



Food and Agriculture  
Organization of the  
United Nations

# Youth-led initiatives in the bioeconomy

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Youth leading the way towards a sustainable future





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# 1 Introduction

Global political and economic development agendas are placing more focus on developing and growing the bioeconomy to support the transformation to sustainable bio-based industries (Dietershagen and Bammann, 2023). The fossil-based industries exacerbate the global challenges of resource scarcity, food security and climate change.

Defined by the International Advisory Council on Global Bioeconomy, the bioeconomy is:

The production, utilization, conservation and regeneration of biological resources, including related knowledge, science, technology and innovation, to provide sustainable solutions such as information, products, processes and services, within and across all economic sectors, and to enable a transformation to a sustainable economy (IACGB, 2020, p.14).

The bioeconomy is heavily anchored in science and technology and drives the responsible and innovative use of bioresources and the substitution of fossil resources with renewable ones. Youth-led initiatives within the bioeconomy are contributing novel and innovative solutions towards the transformation.

Acknowledging the importance of youth in the bioeconomy, FAO conducted a stocktaking study to highlight opportunities and barriers for youth employment and entrepreneurship within the bioeconomy (Dietershagen and Bammann, 2023). The findings were presented at the 2023 World Food Forum – Youth in Bioeconomy side event which also featured prominent youth-led bio-based businesses. Despite the challenges highlighted in the report and those described by the youth entrepreneurs at the forum, youth are continuing to engage and innovate within the bioeconomy. This publication is produced to acknowledge and showcase their contributions, inspire other youth and raise awareness of opportunities for youth engagement in the bioeconomy.

Thirteen (13) youth-led initiatives were selected to share the stories of young individuals who were inspired by the challenge to make a living through innovative ideas and investment in sustainable production technologies and bioeconomy-based enterprises. The descriptive narratives are presented to stimulate readers to think innovatively and to trigger ideas for more bioeconomy-based enterprises. The lessons learned and recommendations are intended to inform decision-makers and policies towards greater youth inclusion.

Bringing visibility to the entrepreneurial journey of the youth champions unearths the struggles and the triumphs of an unwavering commitment to a bio-based future. Such conviction motivates them and activates their innovative mindset, creativity, resilience and adaptability to push through for success within the bioeconomy. Ranging from biodegradable packaging, bio-based agriculture solutions, biodegradable hair extensions, bio-based bicycles, luxury leather products to bio-based batteries their initiatives are critically contributing to the transition to the bioeconomy.

The main target audience of this publication are youth and youth organizations to stimulate thinking and encourage them to engage in the bioeconomy, as well as policymakers, development and other civil society organizations and their networks working on the topic of bioeconomy. FAO fosters the design of youth-responsive bioeconomy policies and strategies that support approaches to identify and disseminate solutions and technologies that match the needs of youth and accelerate youth participation in the innovation process. Emphasis is on youth-led innovations, including new start-ups and novel product development, which are low-cost, timely with regard to their uptake, and produce lasting positive impacts.

## 2 Methodology

Potential youth champions from around the world were identified from recommendations made by FAO colleagues, the authors own networks, LinkedIn and Google searches (e.g. Forbes 30 under 30 and innovators under 35). Using the criteria below an extensive list of 50 enterprises were narrowed down to select the final cases:

- An initiative that is youth-led (youth champions between the ages 14–35 years) or a business in bioeconomy that employs a significant number of young persons;
- A youth-led group (network) or one linked to bioeconomy education, research, or policymaking;
- Operates in one of the bioeconomy sectors listed below:
  - a. bioenergy
  - b. agriculture (including fisheries and forestry)
  - c. pulp and paper
  - d. bio-based construction materials and furniture
  - e. food and agro-industry
  - f. bio-based textiles, including plant-based textiles and leather
  - g. waste management
  - h. recreation associated with ecotourism
  - i. health care and biopharmaceuticals
  - j. bio-based chemicals and polymers, including bio-based materials
- Contributes to the achievement of sustainability criteria articulated in the *Principles and Criteria for a Sustainable Bioeconomy* (FAO, 2021) and the Sustainable Development Goals (SDGs). Specific focus was placed on youth enterprise’s contribution to:
  - a. SDG 12.2 sustainably manage and use natural resources;
  - b. SDG 12.4 responsibly manage chemicals and waste and;
  - c. SDG 12.5 substantially reduce waste generation.

FAO’s bioeconomy work specifically refers to these three SDG targets.

Thirteen (13) case studies were selected, and information gathered through desk research and in-depth key informant interviews [KII]. A heavy focus was placed on capturing qualitative information to highlight the perspectives of the youth entrepreneurs. Comprehensive quantitative data to assess financial viability and markets were not captured. Links for additional information about each case is provided in Annex 2.

The cases are descriptive and outline the problems being solved, the innovation, challenges, successes and potential for scaling-up. The success factors of each case were noted, then the common success factors were extracted, categorized and further examined to better understand their contribution to youth entrepreneurship, business growth and youth employment and engagement in the bioeconomy. Recommendations from the youth champions specific to policymakers and to other aspiring youth were also captured and documented.

The interviews were held in 2023 and thus, the stories reflect the age of the entrepreneurs as well as their experiences at that time period. The first draft of the case studies was validated by the respective youth champions then it was peer reviewed by FAO colleagues.

### 3 Youth stories

The stories of young bioeconomy entrepreneurs who are harnessing their ingenuity, skills, scientific knowledge, and visionary thinking to implement innovative solutions that contribute to the transition to a bioeconomy are presented briefly in this chapter. The details of each compelling case study are discussed in Annex 1 with links for supplemental information in Annex 2. The descriptive stories display the resilience, adaptability, and unwavering commitment of these trailblazers to a greener, bio-based future. Their endeavours not only inspire, but also demonstrate the pivotal role youth-led initiatives can play in transforming the bioeconomy. They also represent the inspiring efforts of other youth around the world who have taken up the challenge to be changemakers and create the sustainable world they wish to live in.

The 13 case studies represent an array of youth bioeconomy initiatives across different sectors spanning a spectrum of industries, ranging from energy and consumer goods to bioherbicides, demonstrating the versatility of bioeconomy applications (overview Table 1). For example, Hemoalgae (Costa Rica) produces bioherbicides. Spora Biodesign Studios (Colombia) and Dharaksha Ecosolutions (India) and Biofase (Mexico) manufacture biopackaging materials. Nexus Power (India) produces biobatteries. Eco braids (Kenya) manufactures biodegradable hair braids, Ziada Solutions (Kenya) produces food for direct human consumption and Loop Pet Food (Kenya) create animal foods. SeaSkin (Morocco) specializes in luxury leather products, and SeGo Industries (Uganda) creates unique floor tiles.

All cases link to the agricultural domain with a conscientious use of sustainable resources. Utilizing crop residues, avocado seeds, rice and soybean husks and eggshells, these businesses emphasize a dedicated commitment to leverage renewable resources and utilize waste streams for the development of bio-based products. They also optimally utilize bio-based raw materials to manufacture several by-products. The incorporation of circular economy principles is notably evident in select cases, such as AfriCereal Group in Benin, Spora Biodesign Studios (Colombia), Chitosan in Egypt and Biofase in Mexico, where the focus lies on transforming waste materials, including organic waste and shrimp shells into valuable bio-based products.

Some of the initiatives also utilized local and indigenous inputs. The use of bamboo in the Bamboo Bicycle Initiative (Ghana) and banana stems by two Kenyan companies Eco Braids and Ziada Solutions reflects an alignment with local ecosystems and underscores a deliberate effort to integrate indigenous resources.

Geographically these initiatives span three regions with two initiatives originating from Asia (India – Nexus Power and Dharaksha Ecosolutions), three from Latin America (Mexico – Biofase; Colombia – Spora Biodesign Studio; Costa Rica – Hemoalgae), and eight from Africa (Benin – AfriCereal Group; Uganda – SeGo Industries; Kenya – Ziada Solutions, Eco Braids, Loop Pet Food; Morocco – SeaSkin; Ghana – Bamboo Bicycle Initiative; Egypt – Chitosan).

