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Strengthening Start-Up Ecosystems for Bio-Based Innovations in the Food Sector

Lessons from East Africa

Paul Nyangau, Zewdu Abro, Julius Ecuru, Menale Kassie, Shira Mukiibi, Heike Baumüller and Joachim von Braun

Abstract

The bioeconomy is emerging as a significant driver of economic growth and sustainability thinking globally and in East Africa. Leveraging bioscience knowledge, tools and techniques, research organisations and start-ups are developing improved bio-based products including crop varieties, as they respond to the region's commitment to sustainability transition. This study evaluated the bio-based start-up ecosystem in four countries in East Africa. The study used a qualitative approach which included document review, key informant interviews (KIIs) with startup managers and focus group discussion (FGD) with stakeholders in the start-up ecosystem in East Africa. In the whole region, probably less than 30 successful start-ups relating to the emerging bioeconomy were established within the last five years. The findings show that access to finance remains a critical challenge for bio-based start-ups in East Africa. While there is growing interest from both public and private investors, many start-ups struggle to secure funding due to factors such as stringent collateral requirements and high-interest rates especially for young innovators. Additionally, allocated funds for research initiatives aimed at developing bio-based products, processes and technologies appear to be insufficient to meet the growing financial capital needs of the startups in the food sector. Findings also show that start-ups operate below capacity because of shortage of raw materials due to weak supply chains and to a great extent weak links to markets. It was found that lack of specialization among start up ecosystem players hinders the support provided to entrepreneurs. The study recommends increased collaboration between national research institutions, universities and international partners in the creation of knowledge, and translating the knowledge to innovation in the region. Additionally, leveraging sector-specific expertise and providing incentives for start-ups and innovation hubs are necessary for building a more resilient and inclusive innovation ecosystem for the food system in East Africa.

Keywords: Bioeconomy, East Africa, Food, Innovation Ecosystem, Start-ups

JEL codes: G3, M13, O14, Q57

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1 Introduction

1.1 Background

The global food industry is undergoing profound transformation driven by increasing consumer demand for sustainable and healthier food products (Noort et al., 2022). These changing consumer attitudes have sparked an increasing interest in bio-based innovations that use natural and renewable resources to produce healthier and safer food products. Arguably, these innovations should minimize negative environmental impacts of food production and consumption, and thereby promote sustainability in the food sector. Consequently, bio-based start-ups are emerging as one of the solutions to the urgent challenges of food security, resource scarcity and climate change (Robert et al., 2020).

East Africa, characterized by its rich biodiversity, diverse agricultural practices and unique food traditions, presents a promising context for the development of bio-based innovations in the food sector (Virgin et al., 2022). The region boasts a wide variety of natural resources, including native crops, livestock and aquatic species. These resources can be used to develop innovative and environmentally friendly food products. Additionally, East Africa faces specific challenges related to food security, population growth and climate variability, making it imperative to explore innovative solutions that promote sustainable economic development (Kinda and Badolo, 2019).

Innovations based on renewable biological resources are increasingly contributing to the production of food, materials and energy in the growing bioeconomy (Trigo et al., 2023). Within the food sector, the East African Bioeconomy Strategy identifies three areas with high potential, namely; (a) value addition to food crops, livestock, and microbial products; (b) development of novel food and feed products; and (c) use of bio-based agricultural inputs. Additionally, the 2022 Malabo-Montpellier Panel Bioeconomy Report stressed the importance of bio-based innovations and identified actions to develop the bioeconomy in the food sector, including cooperation between academia and industry, and consumer awareness to drive demand for bio-based products and bio-solutions (Malabo-Montpellier Panel, 2022).

Efforts to scale bio-based innovations and businesses in the food sector will require an understanding of the existing start-up ecosystem challenges and opportunities. This study aimed at drawing lessons from bio-based start-ups in the region. In the whole region, probably less than 30 start-ups established within the last five years are relating to the emerging bioeconomy. Therefore, using the lens of start-ups supported through BioInnovate Africa, the study identifies best practices, key challenges and potential opportunities for start-ups in the emerging bioeconomy of the region.

BioInnovate Africa is a regional science and innovation initiative fostering a bioeconomy in East Africa. It is supported by the Swedish International Development Cooperation Agency (Sida) and implemented by the International Centre of Insect Physiology and Ecology (*icipe*). BioInnovate Africa assists entrepreneurial scientists to either partner with private sector companies to expand bio-based businesses or to create their own start-ups in East Africa. BioInnovate Africa operates regionally in Burundi, Ethiopia, Democratic Republic of the Congo (DR Congo), Kenya, Rwanda, South Sudan, Tanzania, and Uganda. To this end, it offers grants to support scientists to link biologically based research ideas, inventions, and technologies to businesses and markets. Through its efforts 17 bio-based products/solutions were market tested and seven start-ups were created (two on bio inputs, one on wastewater treatment, three on biofortified foods and one on biofuels) between 2018 and 2023. Among the successful products and innovations fostered by BioInnovate Africa are nitrogen enhanced organic fertilizer, fungal based bio-pesticides, high strength wastewater treatment, aroma honey toffees, disease free crop plant materials, insect proteins, biofortified foods, and smart post-harvest fruit and vegetable processing methods. These ventures are implemented in at least three countries in East Africa.

Understanding the dynamics, challenges and opportunities that influence the growth of start-ups focusing on bio-based innovations is essential for creating a supportive environment that catalyses sustainable food systems transformation. This includes examining how government policies support industry partnerships and international collaborations for bio-based and food sector start-ups. The study provides insights on transformations taking place in the food systems in the region, including the crucial role played by small and medium enterprises (SMEs) in the midstream of the output food sector value chains.

