants, or investment for equipment and growth)	Government, grant-makers, lenders, venture capitalists, tariff and levy authorities, KRA	• Provide favourable loans, exemptions and levy reductions, • Improve MSME access to public and green finance.
Capacity (Skills building) Gaps in technical, managerial, and business skills; curricula misaligned with market needs	KNCCI, universities, TVETs, industry associations, private sector	• Review and align curricula with market needs; • support subsidised memberships and continuous training for MSMEs and workers. (memberships in sector associations that offer skills development and services)

2.7. Milestones: 2030 and 2040

By 2030 (mid-term)

- Expand operations to multiple Sub-Saharan African countries.
- Attain leadership in biodegradable packaging solutions in the region.
- Launch and grow menstrual dignity initiatives with the goal of reducing period poverty by 15%.
- Establish major infrastructure projects, such as waste treatment and conversion plants, in five or more towns.

By 2040 (long-term)

- Achieve global presence, with operations in America and Europe.
- Become a leader in sustainable packaging solutions.
- Create more than 10,000 new jobs in Kenya
- Replace over 100,000 tons of single-use plastic per week with biobased sustainable alternatives.
- Establish and operate several large industrial-scale , Kenyan biobased production and biorefinery facilities.

ANNEX

List of members and enterprises

	NAME	ORGANIZATION
1	Rose Sikulu	Fibertex Green paper ltd
2	Brian Ndung'u	Ecobana Limited
3	Samuel Thuo	Ziada Solutions ltd
4	Kelie Ogola	Ecobana Limited
5	Gloria Kisilu	The Shaba ltd
6	Joseph Nguthiru	Hyapak
7	Melissa Seidel	icipe
8	Valibe Moraa	Icipe/ Bioinnovate
9	Dickson Ochieng	Sanivation
10	Sharon Otieno	Loocid

ABBREVIATION / ACRONYM LIST

ABDK	Advancing Bioeconomy Development in Kenya
AI	Artificial Intelligence
AU	African Union
B2B	Business-to-Business
CABI	Centre for Agriculture and Biosciences International
DFI	Development Finance Institution
EAC	East African Community
EU	European Union
GHG	Greenhouse Gas
GMP	Good Manufacturing Practices
ICIPE	International Centre of Insect Physiology and Ecology
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEBS	Kenya Bureau of Standards
KEFRI	Kenya Forestry Research Institute
KEPSA	Kenya Private Sector Alliance
KIRDI	Kenya Industrial Research and Development Institute
KNCCI	Kenya National Chamber of Commerce and Industry
KRA	Kenya Revenue Authority
MSME	Micro, Small and Medium Enterprise
NEMA	National Environment Management Authority
NGO	Non-Governmental Organization
R&D	Research and Development
SACCO	Savings and Credit Cooperative Organization
SDG	Sustainable Development Goal
SEI	Stockholm Environment Institute
Sida	Swedish International Development Cooperation Agency
SME	Small and Medium Enterprise
SWOT	Strengths, Weaknesses, Opportunities, Threats
TVET	Technical and Vocational Education and Training
USD	United States Dollar
VAT	Value Added Tax