**Table 1. Overview of youth case studies by country, company/initiative, starting year, final products and bio-based raw materials**

	Country	Name of company/initiative	Starting year	Final product(s)	Bio-based raw materials
1	Benin	AfriCereal Group	2020	<ul style="list-style-type: none"> <li>• Organic fertilizers</li> <li>• Charcoal briquettes</li> <li>• Livestock feed</li> <li>• Bokashi (compost)</li> <li>• Biochar (green charcoal)</li> <li>• Mattresses</li> </ul>	<ul style="list-style-type: none"> <li>• Rice and soybean husks and fibres</li> </ul>
2	Colombia	Spora Studio	2023	<ul style="list-style-type: none"> <li>• Biodegradable packaging</li> </ul>	<ul style="list-style-type: none"> <li>• Flower waste,</li> <li>• Fungi</li> </ul>
3	Costa Rica	Hemoalgae	2016	<ul style="list-style-type: none"> <li>• Bioherbicides</li> </ul>	<ul style="list-style-type: none"> <li>• Photosynthetic organisms</li> </ul>
4	Egypt	Chitosan	2018	<ul style="list-style-type: none"> <li>• Chitosan (organic biopolymer) to produce organic pesticides, fertilizers, and other agricultural products</li> </ul>	<ul style="list-style-type: none"> <li>• Shrimp shells</li> </ul>
5	Ghana	Bamboo Bicycle Initiative	2009	<ul style="list-style-type: none"> <li>• Bicycles</li> </ul>	<ul style="list-style-type: none"> <li>• Bamboo</li> </ul>
6	India	Nexus Power	2020	<ul style="list-style-type: none"> <li>• Biobatteries</li> </ul>	<ul style="list-style-type: none"> <li>• Crop residues</li> </ul>
7	India	Dharaksha Ecosolutions	2020	<ul style="list-style-type: none"> <li>• Biodegradable packaging</li> </ul>	<ul style="list-style-type: none"> <li>• Crop stubble,</li> <li>• Fungi</li> </ul>
8	Kenya	Ziada Solutions	2022	<ul style="list-style-type: none"> <li>• Biogas</li> <li>• Flour</li> <li>• Fibre for basketry</li> <li>• Fertilizer</li> </ul>	<ul style="list-style-type: none"> <li>• Banana fruit and stems</li> </ul>
9	Kenya	Eco Braids	2022	<ul style="list-style-type: none"> <li>• Hair extensions</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Banana stems</li> </ul>
10	Kenya	Loop Pet Food	2021	<ul style="list-style-type: none"> <li>• Dog food</li> </ul>	<ul style="list-style-type: none"> <li>• Insects,</li> <li>• Food Waste</li> </ul>
11	Mexico	Biofase	2012	<ul style="list-style-type: none"> <li>• Bioplastic</li> </ul>	<ul style="list-style-type: none"> <li>• Avocado seeds</li> </ul>
12	Morocco	SeaSkin	2017	<ul style="list-style-type: none"> <li>• Leather products</li> </ul>	<ul style="list-style-type: none"> <li>• Fish skin</li> </ul>
13	Uganda	Sego Industries	2016	<ul style="list-style-type: none"> <li>• Floor tiles</li> <li>• Liquid fertilizer</li> </ul>	<ul style="list-style-type: none"> <li>• Eggshells, recycled plastic</li> </ul>

Source: Authors' own elaborations.

## 4 Common success factors

Success factors may vary depending on the country, industry, market, and specific local circumstances. These factors are what gives a business an edge over competitors, ready access to needed resources and connections that catalyse the growth of the business. The most common factors were extracted from the 13 cases spanning different countries, categorized and further examined to better understand their contribution to youth entrepreneurship, business growth and youth employment and engagement in the bioeconomy. Although these factors can benefit anyone operating within the bioeconomy, no matter their age, some factors addressed very specific challenges faced by youth. Challenges due to age and lack of experience and resources were overcome through access to education, skills building, incubator and mentoring programmes, and financing interventions targeted at youth. Other interpersonal challenges of self-confidence were overcome by youth agency as they embrace their value and worth as young men and women positively impacting the world.

In the publication, *Towards sustainable bioeconomy*, Gomez San Juan, Bogdanski and Dubois (2019) highlight success factors within the bioeconomy that correspond to topics from the Global Bioeconomy Summit definition of bioeconomy (IACGB, 2020). These categories are used to group the common success factors extracted from the youth case studies with one category added to include the innate personal abilities of young persons, **F. Youth power and agency**. Under each category the most common factor is highlighted as a subgroup and discussed in the following paragraphs.

### **A. The production, utilization and conservation of biological resources:**

1. Ready access to low-cost raw materials.
2. Circular bioeconomy.

### **B. Knowledge, science, technology, and innovation related to bioeconomy;**

1. Knowledge and education.
2. Innovation, research and development.

### **C. Tools and concepts to provide and manage information, products, processes and services across all sectors:**

1. Access to information.
2. Product diversification.

### **D. Stakeholder relations among different sectors:**

1. Good collaborations/partnerships.
2. Empowering local communities.

### **E. Strategies and policies aiming toward a sustainable bioeconomy:**

1. Access to finance.
2. Supportive policies.

### **F. Youth power and agency**

#### **A.1 READY ACCESS TO LOW-COST RAW MATERIALS**

This publication highlights youth champions who identified untapped resources and utilized them efficiently, sustainably and creatively. For instance, two Indian companies address the problem of waste from crop residues in vastly diverse ways. Nexus Power extracts protein and uses biomimicry to produce biodegradable batteries and Dharaksha Ecosolutions uses the crop residues as raw material to create sustainable packaging solutions. Others, active in the blue bioeconomy, use fish skins to produce luxury fashion products, or shells of shrimps to produce organic fertilizers and pesticides. In the forestry related bioeconomy, the Ghana Bamboo Bicycle Initiative focused on the use of bamboo in bicycle production. Similarly, Loop Pet Foods converts insects into valuable protein source

for animal feed production. The local waste resources are available at minimal or no cost and offer readily available raw materials at a cost advantage.

## **A.2 CIRCULAR BIOECONOMY**

Youth applied principles of circular bioeconomy to optimize the use of waste as raw materials. Spora Biodesign Studio was founded with the purpose to generate impact for people, planet and profit by applying circular systems thinking to design innovative solutions.

Some of the businesses produce multiple by-products which generate multiple income streams to diversify their businesses. Sego Industries in Uganda demonstrates the potential of recycling eggshells and polythene bags to create unique floor tiles, while exploring the potential of creating fertilizer from the by-product of the tile making process. Additionally, in the case of the AfriCereal Group, discarded fibres and husks left on the field after threshing and winnowing operations are collected to create several products such as organic fertilizers, feed, mattresses, compost and green charcoal. These examples emphasize the importance of aiming for product diversification and a wider target market to reduce risks and build resilience against shocks and competition.

## **B.1 KNOWLEDGE AND EDUCATION**

Access to education for the acquisition of expert and requisite knowledge in their field of interest was another key factor that enabled youth to succeed in the bioeconomy. The application of knowledge gained together with their innate creativity resulted in the creation of highly innovative products and solutions from biological resources.

The youth champions highlighted the value of education to gain a deeper understanding of the technologies and businesses they desired to create. From attaining degrees to enrolling in courses ranging from finance to nanotechnology, they all were able to access and benefit from some level of education that adequately equipped them with the basic principles of science, technology, engineering, and mathematics (STEM). The founder of Biofase holds both chemical and environmental engineering degrees while others such as Nikita and Nishita Baliarsingh, co-founders of Nexus Power, who are non-engineering graduates developed bio-batteries and learned about the technology from certification courses.

## **B.2 INNOVATION AND RESEARCH AND DEVELOPMENT**

All the stories showcased different forms of innovation from design of new products, change in existing processes to new ways of collaborating with partners. The capacity to innovate using the knowledge gained is a key success factor that created unique and high-quality bioproducts. For some products, such as the hemoalgae herbicide, copious investment and time for adequate research and development was required to refine the product. Being able to afford and facilitate the research and development was another success factor.