1.2 Objectives of the study

The objective of this study was to evaluate the start-up ecosystem for innovators of bio-based products in countries where BioInnovate Africa operates.

More specifically, the study was to:

- outline the different elements of the start-up ecosystem, including e.g. access to public and private start-up finance, public R&D investments, innovation hubs/accelerators, human capital, general business environment, and science and technology policies and standards.
- highlight lessons from selected bio-based start-ups operating in the region, and
- provide a brief comparative analysis of the start-up ecosystems in the countries.

2 Materials and methods

2.1 Study Design

The study used data collected through key informant interviews, focused group discussion, field observations and desk review (Figure 1). The study was conducted between September (2023) and March (2024).

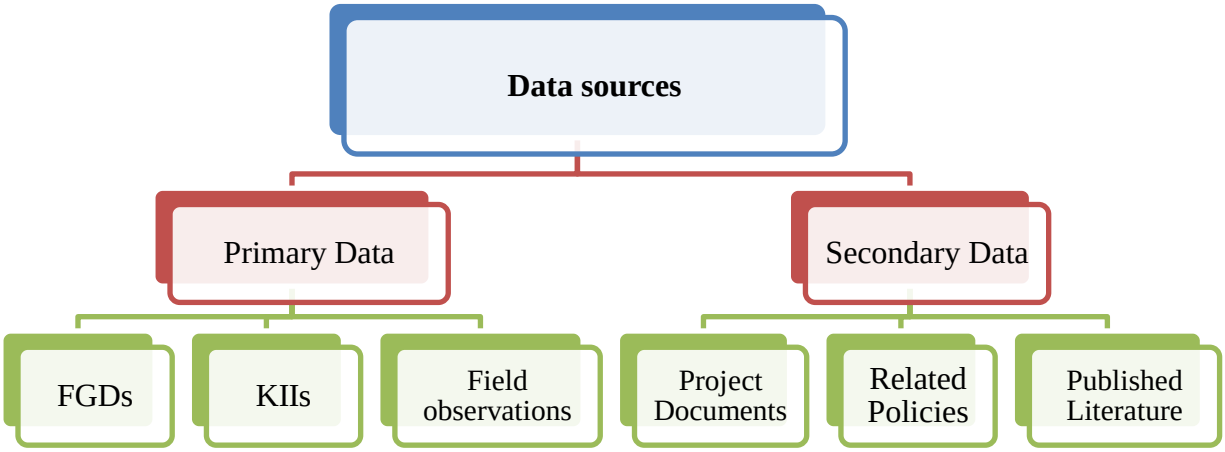

Figure 1: Summary of Study Design

Focus group discussion (FGD)

A focus group discussion (FGD) was held with incubators/accelerators and policymakers in East Africa. Participants in the FGD were identified through a snowball technique. Subsequently, 6 incubators, 4 accelerators, and 2 policymakers were invited to participate in a virtual FGDs. Eleven of them joined the discussion that took for about 2 hours. Table 1 shows the type of participants in the discussion. The discussions covered access to public and private finance, R&D investments, the presence of innovation hubs and accelerators within the ecosystem, and the services/resources they offer, as well as the policies and standards that support bio-based start-ups and innovative products in East Africa.

Table 1: Participant type

	Participant type	**Country**
1	Accelerators	Kenya, Uganda, Ethiopia, Tanzania
2	Incubators	Kenya, Uganda, Ethiopia, DRC, Tanzania
3	Incubator/ Accelerator	Somalia
4	Policy makers	Kenya

Key informant interviews (KIIs)

KIIs were held with policymakers. Using snowball sampling technique, individuals who possess relevant knowledge, expertise and insights related to the start-up ecosystem policy in East Africa were selected for the interviews. The KIIs covered the primary policies or regulations governing bio-based agricultural innovations, particularly concerning safety, sustainability or commercialization, interaction with start-ups and innovation hubs, and collaborations with other organizations such as research institutions and industry associations.

Field observations

Visits were made to start ups in four countries: Ethiopia, Kenya, Tanzania and Uganda (Figure 2). Specifically, the countries were selected for their diverse start-up ecosystems, the segments of the food sector that the innovations addressed, and the target markets of the start-ups. A total of five start-ups were purposively selected, considering the information obtained from the mapping of the start-up ecosystem. Most of them were start-ups supported by BioInnovate Africa. The selected start-ups included Duwame Bakery and Almi Foods Plc in Ethiopia, InsectPro Ltd in Kenya, Guavay Company Ltd in Tanzania, and Senai Bioscience Laboratories (trading as Senai Farm Supplies Ltd) in Uganda. Field observations were conducted to gather firsthand information about start-ups. Each of the selected start-ups was based on their growth prospects in the food sector as described in section 3.1.

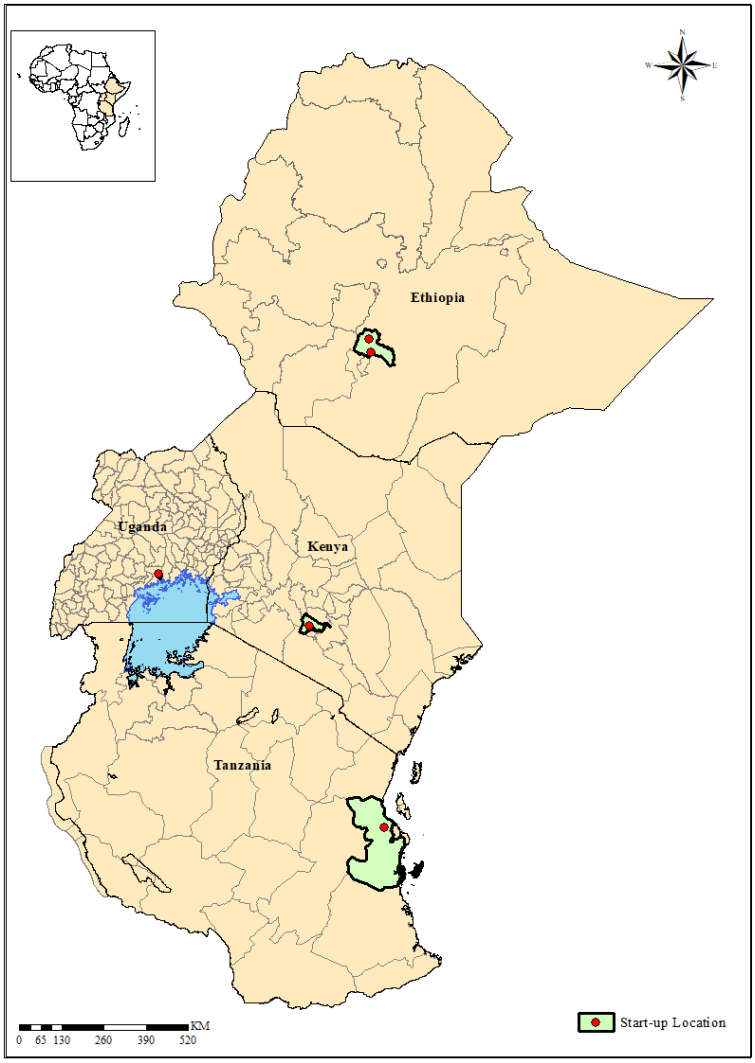

Figure 2. Map of countries where startups studied are located.

Desk review

Literature review was conducted to analyze secondary data, including business directories, relevant indices and business documentation. Both peer-reviewed and grey literature encompassing a wide range of perspectives and insights on the start-up ecosystem in East Africa were included in the review. The literature was obtained using key databases such as Web of Science, Google Scholar, ScienceDirect, and Semantic Scholar. The search terms used included "Bio-based products" or "Bioeconomy" or "Bioeconomy Policy" or "food sector" as the object, "Sustainable" OR "Innovative" OR "Development" as the adjectives, and "East Africa" OR "Developing Country" as the location.

Data analysis

Both the FGDs and KIIs were audio-recorded and transcribed by the interviewers within one week after the discussion or interview. An anonymization process was used to give study participants codes instead of participants' real names. Finally, the triangulation approach was used to compare data collected through FGDs, KIIs and desk review.

3 Results and discussion

3.1 Description of start ups

Duwame Bakery Plc, Ethiopia

Duwame Bakery specializes in selling bakery products made from orange-fleshed sweet potato (OFSP) puree. OFSP is an improved variety of sweet potato with high vitamin A content. The motivation behind starting the business was to provide healthy food with the addition of OFSP puree. The company received grant funding from BioInnovate Africa. The company used the funding to purchase pilot production equipment (Figure 3). The company also received a training from Growth Africa and Hawassa University. The main challenge faced by the company is the seasonal supply of OFSP. Other challenges include absence of a 3-phase transformer to supply electricity to the company's machine and difficulties in sourcing of OFSP due the ongoing political conflict in the country. The company is also constrained by limited operational space and has been unsuccessful in its applications for space allocation at the Hawassa Industrial Park.

Figure 1: The mixer and washer machines used in process OFSP at Duwabe bakeries
(Source: BioIonnvate Africa, icipe)

Almi Foods Plc, Ethiopia

Almi Foods produces home-based blended products (flour, bread and cake) primarily targeting children under 5 years old to improve nutrition. The products have been developed through a research collaboration with Hawassa University. The local government has recognized and appreciated their efforts, providing the company with space within the Hawassa Industrial Park (Figure 4). Almi Foods also received grant funding from BioInnovate Africa. Almi Foods used the funding to purchase production equipment. The company collaborates closely with Hawassa University to fulfil the regulatory requirements for food production. Currently, the company is operating below capacity due to a limited local supply of raw materials (wheat, OFSP and teff) caused by political instability in Ethiopia. However, the manager believes there is a big market for their products due to the growing population and high demand for nutritious children's food.

Figure 2: The grinder machine used at Almi foods production facility Hawassa Industrial Park (Source: BioInnvate Africa, icipe)

InsectPro Ltd, Kenya

InsectPro produces black soldier fly larvae, which it uses to make protein supplement in feed, while the compost (frass) is used as fertilizer for crop production. The company also rears and processes cricket for food. The company started insect farming with the aim of offering affordable alternative sources of protein for food and feed and maximizing biowaste utilization and improving plant nutrient availability. This approach has reportedly resulted in an increase in yield for smallholder farmers and improved soil health. The company frequently engages with different regulatory bodies involved in insect rearing through its partnership with *icipe*. The main challenge is the high cost of operation, and the new income tax, value-added tax and the housing levy imposed in 2023 (Grant Thornton, 2023).