Munguia, founder of Biofase, applied his chemical and environmental engineering knowledge and experience to conduct extensive experiments with various raw materials which led him to avocado seeds. The robust research team lead by experienced scientist at Dharaksha Ecosolutions continue to refine their current process and explore other material uses of the mushroom metabolites to diversify the company's product offerings.

## **C.1 ACCESS TO INFORMATION**

There is a growing demand for bioproducts and more environmentally safe solutions to global pollution and other environmental challenges. The youth champions were able to tap into this demand and with an understanding of the customer and market they continue to grow their businesses. They accurately identified environmental and social issues, their target customers and created innovative solutions. For example, as reported by AfriCereal Group, they experienced significant turnover and growth when they targeted specific customers and implemented efficient post-harvest operations and distribution channels of liquid fertilizers.

## **C.2 PRODUCT DIVERSIFICATION**

Ziada solutions of Kenya adopted an integrated system producing multiple products from banana plants. The stems are fed into a decorticator which extracts the fleshy part leaving just the fibre which is dried and sold. The fleshy waste, also called pulp, is then fed into an anaerobic digestion system which converts the waste into biogas. That biogas is then used as a heat source to dry the fibre and banana fruits. The dried fruits are then milled and turned into flour using a solar milling machine and sold in the local market. With the integrated system they recycle, optimize by-products and combine the production of biogas, flour, dried stems and fertilizer. Again, this

is another example of smart enterprise decision-making to reduce costs on one hand and maximize returns and reduce risks by diversifying the products and end markets.

### **D.1 GOOD COLLABORATIONS AND PARTNERSHIPS**

Collaboration with organizations, government entities, and local communities played a crucial role in overcoming challenges, achieving success and enhancing visibility for the initiatives of youth within the bioeconomy. Strategic partnerships provided funding, resources, oversight and mentorship to the youth champions to enhance the impact of their businesses. Mentors and advisors can also play a crucial role in advising and guiding entrepreneurs through the complexities of their ventures.

SeaSkin Morocco would not have been able to expand their business and improve their product quality without partnering with experts in leather production. This company also established partnerships with restaurants and fish processing plants to secure a consistent supply of raw materials. Biofase in Mexico has a similar model through partnerships with avocado processing companies to secure a steady supply of avocado seeds to manufacture their bioplastics.

### **D.2 EMPOWERING LOCAL COMMUNITIES**

Involving and empowering local communities, particularly women and youth, can drive the success of bioeconomy initiatives. The involvement of the community in the production and promotion of bio-based products creates a sense of ownership and pride in the products, contributing to their success. The bio-business accrue great benefits to the communities through the provision of jobs and improvement in their standard of living.

The Ghana Bamboo Bicycle Initiative, for instance, partnered with women and youths from the community to create economic opportunities and promote gender equality. The collaboration with approximately 10 000 women contributed greatly to Chitosan Egypt's success. These women, waste collectors who collect shrimp shells were provided with additional economic opportunities while the company ensured a consistent supply of raw materials.

### **E.1 ACCESS TO FINANCE**

Lack of initial capital, ready access to funding to operate and scale businesses are major barriers for any start-up in any economy, especially for youth-led start-ups. Successful youth ventures in the bioeconomy were able to access funding and training from programmes and policy interventions which targeted youth, innovative ideas, and eco-businesses. The funds and training to support their growth were secured from investments from investors, collaboration with industry players to ensure a steady supply of resources and market penetration, fellowship grants and support from government and non-government organizations (NGOs) and tech incubation programmes.

The founders of Nexus Power were recipients of two fellowship grants from the Indian Government under its Technological Incubation and Development of Entrepreneurs (TIDE) and through the Kalinga Institute of Industrial Technology- Technology Business Incubator (KIIT TBI). These grants provided the necessary funding and support to start and expand their businesses through training and investments for necessary equipment and machinery, research and development, and initial operational costs.

AgriCereal received funding from the United States African Development Foundation (USADF) and technical support from the Actions for the Promotion of Community Initiatives (APIC NGO). Their first seed capital was obtained from the Tony Elumelu Foundation whose aim is the empower African Entrepreneurship with an emphasis on the Green Economy. In 2018, Narwal, the founder of SeaSkin was the recipient of USD 10 000 grant at the Africa Youth Conference which awards innovative youth-led African social entrepreneurs.

### **E.2 SUPPORTIVE POLICIES**

Incubator programmes were invaluable to the advancement of the business ventures and helped position many of the companies for future growth. The founders of Hemoalgae participated in incubator programmes such as TECEmprende Labs, Impact Hub San José, RebelBio, and the BlueBio Value Program which provided essential resources, mentorship, and networking opportunities. Additionally, the founders of AgriCereal Group attended incubator and accelerator programmes organized by FAO, the African Agribusiness Incubators Network (AAIN), University of Abomey-Calvi (UAC) "Uacstartup Valley", Etrilabs (*écosystème d'entrepreneurs créateurs de solutions*

*innovantes*) and Sèmè City (International city of innovation and knowledge flagship project by the Government of Benin).

### **E.3 AWARDS AND RECOGNITION**

Several of the youth-ventures received international recognition and support, which contributed to their success. Winning awards and challenge prizes for bio-based solutions not only boosted their reputation and confidence but also provided validation for their innovative solutions.

Dhupar, from Dharaksha Ecosolutions, was named by Forbes in 2018 one of the 30 under 30 social entrepreneurs and by the United Nations the 2018 Young Champion of the Earth for Asia and the Pacific Regions. The company was also recognized as one of the 30 Most Promising Startups of 2022. Narwal of SeaSkin was one of the three winners of the BeChangeMaker, an acceleration program for social entrepreneurship in 2019. Spora Biodesign Studio was awarded the Eco-Friendly Product Innovation in 2024 by Clean Cyclers at the House of Lords, United Kingdom of Great Britain and Northern Ireland.

### **F. YOUTH POWER AND AGENCY**

The innate ability of some youth to see a problem, conceptualize a solution and believe in themselves to develop a vision is a tremendous success factor. Being willing to try something different, challenge the norm and even fail at different attempts takes courage. These youth champions have demonstrated power, agency, self-confidence, creativity and dedication to engineer and manage innovative solutions to pressing environmental issues. They noted the invaluable soft skills they acquired and honed on their entrepreneurial journey. Skills such as effective communication, resilience, teamwork, problem solving, leadership, networking, time management and adaptability equipped them to be more tactical at making better decisions, negotiations and to navigate challenges.

In traditionally male-dominated sectors, such as agriculture, fisheries, and forestry as well as the investment environment, which are closely linked to the bioeconomy, women entrepreneurs face additional challenges. However, the determination and mindset of individuals like Shahira, the founder of Chitosan Egypt, or Nikita the co-founder of Nexus Power, allowed them to overcome gender-related challenges and demand equal opportunities which aided their success in the bioeconomy.

These six factors contributed to the success of youth in bioeconomy enabling them to overcome challenges and create sustainable and socially responsible businesses. Youth seeking to capitalize on opportunities in the bioeconomy face several barriers and can be propelled by these factors. The opportunities and barriers for youth employment and entrepreneurship in the bioeconomy are outlined in the technical study *Opportunities for youth in the bioeconomy* (Dietershagen and Bammann, 2023). This publication relays the situation analysis of youth in the bioeconomy and highlights factors that push and pull youth into the bioeconomy. Policymakers, practitioners and the private sector can further support youth to gain the requisite knowledge, competence and resources to increase their engagement in the bioeconomy.



## 5 Conclusions and recommendations

The youth in bioeconomy stories showcase impressive, innovative and sustainable solutions to tackle complex problems such as food waste, plastic pollution and the energy crisis. By leveraging their creativity and determination, these young leaders created innovative products that benefit both, the environment and society. The stories provide a small sample of youth-driven bioeconomy solutions and demonstrate the importance of strategic partnerships, collaborations and the application of circular bioeconomy principles. The creation of employment opportunities for local communities and other youth demonstrates the positive social impact of such ventures.