Guavay Company Limited, Tanzania

Guavay Company Limited, located in the Kibaha-Coast region of Tanzania, specializes in the production of Hakika organic fertilizer (Figure 5). They have also registered two other products. Hakika Avomax is a biofertilizer solution specifically designed for avocados. Hakika Bioline is a treatment for acidic soils. Besides, the company assists farmers in testing the acidity of their soils. Hakika organic fertilizer is marketed as an excellent choice for cultivating a wide variety of fresh fruits, vegetables and healthy food crops, as well as vibrant flowers. According to the managing director, the customer feedback survey has indicated that the soil has improved in terms of water holding capacity and yield increased by 25-30% for avocado farmers. The support from BioInnovate Africa has played a crucial role in enhancing the capital and product performance of the company by assisting them in developing and implementing effective marketing strategies. It has also aided in creating market awareness and creating job opportunities. The main challenge is the seasonal demand for fertilizer which is only high during the planting season.

Figure 3: Mixer used for Hakika fertilizer production at Guavay company
(Source: BioIonnvate Africa, icipe)

Senai Farm Supplies Limited, Uganda

Senai Farm Supplies focuses on vegetatively propagated crops like sweet potato, banana and cassava (Figure 6). They also sensitize farmers on the use of clean planting materials and facilitate market connections. The support and guidance they have received from Bioinnovate Africa includes infrastructure support, organizing farmer cluster groups, and training on branding, product development and market testing. Plans for scaling up or expanding the business are limited by space availability. Unpredictable markets weaken the linkage between production and the market. Therefore, the company offers discounts on planting materials to farmers who book in advance.

Figure 4: Cassava and sweet potato multiplication at Senai Farm Supplies Ltd, Kampala
(Source: BioIonnvate Africa, icipe)

3.2 Elements and challenges of the start-up ecosystem in East Africa

Access to public and private start-up finance

Accessing finance remains a major challenge for many start-ups in East Africa. Different public and private funding sources are available but they are either insufficient or inaccessible to start-ups. The low maturity level of early-stage start-ups creates additional challenges to raising funds. Factors such as limited collateral, high interest rates and a lack of financial literacy among entrepreneurs contribute to the limited access to funds by start-ups (Lee et al., 2015; Santos and Cincera, 2022). Additionally, the COVID-19 pandemic worsened these challenges, leading to a decline in investment activity and increased risk aversion among investors (Ritika et al., 2023).

The funding landscape especially for bio-based innovations is still relatively underdeveloped compared to other regions (Mwaniki and Nyaboke, 2023; Nakalembe et al., 2023). During the FGD, participants expressed concerns about the difficulties in accessing both public and private financing for start-ups. Limited availability of funding from government grants and development support programs was cited as a significant barrier, hindering the growth and development of bio-based innovative ventures. Entrepreneurs often face challenges in meeting the stringent eligibility criteria and navigating the complex application processes for securing financing, leading to a lack of adequate funding for their ventures. One of the accelerators said:

> *'I think from our experience that it is way too early for private sector players to come in and invest and there is just a very limited amount of public sector funding.'* [FGD 1]

Moreover, there is limited support and resources tailored specifically for young and aspiring entrepreneurs. Many young innovators struggle to access mentorship, training and networking opportunities essential for transforming their ideas into viable business ventures. Without adequate support systems in place, promising ideas may fail to materialize into successful start-ups, thereby stifling innovation and entrepreneurial development in the region.

> *'Young people will get out of the universities and all they have is energy. Very few support agencies would put their money on such individuals. They believe they're too risky, rightly so because they are young and excitable and probably what they think they can make money or can be a success, often at times may not succeed, so I may understand this scepticism.'* [FGD 2]

Securing adequate funding was noted as a major challenge for bio-based start-ups, given the high upfront costs associated with R&D, pilot-scale production and market entry. Limited access to funding in turn constrained the growth and scalability of bio-based ventures.

> *'It's very hard to get funding, especially for an African woman trying to raise money for a startup in Kenya. In addition, most incubators are focused on ideation stages to business, but we are already a business, so there is a big gap in the market for that kind of acceleration'* [Start-up in Kenya 1]

In cases where the start-up received support from organizations such as Bioinnovate Africa, it included infrastructure support and training on branding, product development and market testing.

> *'Most of the support we have received is collaborative research. We deal with subsistence farmers who may not have enough capacity to buy quality seed. So, these projects in a way are coming to assist farmers access clean planting materials, and to create market linkages'* [Start-up in Uganda 2]

There are opportunities for innovation and collaboration to meet the financing requirements of start-ups in East Africa. Various initiatives, such as crowdfunding platforms[1], peer-to-peer lending networks

[1] Some of the crowdfunding platforms include M-changa supporting Mavuno AgriFinance, PesaZetu, Akabbo and Yewou

and impact investing funds, provide alternative sources of capital for entrepreneurs (FSDAfrica, 2016). Efforts to attract angel investors, venture capital firms, impact investors and corporate accelerators who provide equity investments, seed funding and mentorship to promising ventures, are increasing in the region. However, most of them are for the fintech and energy sectors. For example, funding in Kenya's start-ups in fintech increased from US$ 47,365,000 to US$ 673,781,000 between 2015 and 2023 (Disrupt Africa, 2024).

The importance of partnerships and data-driven approaches was emphasized during the FGD. Participants highlighted the lack of collaboration within the food system ecosystem, noting that stakeholders operate in silos instead of working together towards common goals. This fragmentation hampers the efficiency and effectiveness of efforts to address pressing challenges such as food security, agricultural productivity and value chain development. There is a recognized need for greater collaboration among stakeholders in the start-up ecosystem to leverage collective expertise and resources for driving innovation and sustainable development in the food sector.

> *'I think that it is possible to make a push for collaborations, but the platform matters a lot. It would be easier to have to push for some kind of funding when you have a bigger group instead of individual organizations.'* [FGD 3]

Public research and development investments

Public research and development (R&D) investments play a crucial role in driving innovation, fostering economic growth and addressing societal challenges in East Africa. Governments in East Africa allocate funds for R&D activities through their national budgets. Some of these allocations support research initiatives aimed at developing bio-based products, processes and technologies that promote sustainable agriculture, renewable energy and environmental conservation, but they are meagre. R&D expenditure as a percentage of GDP is very low compared to other world regions, reflecting limited resources and competing priorities (Adepoju, 2022; Lutomiah et al., 2022). For instance, in 2019, the region allocated only 0.42% of its resources to R&D, a figure that falls well below the global average of 1.7% (Adepoju, 2022).

East African countries have established national research institutions dedicated to biotechnology, agricultural research and environmental science. Examples include the Kenya Agricultural and Livestock Research Organization (KALRO), the National Agricultural Research Organization (NARO) in Uganda, the Tanzania Commission for Science and Technology (COSTECH) and Ethiopia's Bio and Emerging Technology Institute (BETin) (Ouru et al., 2018). These institutions receive funding from government budgets and collaborate with international and local partners. For example, COSTECH collaborates with Buni hub, a space that fosters innovation for individuals at the early stages of their entrepreneurial journey. This hub helps them on their path to becoming successful entrepreneurs or business owners.

Universities and research universities in East Africa conduct R&D activities in bio-based innovation through their agricultural, engineering and biotechnology departments (Virgin, 2016). These institutions receive funding from government sources, research grants and international partnerships to support research projects on bio-based products, biomaterials and bioenergy. For example, Hawassa University in Ethiopia collaborates with Almi Foods and Duwame Bakeries in the production of bio-based products. These products are the result of the University's research. However, limited financial resources have hindered the ability to commercialize these products and scale up the research from prototypes to market-ready products. This constraint restricts the development, testing, and commercial production of bio-based products, often causing promising innovations to remain stuck at the research stage.

Presence of innovation hubs and accelerators

Innovation hubs and accelerators have recently proliferated across East Africa, serving as focal points for start-up activity and entrepreneurship support. In the region, the Kenyan capital Nairobi hosts the leading tech hubs. The most prominent ones include Villgro Africa, Growth Africa, Nailab, Pangea Accelerator, and BioInnovate Africa's BioVenture Hub (Muathe and Otieno, 2022). These hubs provide co-working spaces, mentorship, networking opportunities and access to funding for start-ups.

The presence of innovation hubs and accelerators are driving entrepreneurship, fostering technological advancements and addressing development challenges in the region. These hubs and accelerators serve as catalysts for innovation, providing a supportive ecosystem for start-ups, researchers and entrepreneurs to develop, test and scale novel solutions. Brief profiles of a few selected incubators and accelerators that provide funding for bio-based products are described below (see also Table A1 in the annex).

GrowthAfrica[2] is a pan-African business accelerator that operates in Kenya, Uganda and Ethiopia, supporting high-potential entrepreneurs and start-ups. It offers tailored acceleration programs, mentorship, business development support and access to funding for early and growth-stage ventures. GrowthAfrica focuses on sectors such as agribusiness, renewable energy, technology and manufacturing, aiming to catalyze economic growth and job creation in East Africa. Out of the 29 ventures accelerated, 24% belong to the bio-based category. Duwame Bakery is one of the companies that received training support on business development from Growth Africa.

Pangea Accelerator[3] is a Nairobi-based accelerator program that focuses on supporting early-stage start-ups across Africa. It offers a three-month intensive program designed to help start-ups scale their businesses, providing mentorship, training and access to funding opportunities. Pangea Accelerator focuses on sectors such as fintech, agritech, healthtech and cleantech, with a mission to drive sustainable innovation and impact in Africa. More than 300 (46% women-run) start-ups have been accelerated. In 2022, 11 entrepreneurs were trained under the food accelerator program.

The Circular Innovation Hub[4] is an initiative based in Kenya that focuses on promoting circular economy principles and sustainable innovation. The hub provides support to entrepreneurs, researchers and businesses working on circular economy solutions, to address climate change, biodiversity loss and pollution. Through training, networking events and collaboration opportunities, the Circular Innovation Hub aims to drive the transition towards a more sustainable economy in Kenya and beyond. Twenty-six start-ups working in circular ecosystems that includes redesign, reuse, recycling and upcycling have been accelerated.

The Innovation Village[5] based in Kampala, Uganda, supports entrepreneurs and innovators across various sectors, including agriculture. It offers co-working spaces, incubation programs and access to funding for start-ups. The hub provides mentorship, training and networking events to bio-based start-ups, in the production process and to access sustainable markets. It collaborates with local and international partners to facilitate technology transfer and promote innovation-led growth in Uganda and beyond. Over 1000 start-ups have been supported.

The Tanzania Commission for Science and Technology (COSTECH)[6] operates an innovation space in Dar es Salaam, Tanzania, aimed at supporting technology-driven innovations, including those in the agricultural sector such as Guavay Limited. The innovation space provides resources, mentorship, and networking opportunities for entrepreneurs developing agricultural solutions. Buni Innovation Hub

[2] https://growthafrica.com
[3] https://pangeaa.com
[4] https://www.circularinnovationhub.com
[5] https://innovationvillage.africa
[6] https://www.costech.or.tz

under COSTECH is a co-creation working space that focuses on promoting innovation and technology entrepreneurship. Over 350 young Tanzanians are active members of the innovation space.