Despite the many challenges the youth champions faced, such as lack of funding, regulations, and lack of market access, they demonstrated great tenacity and ingenuity leveraging technology to drive positive change. Their self-agency is a major contributing factor to their success which bolstered by other factors such as access to education, mentor and incubator programmes and funding for bio-based businesses. These factors enabled them to find resources, be resourceful and persist with their mission. The case studies demonstrated that targeted policies geared towards youth and the development of businesses within the bioeconomy increases the success rate. However, as noted by the youth champions additional support can be facilitated by programmes, stakeholders and decision-makers to provide greater access to funding, resources, training and better regulations for youth to capitalize on other existing opportunities.

It would be prudent for policymakers to prioritize youth-led approaches, promote sustainable practices and develop policies and frameworks that create or stimulate greater demand for bio-based products to encourage local production instead of relying heavily on imports. More emphasis can be placed on educating retailers, value chain actors and raising public awareness of the bio-based products as solutions to some of the planet's pressing environmental pollution issues, such as plastic waste. These initiatives can be coupled with incentives like tax exemptions for businesses that embrace sustainable practices and the provision of resources and funding that specifically support youth-led initiatives. Investing in education, skills and capacity building can help foster an environment conducive to innovation among youth who recognize the potential for leveraging natural resources sustainably towards achieving positive outcomes, both environmentally as well as economically. Adequate funding mechanisms such as grants or impact investments could help scale youth-led operations while creating employment opportunities within communities and contribute positively towards environmental conservation efforts globally through more efficient utilization of natural resources.

Recommendations for future support to youth champions were captured during the information gathering phase where informants were asked, based on their experiences to make specific recommendations to policymakers to better support youth in the bioeconomy. Table 2 lists recommendations and highlights the policies required to facilitate a better enabling environment for their success. The needs of youth in the bioeconomy are well summed up by Luis Barboza of Hemoalgae who notes:

In essence, policymakers should strive to create an ecosystem that nurtures youth involvement in the bioeconomy. By providing access to education, funding, mentorship, and resources while simplifying regulatory processes, they can empower young innovators to drive sustainable change and contribute to the growth of the bioeconomy (L. Barboza, personal communications, 2023).

**Table 2. List of recommendations from the youth champions to policymakers**

Youth bio-business	Recommendation to policymakers
<b>Benin – AfriCereal Group</b>	<ul style="list-style-type: none"> <li>• To encourage youth participation in the bioeconomy, policymakers should create an enabling ecosystem by investing in education and vocational training for young people, facilitating access to financing, and supporting entrepreneurial initiatives. Awareness programmes about the opportunities offered by the bioeconomy should be implemented, highlighting successful examples.</li> <li>• Additionally, public-private partnerships should be encouraged to promote innovation, research, and technological development in this field, while also promoting policies that facilitate access to raw materials and markets for young entrepreneurs.</li> </ul>
<b>Colombia – Spora Biodesign Studio</b>	<ul style="list-style-type: none"> <li>• Foster an enabling environment: Create policies and regulations that promote sustainable practices and incentivize innovation in the bioeconomy sector. Provide support and resources for young entrepreneurs and startups.</li> <li>• Facilitate collaboration and knowledge sharing: Establish platforms and programmes that encourage collaboration between young individuals, universities, research institutions, and industry experts. Foster a culture of knowledge-sharing and learning.</li> <li>• Provide financial support: Offer grants, funding opportunities, and incubator programmes specifically tailored to the needs of youth in the bioeconomy sector. This can help overcome financial challenges and support the growth of innovative startups.</li> </ul>
<b>Costa Rica – Hemoalgae</b>	<ul style="list-style-type: none"> <li>• Access to education and training: Develop educational programmes that offer specialized training in biotechnology, agriculture, and related fields. Provide scholarships and grants to make these programmes more accessible to young students, enabling them to gain the necessary skills and knowledge.</li> <li>• Funding and grants: Establish funding mechanisms specifically tailored to young entrepreneurs in the bioeconomy. Offer grants, low-interest loans, or equity-based financing to help them overcome financial barriers associated with research, development, and scaling up.</li> <li>• Access to resources: Ensure that young innovators have access to research facilities, labs, and equipment. This could involve partnerships between universities, research institutions, and startups to share resources.</li> <li>• Regulatory support: Streamline regulatory processes for bio-based products and technologies, making it easier for young entrepreneurs to navigate complex regulations and get their products to market faster.</li> <li>• International collaboration: Encourage international collaboration and exchange programmes. This exposure can broaden the horizons of young innovators, allowing them to learn from global best practices and expand their networks.</li> <li>• Awareness and outreach: Promote awareness about the bioeconomy and its potential among youth. Organize seminars, workshops, and events to inspire young minds and encourage them to explore opportunities in this field.</li> <li>• Sustainability focus: Emphasize the importance of sustainability and environmental responsibility in bioeconomy endeavours. Encourage youth to develop solutions that address pressing global challenges, such as climate change and resource conservation.</li> <li>• Networking platforms: Create networking platforms and forums where young entrepreneurs can connect with industry experts, potential collaborators, and investors. These platforms can facilitate knowledge sharing and partnership building.</li> <li>• Support for failure: Acknowledge that failure is part of the entrepreneurial journey. Offer resources and counselling to help young entrepreneurs rebound from setbacks and continue their efforts.</li> <li>• Incubation and mentorship: Create and support incubators and accelerators that focus on biotech and bioeconomy startups. These programmes should include mentorship components, connecting young entrepreneurs with experienced professionals who can guide them in navigating challenges and making informed decisions.</li> <li>• For future incubator programmes, policymakers can diversify support services, offering flexible funding options, and promoting international exposure for startups. Robust mentorship networks, collaborative workspaces, and outcome-focused metrics are essential. Post-incubation support, industry-specific tailoring, and feedback collection enhance program effectiveness. Public-private partnerships and inter-sectoral collaboration foster a resource-rich ecosystem.</li> <li>• Additionally, policymakers should prioritize intellectual property (IP) support, including IP education, access to experts, strategy development, IP management tools, and funding initiatives. This empowers startups to protect their innovations, nurture creativity, and</li> </ul>

Youth bio-business	Recommendation to policymakers
	secure IP assets. In summary, policymakers should create adaptable, inclusive, and industry-specific programmes with a focus on mentorship, international engagement, measurable outcomes, and robust IP support.
<b>Kenya – Eco braids</b>	<ul style="list-style-type: none"> <li>• Initiatives such as local production of eco braids from banana stems waste can be encouraged by offering initiatives such as tax exemptions.</li> <li>• Provide easy access to Target savings, impact investments and credit financing to upcoming youth innovators can also.</li> <li>• To assist with the fight against unemployment youth can be encouraged to embrace sustainable innovation and research.</li> <li>• Establishment of incubation centres in rural areas so that youths who are jobless and have great ideas can be rehabilitated there to avoid drug abuse and crime.</li> <li>• Address challenges within agricultural value chain and promote environmental conservation, resource efficiency and long-term viability.</li> </ul>
<b>Kenya – Loop pet food</b>	<ul style="list-style-type: none"> <li>• Natural resources are not free. Therefore, there should be a movement and push by policymakers to move industry towards sustainable practices to ensure that we can continue to benefit from our natural environment. It is time to rethink the way that things have always been done. We are so privileged to live in an age of limitless information and the ability to connect with people all around the world so let us leverage this and start asking people how they would like their lives to be so that we can create solutions with them at the core.</li> </ul>
<b>Kenya – Ziada Solutions</b>	<ul style="list-style-type: none"> <li>• Policies geared towards educating youth on various aspects of the bioeconomy, such as, accounting, agricultural practices and circular bio economies can be initiated.</li> </ul>
<b>Uganda – Sego Industries</b>	<ul style="list-style-type: none"> <li>• Develop adequate national bioeconomy policies and frameworks that create demand for bio-based products, guide investments and allow for government intervention aimed at making it easier for youth to scale their businesses. Also, government can drive innovations through competitions that provide funding.</li> </ul>

Source: Authors' personal communications with youth champions.

There is a need for more knowledge-sharing platforms to facilitate knowledge exchange and to disseminate information on best practices within the bioeconomy. Organizations active in the bioeconomy can explore ways to support youth-led start-ups through the provision of necessary resources, knowledge sharing platforms and capacity building programmes. Youth can also benefit from advice from other youth at different stages of their business as well as from seasoned entrepreneurs operating successful bio-based businesses. The research also captured words of wisdom and encouragement from the youth champions to other aspiring young people engaging or desiring to engage in the bioeconomy (Table 3).