These hubs are considered effective in supporting the growth and success of start-ups in East Africa. Their structured programs, mentorship, networking opportunities, access to funding and impact measurement mechanisms contribute valuable resources for entrepreneurs looking to scale their businesses in the region.

However, their presence at the grassroots is limited or non-existent in many areas. This could be because of the significant challenges faced by different hubs, including limited access to funding, inadequate infrastructure, and a shortage of skilled talent. These challenges constrain their ability to effectively support start-ups. Navigating complex regulatory environments and market access difficulties further complicate operations. Sustainability issues arise due to heavy reliance on short-term donor funding. Additionally, a lack of experienced mentors hampers the quality of guidance provided to start-ups. Furthermore, challenges in measuring and evaluating program impact hinder the ability to demonstrate value and secure ongoing support. Addressing these multifaceted challenges is crucial for enhancing the effectiveness of incubators and accelerators in fostering innovation and entrepreneurship in the region.

Policies

In East Africa, policies related to the bioeconomy are continuously evolving to foster the development of sustainable and innovative practices across multiple sectors. While specific policies may vary from one country to another, there is a growing recognition of the importance of promoting bio-based industries to stimulate economic growth, improve environmental sustainability and create employment opportunities.

Bioeconomy related policies: A study by the African Technology Policy Studies Network (ATPS) documented the key bioeconomy-related policies in East Africa (see Table A2 in the Annex for an overview of relevat policies in selected countries for this study). All countries have policies related to agriculture, environment, science, technology and innovation, reflecting a common focus on sustainable development and economic growth (ATPS, 2021). There is a shared emphasis on common priorities for resource utilization and sectoral development. For example, Ethiopia has an Agriculture Sector Policy and Investment Framework (PIF) 2010-2020, while Rwanda emphasizes the National Agriculture Policy and the Agriculture Sector Strategic Plan (ASSP) (2015-2020).

Most countries in EAC have established policies or regulations related to biosafety, biodiversity conservation and land management, highlighting a commitment to human health, environmental protection and conservation efforts. For example, Kenya's Biotechnology and Development Policy of 2006 (Republic of Kenya, 2006) and Uganda's National Biotechnology and Biosafety Policy of 2008 (Ecuru and Kawooya, 2015). In addition, almost all countries have the Science, Technology and Innovation Policy (STIP) in place that provides a regulatory framework for R&D activities (ATPS, 2021).

Other policies aim to strengthen intellectual property rights protection and establish quality standards that support innovation-led growth. They include Kenya's Science, Technology and Innovation Policy 2020-2030 (Republic of Kenya, 2020), Uganda's National Intellectual Property Policy of 2019 (Republic of Uganda, 2019) and Tanzania's Intellectual Property Policy of 2022 (National Institute for Medical Research, 2022).

The EAC recently launched a bioeconomy strategy aimed at catalyzing policies for sustainable, bio-based and inclusive economic growth in the region. The strategy aims to harness the potential of biological resources, such as agriculture, forestry, fisheries and biodiversity (Virgin et al., 2022). Its primary objectives are to drive innovation, create jobs and address urgent socio-economic and environmental challenges (EAC, 2022). To achieve this, the strategy focuses on promoting bio-based industries, enhancing value addition, fostering innovation and entrepreneurship, promoting

sustainable resource management practices and strengthening regional collaboration and partnerships.

Policy incentives: Policy incentives for start-ups and hubs are not so evident. Incentives such as tax breaks and other forms of support like pooled infrastructure in industrial parks and export processing zones exist. Such incentives are designed to reduce entry barriers and foster an enabling environment for entrepreneurship and innovation, but access to these support systems is difficult for start-ups. It was the general feeling by most start-ups in the FGD that the available incentives are not enough to sustainably support them.

> *'What we currently have is not sufficient, and this applies for both hubs and our start-ups. Especially start-ups need incentives to ensure that even when they set up, they have enough time to grow themselves to a point where they are stable enough to start paying taxes.*' [FGD 5]

As the word cloud in Figure 7 clearly demonstrates, the importance of providing incentives was also emphasized by FGD participants. Nonetheless, few start-ups mentioned that they were able to secure a subsidized working space when they initiated their respective companies.

> *'The space we are occupying now was given to us by the local government that recognized the importance of our product. We pay a subsidized rent for this commercial space.'* [Start-up in Ethiopia 3]

Figure 5: Word cloud on the importance of strengthen startup ecosystem in East Africa drawn from the FGD data

High taxes and levies increase the cost of doing business, affecting the overall budget and financial planning of start-ups. For example, the introduction of new taxes and levies in Kenya has exacerbated the cost of operation for start-ups, eroding their profit margins, and is likely to constrain growth and innovation. The feeling is that increased taxes may impede the scalability and long-term success of the start-ups.

> *'The government has now made my tax base almost 48%. I pay more taxes here in Kenya than I do in Europe. All the new taxes have not been easy...If they could incentivize more for starters, especially startups in the green economy, that would make my life significantly easier.'* [Start-up in Kenya 1]

Talent and skills: The lack of specialization in the food systems sector and the need for sector-specific experts was highlighted.

'We have struggled to get experts who would be able to offer support to producer organizations. The organizations faced multiple challenges in terms of setting up the facility, quality control and disease management.' [FGD 4]

There is a need for specialized professionals, such as highly skilled agronomists, food scientists, supply chain experts, and policy analysts, who can provide targeted support and guidance to entrepreneurs and start-ups operating in the sector. Access to sector-specific expertise is essential for developing innovative solutions, navigating regulatory frameworks and scaling impactful ventures in the food systems space.

Other economic factors: The fluctuating demand for bio-based product as well as risk and uncertainty in the operating environment affect the start-ups' and the ecosystem actors' business operations and financial performance. For example, the seasonal demand for planting materials such as seeds, potato vines and fertilizer affect the production and subsequently the financial operation of the company.

'The challenge is unpredictable market. So you cannot know the farmers will plant this much. The solution would have been if farmers can do what we call pre booking. That next season I'll need so much of a planting material. Then you plan ahead. But again, most of our farmers are the ones who cannot afford that type of pre booking.' [Start-up in Uganda 2]

4 Conclusions and recommendations

The bio-based start-up ecosystem in East Africa has experienced significant growth in the last ten years. Each country in the region has unique strengths and challenges in this regard. A common trend is that the start-ups are innovating and using technology to address sustainability issues in the food sector. Based on the findings, it appears that limited funding from both public and private sources is a major barrier to the growth and development of innovative ventures. This is followed by inadequate specialization and few highly skilled individuals in the bio-based start-up ecosystem. Additionally, there is weak collaboration among actors in the ecosystem. The incentives available for start-ups and hubs are insufficient, further slowing a fast growth of bio-based start-up ecosystem.

Based on the study's findings, collaboration between governments, private sector stakeholders and development partners is crucial and highly encouraged to create an enabling environment for the growth of bio-based start-ups in the food sector in East Africa. Improving access to both public and private start-up financing is essential for the start ups' entrepreneurial activities and innovation. There is need to attract more highly skilled and specialised individuals to work with accelerators, innovation, hubs and the start-ups themselves. Moreover, ensuring a favourable business environment characterized by transparent regulations and supportive infrastructure is necessary for attracting investment and fostering entrepreneurship in the food sector start up ecosystem. Bio-biased innovations also rely on a reliable supply of raw materials which in turn requires investments in productive capacities and market linkages. In view of the international growth and diversification of the bioeconomy around the world (Dietz et.al. 2024), East African entrepreneurs could benefit from international cooperation, as could partners elsewhere in the world from collaborations with entrepreneurs in East Africa.

Though the study offers valuable insights into bio-based start-up ecosystems in East Africa, there are some limitations that should be considered. First, the selection of participants may lead to sampling bias, which could potentially compromise the generalizability of the findings. Second, the subjectivity in data interpretation and researchers' biases could influence conclusions (Mwita, 2022). Finally, there is a possibility of social desirability bias distorting participants' responses, and the small sample size and specific contexts of the study may limit its generalizability (Vasileiou et al., 2018).

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Appendices

Table A1: Mapped incubators/ accelerators[7] in the bio-based startup ecosystem in East Africa

Incubator/ Accelerator	Address	Countries of Operation	Stage(s) supported
GrowthAfrica	Lenana Towers, 5th floor Lenana Road P.O. Box 17726 - 00100 GPO Nairobi, Kenya	Ethiopia, Kenya, Malawi, Tanzania, Uganda, Zambia	Growth stage
Intellecap Advisory Services	4th Floor, The Riverfront, along Prof. David Wasawo Drive off Riverside Drive, Nairobi, Kenya.	Global presence	Early stage, Growth stage
Kenya Climate Innovation Centre	Strathmore University Business School, 3rd Floor, Ole Sangale Rd, Madaraka. P.O Box 49162 – 0200, Nairobi, Kenya.	Kenya	Early stage, Growth stage
Pangea Accelerator	Ikigai Lavington, 90 James Gichuri Rd	Kenya, Ethiopia	Early stage, Growth stage
2SCALE Innovation	https://www.2scaleinnovation.org/	Burkina Faso, Côte d'Ivoire, Egypt, Ethiopia, Ghana, Kenya, Mali, Niger, Nigeria, and South Sudan	Early stage, Growth stage
GrowUP incubator (Yunus Environment Hub)	https://yunusenvironmenthub.com/	Kenya, Ethiopia, Rwanda, Tanzania, Uganda, and Burundi	Early stage, Growth stage
Village capital (O-farm)	https://vilcap.com/current-programs/o-farms	Kenya, Ethiopia and Uganda	Early stage, Growth stage
Anza Entrepreneurs	NSSF Mafao House, 7th Floor Old Moshi Road Arusha	Tanzania	Early stage, Growth stage

[7] The list is by no means exhaustive.

The World Food Program Field Innovation Hub Tanzania	https://innovation.wfp.org/tanzania	Tanzania	Early stage, Growth stage
Sahara Accelerator (a part of Sahara Ventures)	Victoria Noble Centre, 4 Floor, Office 406 New Bagamoyo Road Dar-es-Salaam, Tanzania	Tanzania	Idea stage, Start-up, Early stage, Growth stage
CEED Global Entrepreneur Network	https://ceed-global.org/	Tanzania	Early stage, Growth stage
Sokoine University Graduate Entrepreneurs Cooperative (SUGECO)	P.O Box 3223 Morogoro, Tanzania	Tanzania	Idea stage, Start-up, Early stage
Sinapis	Rainbow Tower, 11th Floor, 32 Muthithi Rd, Nairobi	Uganda, Kenya, Rwanda, Ghana	Growth stage
Bid Capital Partners	Kenya: Ratna Square, Fidel Odinga Road, Close the Gap Kenya Ltd and the Gap Hub Mombasa, Kenya Uganda: Plot 15B, Bandali rise, Bugolobi P.O.Box 2040 Kampala Uganda Rwanda: M-Peace Plaza KN 4 Ave 10th floor, Block B Kigali, Rwanda	Netherlands, Rwanda, Uganda, Kenya, Belgium	Growth stage
The Consortium for enhancing University Responsiveness to Agribusiness Development Limited (CURAD)	Namanve Industrial Park, Kampala-Jinja Expy, Uganda P.O. Box 1509, Kampala, Uganda https://curadincubator.org/	Kenya, Rwanda, Uganda	Idea stage, Start-up, Early stage, Growth stage
The Agribusiness Incubator (ABI) of the International Crops Research Institute for Semi-Arid Tropics (ICRISAT)	The International Crops Research Institute for the Semi-Arid Tropics Hyderabad, Telangana, India https://www.icrisat.org/	Africa, Asia	Start-up
Bluemoon	METI Building, Namibia St, Addis Ababa, Ethiopia	Ethiopia	Start-up