Funding is a major challenge for businesses within or outside of the bioeconomy and this is no different for youth-led businesses that face additional challenges. There is therefore a need to explore and diversify funding sources to ensure the sustainability of youth initiatives. The private sector and investors active in the bioeconomy can support these innovations by employing young minds, doing business with youth-led enterprises or invest in their solutions. Public-private partnerships can also be a powerful tool in scaling up bioeconomy youth initiatives worldwide by providing access to capital and resources needed for innovation.

**Table 3. Advice from youth champions to other aspiring youth already in or desiring to enter the bioeconomy**

Youth bio-business	Advice for other youth
<b>Colombia – Spora Biodesign Studio</b>	<ul style="list-style-type: none"> <li>Stay committed to sustainability: Uphold your company's sustainability values, even when facing challenges. Innovative and sustainable solutions often emerge during moments of adversity.</li> <li>Stay informed and connected: Stay updated with the latest advancements, research, and technologies in the bioeconomy sector. Attend conferences, workshops, and seminars to expand your knowledge.</li> <li>Build a strong network within the industry and collaborate with like-minded individuals and organizations. Be flexible and adaptable: Be ready to pivot and adapt your strategies as new challenges and opportunities arise. Flexibility is key in an evolving sector like the bioeconomy.</li> </ul>
<b>Costa Rica - Hemoalgae</b>	<ul style="list-style-type: none"> <li>Knowledge is key: Invest in education and stay updated on bioeconomy trends and technologies. Also, understand the market needs - without a market, there is no business.</li> <li>Network and collaborate: Build a strong professional network and seek collaborations for innovative solutions.</li> <li>Business acumen: Develop business skills alongside scientific expertise to translate ideas into viable products.</li> <li>Seek funding: Explore funding sources and opportunities to support your bio-based initiative</li> </ul>
<b>Kenya – Eco Braids</b>	<ul style="list-style-type: none"> <li>Identify opportunities near you and try to solve problems in the society through sustainable innovation.</li> <li>Youths should take up the agricultural sector and capitalize on the food value addition which some presents a virgin market with limited competition.</li> <li>We need more youth innovators working with agricultural waste to produce other useful products that are environmentally friendly and of higher economic value.</li> </ul>
<b>Kenya – Loop pet food</b>	<ul style="list-style-type: none"> <li>If you have passion and a great idea, don't give up! It is not easy but it is worth it! Also, ask for help! You don't have to do it alone.</li> </ul>
<b>Kenya – Ziada</b>	<ul style="list-style-type: none"> <li>Solutions start small, research a lot and create working concepts that can be used to educate people and expand in the future.</li> </ul>
<b>Uganda – Sego Industries</b>	<ul style="list-style-type: none"> <li>Embrace innovation and businesses in the bioeconomy sector. Our future is in sustainability and circular economy if we are to have a better world.</li> </ul>

Source: Authors' personal communications with youth champions.

Several of the successful enterprises in the bioeconomy are started and managed by young women. It is essential that we recognize young women entrepreneurs who have demonstrated their potential in leading successful initiatives in this field despite facing numerous barriers along their journey towards success. Their contribution is invaluable and targeted support can be tailored for young women to encourage more female engagement in the bioeconomy. Such support will be particularly valued and relevant in countries where females face additional social and economic barriers.

The successful youth-led solutions showcased in this publication demonstrate the great potential of youth to be a driving force for change and creation of innovative bioproducts and services required for the transition from a fossil based to bio-based economy. Through replicating successful models in other regions while staying committed to the mission of sustainability and resource optimization, more responsible bioeconomy-based production systems beneficial to everyone can be fostered.

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## Annexes

### Annex 1. Youth case stories

Detailed discussion of each youth case story is presented in this annex to complement the brief outline and short descriptions of the 13 cases noted in Chapter 3.

**Table A1. Overview of youth case studies by country, company/initiative, starting year, final products and bio-based raw materials**

	Country	Name of company/initiative	Starting year	Final product(s)	Bio-based raw materials
1	Benin	AfriCereal Group	2020	<ul style="list-style-type: none"> <li>• Organic fertilizers</li> <li>• Charcoal briquettes</li> <li>• Livestock feed</li> <li>• Bokashi (compost)</li> <li>• Biochar (green charcoal)</li> <li>• Mattresses</li> </ul>	Rice and soybean husks and fibres
2	Colombia	Spora Studio	2023	<ul style="list-style-type: none"> <li>• Biodegradable packaging</li> </ul>	Flower waste, fungi
3	Costa Rica	Hemoalgae	2016	<ul style="list-style-type: none"> <li>• Bioherbicides</li> </ul>	Photosynthetic organisms
4	Egypt	Chitosan	2018	<ul style="list-style-type: none"> <li>• Chitosan (organic bio-polymer) to produce organic pesticides, fertilizers, and other agricultural products</li> </ul>	Shrimp shells
5	Ghana	Bamboo Bicycle Initiative	2009	<ul style="list-style-type: none"> <li>• Bicycles</li> </ul>	Bamboo
6	India	Nexus Power	2020	<ul style="list-style-type: none"> <li>• Biobatteries</li> </ul>	Crop residues
7	India	Dharaksha Ecosolutions	2020	<ul style="list-style-type: none"> <li>• Biodegradable packaging</li> </ul>	Crop stubble, fungi
8	Kenya	Ziada Solutions	2022	<ul style="list-style-type: none"> <li>• Biogas</li> <li>• Flour</li> <li>• Fibre for basketry</li> <li>• Fertilizer</li> </ul>	Banana fruit and stems
9	Kenya	Eco Braids	2022	<ul style="list-style-type: none"> <li>• Hair extensions</li> </ul>	Banana stems
10	Kenya	Loop Pet Food	2021	<ul style="list-style-type: none"> <li>• Dog food</li> </ul>	Insects, food waste
11	Mexico	Biofase	2012	<ul style="list-style-type: none"> <li>• Bioplastic</li> </ul>	Avocado seeds
12	Morocco	SeaSkin	2017	<ul style="list-style-type: none"> <li>• Leather products</li> </ul>	Fish skin
13	Uganda	Sego Industries	2016	<ul style="list-style-type: none"> <li>• Floor tiles</li> <li>• Liquid fertilizer</li> </ul>	Eggshells, recycled plastic

Source: Authors own elaboration.

#### 1. BENIN - BIOPRODUCTS FROM RICE AND SOYBEAN WASTE

**Situation/problem overview:** The fibres and husks generated from the threshing and winnowing of rice and soybean were often dumped in the fields, resulting in both waste and environmental pollution. As a solution to this issue, one of the founders of the **AfriCereal Group**, Steve Hoda, realized the potential of creating various bio-products from the waste material.

The AfriCereal Group, a company in Benin, is a service provider that supports 10 000 small farmers and agricultural stakeholders through the provision of threshing and winnowing services for rice and soybean. They

also provide workshops and training courses to farmers on rice hulling, cultivation, parboiling and other aspects of production and processing. All their 15 employees are youth within the ages of 20–35 years old.

**Innovation:** AfriCereal Group capitalized on the opportunity to create several bioeconomy side income streams from their core winnowing and threshing services. The waste fibres and husks are collected or bought back from the farmers as a raw material to manufacture bio-products. Examples of these bio-products include, organic fertilizers, charcoal briquettes, livestock feed, bokashi (compost), biochar (green charcoal) and even used to produce mattresses. AfriCereal has a competitive edge over other companies sourcing the same raw materials as they have direct access to the waste that is used as (input for their products). They collect it at no cost or at a very low price when it is most fresh, which is important for the quality of the final products.

**Challenges and successes:** After the failure of Steve Hoda's first business he took the lessons learned and build his business management skills through trainings and teamed up with four other youth to establish their current company, the AfriCereal Group in 2020. The company built their core business skills through participation in trainings, incubator and accelerator programmes offered by FAO and the African Agribusiness Incubators Network (AAIN); University of Abomey-Calvi (UAC) "Uacstartup Valley", *Etrilabs (écosystème d'entrepreneurs créateurs de solutions innovantes)* and Sèmè City (International city of innovation and knowledge flagship project by the Government of Benin).