Villgro Africa	Bishop Magua Centre, 2nd floor Ngong Rd, Nairobi	Kenya	Start-up
BioInnovate Africa	International Centre of Insect Physiology and Ecology – icipe, Duduville Campus, Kasarani. P.O. Box 30772-00100 Nairobi, Kenya.	Burundi, Ethiopia, Democratic Republic of the Congo (DRC), Kenya, Rwanda, South Sudan, Tanzania, and Uganda	Early stage
Netherlands Food Partnership	HNK Utrecht Central Station Arthur van Schendelstraat 500, 3511 MH Utrecht, Netherlands	Kenya, Rwanda, Uganda, Tanzania	
Grid Innovation and Incubation Hub, University of Rwanda	KN 19 St, Kigali, Rwanda	Rwanda	Early stage
Chandaria Business Innovation and Incubation Center	Kenyatta University director-innovationsupport@ku.ac.ke https://www.ku.ac.ke/iiuil/	Kenya	Start-up
Circular innovation hub	233, Owashika Road, Lavington, Nairobi.	Kenya, Nigeria and Ghana	Start-up
GAIN Business incubator	9, Dopemu Road, Opp. First Bank Plc, Aluminum Village, Dopemu, Lagos, Nigeria.	Bangladesh, Benin, Ethiopia, India, Indonesia, Kenya, Mozambique, Nigeria, Pakistan, Tanzania and Uganda	
Association of Startup and SMEs Enablers of Kenya (ASSEK)	Pinetree Plaza, Kaburu Drive, Ngong road P.o Box 1730-00606 - Nairobi, Kenya	Kenya	Start-up
Startup Uganda	https://startup.ug/	Uganda	Start-up
Centre for African Bio-Entrepreneurship (CABE)	Wu Yi Plaza, 2nd Floor, Wing E, Suite- E6 Galana Road (Off Argwings Kodhek) P.O. Box 25535-00603 Lavington Nairobi – Kenya	Kenya	Start-up

Table A2: Bioeconomy related policies in selected East African Countries

Ethiopia	Kenya	Tanzania	Uganda	Rwanda
Education and Training policy (1994	Agriculture Act 1986	Fair Trade Practices Act of 1994	Ugandan Forestry Policy (2001)	National Biosafety Policy (NBF)- (2005)
Ethiopian Environment Policy (1997)	Environmental Management and Coordination Act (EMCA) 1999	National Land Policy of 1995	National Industrial Policy (2007)	Science, Technology and Innovation Policy (STIP), 2006
National water resources management policy (1999)	Industrial Property Act 2001	Investment Act 1997	National Biotechnology Policy (2008)	Law on Mining and Quarry Exploitation (2008)
	Sessional Paper No. 4 on Energy of 2004	Village Land Act, 1999	Science Technology and Innovation Policy (2009)	National Energy Policy and National Energy Strategy (2008-2012)
Rural development policy and strategy (2002)	Forest Act 2005	Energy and Water Utilities Regulatory Authority Act, 2001	National Agriculture Policy (NAP) (2013)	Rwanda Trade Policy 2010
Industrial Development Strategy (2002)	Environmental Management and Coordination Act 2006	Land Regulation of 2001	Agriculture Sector Strategic Plan (ASSP) (2015-2020)	Electricity Act (2011)
Proclamation on Access to Genetic Resources and Community Knowledge and Community Right (2006)	Biosafety Act No. 2 of 2009	Forest Act 2002	National Biodiversity Strategy and Action plan (2015-2025)	National Forestry Policy 2017
Agriculture sector policy and investment framework (PIF) 2010-2020	Land Act (2012)	Land Amendment Act of 2004	Uganda Green Growth Development Strategy of 2017/18 – 2030/31	Rwandan 2017 National Agriculture Policy
Science, Technology and Innovation Policy (2012)	Science Technology and Innovation Act 2013	Rural Energy Agency Act, 2005	National Environment Act no 5 (2019)	Draft National Environment and Climate Change policy 2018
	Agriculture and Food Authority Act 2013	Environmental Management Act, 2005		Rwanda Vision 2020
	Community Land Bill 2013	Export processing zones Act 2006		
	Forest Conservation and	Land Use Planning Act, 2007		

	Management Bill 2014	
	Climate Change Act 2016	Electricity Act, 2008
		Standards Act 2009
		Natural Gas Policy of Tanzania, 2013
		Oil and Gas Revenues Management Act, 2015
		Extractive Industry (Transparency and Accountability) Act, 2015

Note: Adpted from ATPS (2021)

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