The company also maximized opportunities from available donor support and have been accountable and responsible ensuring continuous funding. They received funding from the United States African Development Foundation (USADF) with technical support from the Actions for the Promotion of Community Initiatives (APIC NGO). The Netherlands Development Organisation (SNV) supported them in the soy sector and the German Agency for International Cooperation GmbH (GIZ) continues to support them through technical assistance and networking. Their first seed capital was obtained from the Tony Elumelu Foundation and the Warys Expertise firm has been assisting and guiding them from the beginning with the certification of their accounts. Various individuals also acted as mentors and were crucial in the company's journey to success.

Through perseverance and educating farmers about the benefits of their practice's farmers relinquished their resistance to change from traditional agricultural practices and the services of AfriCereal were more readily accepted. Other factors that contributed to the companies' growth, were successful customer targeting, go-to-market strategy, a good match between the start-up team members, and making the right connections. The overall turnover increased by 4 000 percent between the year 2020 and 2022. The turnover for their post-harvest operations and distribution of liquid fertilizers to rice, maize, soybean and cashew producers by 400 percent between 2021 and 2022. The workforce has increased from five workers in 2020 to 15 workers in 2023. For the bioeconomy side-income streams, 1 000 litres of organic fertilizers and 100 kg of briquettes were produced on a trial basis in 2022.

**Potential for scaling:** The demand for their services and products are constantly growing. The company currently operates in North, Central and South Benin, and recently launched in the Democratic Republic of Congo. They also signed a partnership agreement with the National Society of Agricultural Mechanization of Benin to serve more producers.

With such growth, the company sees great potential to develop and expand their business across Africa and beyond the continent. With an app which currently acts as an online marketplace, they plan to set up a traceability feature for the agricultural products and also products processed from cereals by large firms around the world. "For this to happen, we need partners in the countries where we want to be. Our strategy for entering a country is to go through a local partner" (S. Hoda, personal communication, 2023). To replicate and scale-up these innovative practices across the continent, good education, funding, and support are essential.

**Success factors:**

- Perseverance to re-start and learn from failures and mistakes.
- Diversification of business (core business: machinery and /harvesting services and extension to farmers; other business: processing by-products into bio-fertilizer and briquettes, dry toilet sales etc.).
- Valuable learning and experiences through incubator, accelerator and mentorship opportunities.
- Smart use of available donor support – being accountable and responsible for continuous funding.

- Successful customer targeting and go-to-market strategy (educating farmers).
- Use of technology - app / online marketplace.



**Members of the AfriCereal group during one of their farmer education activities.**

© AfriCereal Group

## 2. COLOMBIA – MYCELIUM-BASED PRODUCTS AND MATERIALS FROM AGRICULTURAL WASTE

**Situation/problem overview:** **Spora Biodesign Studio**, is a women-led start-up in Colombia which aims to tackle the pressing issues of waste generation and disposal, inefficient resource use, and the lack of sustainable alternatives. Recognizing the need to tackle these challenges and wanting to help drive change through innovation rather than incremental change, Spora Biodesign Studio saw the potential of fungi to generate systematic change. The team is harnessing the power of fungi to create circular and home compostable materials that can be used in a range of industries from product packaging, construction, architecture, interior design to textiles.

The company was founded with the purpose of “designing innovative solutions using circular systems thinking that generate triple impact: people, planet and profit” (C. Cruz, personal communication, 2023). Spora believes in co-creating with nature and applying the natural architecture system to solve human needs and requirements. Their first solution offers a material that can help reduce our reliance on plastics, primarily single use plastic, by using their mycelium-based material for product packaging.

**Innovation:** Spora Biodesign Studio's innovative lab-tested solution mixes local agro-industrial waste with fungal spores to create mycelium-based materials (MBm) and mycelium-based products (MBp) which are “co-designed with nature”. These products are sustainable non-plastic alternatives to animal and petroleum-based materials like expanded polystyrene, carton, polyethylene terephthalate (PET) and others. Spora’s MBm breaks down in less than 90 days and its building blocks are fully re-incorporated in the natural environment without harm.

The company has successfully grown mycelium materials from several local agro-industrial waste streams including, rice husks, flower stems, coconut fibres, sugarcane bagasse, coffee grounds and hemp. Mycelium acts as



a natural binder of the organic waste and the result is a natural polymeric composite fibrous material with a white foamy look and velvet feel. Throughout the manufacturing process the remarkable bioremediation capabilities of the fungi species are utilized. The mycelium effectively breaks down chemical pollutants commonly found in agro-industrial waste, such as flower stems successfully used by the company to grow their mycelium-based material (MBm). Spora Biodesign Studio has demonstrated that the mycelium network growth efficiently decomposes chemical compounds found in pesticides, serving a dual purpose of waste repurposing and removal of harmful residues.

As part of their business model, the women also created the “my-factory in situ” for companies that want to integrate mycelium-based products (MBp) directly on site into their supply chain. For example, a drink and brewing company can produce its own six-pack holder packaging in situ from its brewer's spent grain (BSG) organic waste. They plan to establish such partnerships with companies to repurpose their waste locally and efficiently.

The company wants to continue driving innovation through circular design and system thinking, growing their solutions portfolio through various products and services.

**Challenges and successes:** Introducing novel biomaterials to existing industries and showing the added value is a challenge. Spora Biodesign Studio overcomes such challenges by educating the local community and potential customers about the advantages and unique properties of mycelium-based materials and recycling waste to gain market acceptance. This requires building trust relationships to demonstrate the win-win solution as well as bringing market-ready solutions that can be price competitive.

Testing different substrates and cultivating mycelium-based materials required experimentation and research to optimise the process. By having access to the biology laboratory facilities at the universities graduates attended, Spora Biodesign Studio was able to invest time and effort in developing the necessary expertise. They also initiated collaborative projects with universities and actively engaged young individuals within their team. This allowed them to leverage diverse expertise and foster creativity and innovation.

To improve marketing and networking, they actively participate in local design and architecture fairs, collaborate with like-minded companies, and utilize digital platforms to raise awareness about their products. The company received recognition for their endeavours and was recently awarded the Eco-Friendly Product Innovation in 2024 by Clean Cyclers at the House of Lords, United Kingdom of Great Britain and Northern Ireland.



**Sample of the versatile mycelium - based material (MBm).**

© Spora Biodesign Studio

**Potential for scaling:** The start-up is currently at an early pre-seed stage and envisions a dynamic path for growth and diversification. Spora Biodesign Studio intends to scale its sales in 2024 and desires to increase product and material knowledge in the general public. Their initial sales strategy focuses on three verticals:

1. Limited edition “capsule” collections with luxury retail partners where they will develop a unique product package design for their products;
2. “MySpora Growth Kits” for individual and educational institutions to experience firsthand the process of growing the material (this allows the company to share knowledge about mycelium, hoping to grow the discussions surrounding fungi and all its web of possibilities) and;
3. Specific purchase orders where Spora Biodesign Studio can help co-create final products for clients such as architectural firms, interior design firms, sole individuals and event planners.

Given the properties of the mycelium-based materials, the business has the potential to provide solutions to address different major industry waste streams such as coffee grounds, sugar cane, rice husks and coconut. They also plan to integrate mycelium-based materials into various applications across different markets. Their goals include revolutionizing packaging, making an impact in the fashion industry, enhancing interior design, and exploring art and education opportunities. By collaborating, partnering, and investing in research and development, they aim to foster sustainable innovation and expand their reach.

**Success factors:**

- Commitment to sustainability in challenging circumstances: upholding sustainability values, is crucial for long-term success in the bioeconomy sector - adversity often leads to innovative and sustainable solutions.
- Continuous learning and networking (staying updated with advancements, research, and technologies within the bioeconomy sector is essential).
- Building a strong network and collaborating with like-minded individuals and organizations fosters innovation and growth.
- Flexibility and adaptation: being ready to pivot and adapt strategies as new challenges and opportunities arise.
- Awarded the Eco-Friendly Product Innovation in 2024 by Clean Cyclers at the House of Lords, United Kingdom of Great Britain and Northern Ireland.

### 3. COSTA RICA - BIOHERBICIDES FROM PHOTOSYNTHETIC ORGANISMS

**Situation/problem overview:** Inspired by the global trend of glyphosate bans, the founders conceived the idea of a Bioherbicide, marking a transformative shift towards sustainable agriculture to tackle the excessive use of agrochemicals in Costa Rica.

In 2016, the journey of **Hemoalgae** commenced after the founders participated in a competition at the Technological Institute of Costa Rica. Initially aiming to create a natural pharmaceutical, the team shifted focus due to challenges in commercialization. In the words of Luis Barboza, 28, co-founder of Hemoalgae, “This transformational moment marked our shift towards sustainable agriculture, driven by the belief that nature's solutions can mitigate the harmful impacts of conventional farming practices.”

**Innovation:** Hemoalgae harnesses the properties of photosynthetic organisms to develop high value eco-friendly compounds and bioherbicides from microalgae. The company uses biotechnology and synthetic biology to create tailored solutions for specific applications, setting them apart from one-size-fits-all alternatives. The natural origin and sustainable production process makes the products unique and gives a distinctive edge over conventional alternatives.

To address the escalating demand for green agricultural solutions, the company cultivates the primary raw material (photosynthetic organisms) in house. This ensures a consistent supply and reduces production costs with raw material costs as low as USD 2 per litre of finished product.

With the adoption of a vertical integration business strategy the company maintains control over the supply chain which affords them to offer competitive prices in the marketplace. The company also benefits from strategic

partnerships which plays a pivotal role in facilitating market entry and rapid adoption. Collaborations with established agricultural distributors provide essential market knowledge and creates robust distribution networks.

**Challenges and successes:** Securing funding to finance the startup of the biotechnology company was one of the main challenges Hemoalgae faced. This was further compounded by a lack of financial support from both government and private investors in the Latin American biotechnology sector, particularly within agriculture. The company overcame these challenges by seeking external partnerships outside of Costa Rica. For example, the collaborations with global businesses with both capital and market understanding, provided essential financial support and valuable market insights. In 2017, Hemoalgae secured USD 100 000 in pre-seed funding which marked a significant milestone towards economic viability. The company is currently in its early stages and is yet to achieve profitability. Its initial investments are strategically directed towards research, development, production setup, and forming crucial partnerships for future success.

Experiences gained through participation in incubator programmes to propel entrepreneurial ventures and strengthen the business sector in Costa Rica (TEC Emprende Labs and Impact Hub San José), and government-funded programmes provided access to resources, mentorship, and non-refundable grants supporting research and development efforts. These programmes provided guidance to refine business plans, develop prototypes, and connect with collaborators and investors globally. International exposure through programmes like RebelBio (the world's first early-stage life sciences accelerator) in Ireland and the BlueBio Value Program (a business accelerator dedicated to the blue bioeconomy) in Portugal expanded Hemoalgae's network and positioned them for future growth in the bioeconomy sector.

The highly educated students of the biotechnology engineering program from the Costa Rica Institute of Technology also cultivated crucial soft skills along their entrepreneurial journey which have significantly contributed to their progress and success. These include adaptability, effective communication, resilience, teamwork, problem-solving, leadership, networking, and time management. The youthful and motivated team brought their enthusiasm and fresh perspectives to the business to create innovative products.

**Potential for scaling:** Hemoalgae is currently not engaged in active sales, but its focus is directed on setting up a production facility with an annual capacity of four million litres of bioherbicide. Focusing on the vibrant Central American agricultural sector, the immediate objective is to carve a niche as a premier provider of eco-friendly herbicides.

Future plans include expanding operations into international markets, starting with South America and progressing to North America. This expansion is envisioned through strategic partnerships with well-established agricultural companies and distributors. Leveraging their market presence, credibility, economies of scale, and marketing expertise, Hemoalgae aims to expedite its market penetration. This collaborative approach allows the company to concentrate on product development while entrusting experienced partners with the effective distribution and marketing of its innovative products.

Financially, Hemoalgae sustains its business operations through a diversified approach. For daily expenditures and prudent cash flow management, the company relies on a mix of revenue streams, including grants, research collaborations and funds sourced through equity investment. These funds are used to cover ongoing operational costs, encompassing essential components such as employee salaries, research materials, and administrative expenses. For capital-intensive endeavours and larger-scale projects, Hemoalgae strategically seeks external funding from investors who share the company's visionary outlook and understand the long-term potential of its biotechnology solutions. This infusion of capital plays a pivotal role in supporting key initiatives such as the scaling up of production facilities, extensive research and development endeavours, and the broadening of the company's market reach.

Hemoalgae's long-term vision is to become a recognized player in the global bioeconomy sector. This includes contributing to sustainable agriculture practices and making a positive impact on environmental conservation. The company believes that its innovative approach and commitment to ecological solutions will drive growth and success in both existing and new markets.

**Success factors:**

- A youthful and motivated team.
- Uniqueness.
- Highly educated students.
- Production of own raw materials.
- Strategic partnerships for distribution and sales.
- Participation in incubator programmes.
- Utilization of biotechnology and synthetic biology.

#### 4. EGYPT - ORGANIC FERTILIZERS AND PESTICIDES FROM SHRIMP SHELLS

**Situation/problem overview:** The cultivation of organic produce is perceived by most farmers as expensive, resource intensive and risky with lower yields and revenue. With their product offering of organic fertilizers and pesticides **Chitosan Egypt** is working to change this perception. The company aims to address several challenges in the agriculture sector, such as waste management, unsustainable agricultural practices, and the need for organic and environmentally friendly alternatives.

Shahira Yahia is the Chief Marketing Officer and Co-Founder of Chitosan, a biotechnology start-up, founded in 2018 in Egypt. Chitosan specializes in using local waste, particularly shrimp shells, to extract chitosan, an organic biopolymer, to produce organic pesticides, fertilizers, and other agricultural products. When compared to conventional chemical ones, according to the company, their products cost less and are more efficient with a yield increase of 44 percent and 7.3 percent return on investment (ROI) to farmers.

**Innovation:** Chitosan Egypt's innovation is its ability to valorise agricultural and food waste, specifically shrimp shells, to produce chitosan-based agricultural fertilizers and pesticides. By utilizing a circular bio-based approach, Chitosan Egypt transforms waste materials that would otherwise be discarded or underutilized into valuable products for agricultural applications. This innovative approach not only reduces waste and environmental pollution but also supports regenerative, circular agricultural systems by returning unused nutrients back into the agricultural cycle.

The extraction process involves a series of environmentally conscious steps. First, the shrimp shells, which would typically be discarded, are collected from local sources. Then, utilizing energy-efficient methods, including room temperature processes, Chitosan extracts chitosan from these shells through deproteinization, demineralization, and discoloration. With 240 industrial applications, chitosan is regarded as one of the most versatile, natural polymers and is increasingly used in a wide variety of agricultural products and medical drugs.

**Challenges and successes:** Developing a scalable and sustainable business model that addresses both shrimp waste management and the increasing demand for organic agricultural solutions was the main challenge Chitosan Egypt faced. The company successfully identified and targeted pain points in the market, such as the need for organic and residue-free agricultural products.

Establishing partnerships and collaborations with local stakeholders, waste collectors, and certified laboratories contributed to the success of Chitosan Egypt. The involvement of approximately 10 000 women who collect shrimp shells, plays a vital role in the success of the initiative. Their participation ensures a consistent supply of raw material and provides economic opportunities for waste collectors.

The company's focus on research, quality control, and meeting international standards, as demonstrated by EU-approved ingredients and certifications, ensures credibility and market acceptance. Its in-house laboratory and collaboration with leading certified laboratories ensure the production of high-performance chitosan-based biofertilizers and biopesticides.

The company received recognition for its work and was the first-place winner at the Middle East and North Africa (MENA) Vested Summit 2019. They also received the 1st place prize at the Innovating for Fayoum GESR Social Innovation Challenge.

On a personal level, Shahira had to overcome several challenges in the traditionally male-dominated sector that Chitosan Egypt operates in. Her tenacious and resilient mindset backed by determination propelled her forward to demand and own her seat at the table.

**Potential for scaling:** Chitosan Egypt has shown immense potential for scaling its operations beyond Egypt and into other Middle Eastern markets. With its successful business model Chitosan has gone from EGP 10 to 47 million market valuation within a year and positioned itself for further expansion. The demand for organic and environmentally friendly agricultural solutions provides opportunities to replicate their model in other countries. Potential markets, such as Saudi Arabia, hold promise for Chitosan Egypt's products and services.

**Success factors:**

- Meeting market demand.
- Innovative circular bio-based approach.
- Collaboration with local stakeholders.
- Acquiring international standards and certifications.

## 5. GHANA - BICYCLES FROM BAMBOO

**Situation/problem overview:** Ghana Bamboo Bicycle Initiative addresses the lack of affordable and eco-friendly transportation in Ghana. This problem has a significant impact on the environment, as well as on the mobility and economic opportunities of the population. The traditional modes of transportation in Ghana are either too expensive or environmentally unsustainable.

The Ghana Bamboo Bicycle Initiative is a women-led enterprise that promotes eco-friendly transportation and empowers women and youth through employment and training opportunities. The initiative was founded in 2009 by Bernice Dapaah and has since then employed more than 35 women and youth in the Ashanti Region of Ghana. The company is solely managed by women, and together with Bernice they have trained over 150 youth on bicycle frame building and assembly. The enterprise has gained recognition for its environmental and social impact, as well as for its innovative use of bamboo as a sustainable material for bicycle production. More than 50 percent of the employees in the company are women, and for every bike sold, the company donates one to a schoolchild, which helps the child save time traveling to school.

**Innovation:** Bamboo is a sustainable material for bicycle production. It is stronger than steel, cheaper than conventional material, and the frame is completely recyclable. For every bamboo plant that is cut down to make a bike, Ghana Bamboo Bikes Initiative plants ten more, which makes it an abundant and renewable resource. Additionally, promoting the use of bicycles reduces the carbon footprint of transportation.

**Challenges and successes:** The Ghana Bamboo Bicycle Initiative faced several challenges in its early years, including limited access to funding and resources, low market demand, and cultural biases against women in leadership roles. Despite the initial slow growth of the enterprise, the initiative's success in creating an eco-friendly and socially responsible enterprise has attracted international recognition and support such as the World Entrepreneurship Award or the Dubai International Award for Best Practice to Improve the Living Environment among many others.

The focus on community engagement in the production and promotion of bamboo bicycles strengthened the Ghana Bamboo Bicycle initiative and created a sense of ownership and pride in the product. The training and employment of women and youth also created economic opportunities and promoted gender equality.

**Potential for scaling:** The initiative's focus on empowering women and youth also highlights the potential for inclusive and equitable economic growth. The initiative's success has attracted interest from other countries and has the potential for replication and scaling in other communities facing similar challenges. The Ghana Bamboo Bicycle Initiative has a positive impact on the environment, the community, and the economy. The initiative also promotes sustainable transportation and has created employment and training opportunities for women and youth, contributing to the development of their skills and economic empowerment. The initiative's success has also raised awareness of bamboo as a sustainable material for other products and industries. Working towards

expanding their market, the company will focus on increasing its marketing efforts and collaboration with more partners and investors to access more resources.

#### Success factors:

- Dedication and perseverance of the founder and team.
- Innovative use of bamboo: a raw material sourced locally and abundant in supply.
- Commitment to empowering women and youth through community engagement.
- Focus on community engagement.

## 6. INDIA - BATTERIES FROM CROP RESIDUES

**Situation/problem overview:** The fossil-fuelled automobile sector in India, contributes significantly to air pollution, fuel consumption and ecological damages. Although electric vehicles (EVs) are becoming increasingly popular in India, the lack of charging infrastructure, high purchasing price and the long charging time are barriers to wide-spread adoption. These challenges, the increasing demand for renewable energy sources and the Indian Government's push towards clean energy provided an opportunity for **Nexus Power** to enter and grow in the Indian market.

The twin sisters, Nikita and Nishita Baliarsingh (26 years old) identified the limitations and hazards posed to the environment by widely used lithium-ion batteries. Motivated by their concern for the environment and their desire to make a positive impact on their society, they sought to create an alternative battery made of sustainable material sourced and manufactured in India. These two young female entrepreneurs co-founded Nexus Power in Bhubaneswar, India, in 2020. The company manufactures sustainable, biodegradable batteries using protein extracts from crop residue. The patented technology could help reduce pollution caused from burning crop residue and can contribute to lower carbon dioxide emissions by reducing fuel consumption.



**Innovation:** Nexus Power produces batteries through the process of biomimicry where protein molecules extracted from crop residue are used to transfer electrons in a similar function to lithium. These proteins are efficient at electron transfer and reduce the charge time of the battery to 20 - 25 minutes, when compared to the four to five hours charge time for a lithium-ion battery. The twins successfully produced a prototype of the battery during the 2020 COVID-19 pandemic lockdown. The outcome was a completely organic and biodegradable battery that is cheaper and charges faster than lithium batteries. The sourcing of raw materials is cost effective, and the entire processing takes place in India.

Bio-fertilizers are created as a by-product from the production of the batteries. This allows the company to follow a zero-waste model and benefit from an additional income stream. Farmers from whom they source the crop residue now secure additional income of Rs 25 000 (USD 305) for every 100 batteries manufactured.

**Researchers at Nexus Power test eco-friendly liquid formulations for EV batteries, driving advancements in sustainability and environmental protection.**

© Nexus Power

**Challenges and successes:** Nikita and Nishita face several challenges, such as the cautious attitude of consumers to adjust to new technologies as well as mild discrimination in the male-dominated market. Hesitations by people to invest in a sole women-led enterprise was one of the gender-related discrimination they experienced. The sisters sometimes face questions such as “Do you actually know what you are doing?”

Gaining expert knowledge in the given technical field was a key factor to overcome those barriers. “But me and my co-founder Nishita, neither of us are engineering graduates. So, that was another challenge, we had to first understand the basic units of all of these and then try and work on them”, said Nikita (Circuit Digest, 2023). They enrolled in certification courses for nanotechnology, battery thermal management and hybrid electric vehicle designing. They learned about the innovative technology they wanted to develop and found bio-based materials that are abundantly available in India.

The women were recipients of two fellowship grants from the Indian Government under Startup India, Ministry for Entrepreneurship and through the Kalinga Institute of Industrial Technology – Technology Business Incubator (KIIT TBI). In 2022, they succeeded to secure an undisclosed amount from the Jain international Trade organization (JITO) Angel Network (JAN), an organisation that raises funds from the private sector to invest in promising start-ups. These opportunities provided training, experience and capital to start and operate their business.

**Potential for scaling:** It is predicted that India's domestic electric vehicle market will see a 49 percent compound annual growth rate (CAGR) between 2022 and 2030 (999 949 EVs were sold in 2022), with 10 million annual sales by 2030. The industry is also projected to create around 50 million direct and indirect jobs by 2030. Currently the charging infrastructure is being expanded with investments from both, government and private companies.

The Indian Government established the National Clean Energy Fund (NCEF) and the Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme to support the development of clean energy technologies and the adoption of EVs. The organic, biodegradable and non-hazardous batteries from Nexus Power are great substitutes for its more expensive competitor, the lithium batteries.

The company grew from two employees in 2020 to 30 in 2023. With a growing team, the company would continue to grow by seeking government and private investor support for investments in research and development, and human resources, regulatory support and by developing partnerships and collaborations with other companies, and stakeholders.

Their next steps would be to explore the potential for industry-scale production to launch the product in the market. Production on industrial scale could have a higher profit margin compared to traditional batteries due to their sustainability and eco-friendly nature. The company plans to continue to explore the use of locally available resources to create sustainable and affordable solutions.

**Success factors:**

- Readily available raw material locally (crop residue).
- Access to education to gain expert knowledge.
- Accessed available funding through fellowships grants from the Indian Government.
- Tenacity to overcome gender discrimination.
- Predicted growth in India's domestic electric vehicle market.

## 7. INDIA - BIODEGRADABLE PACKAGING FROM CROP STUBBLE

**Situation/problem overview:** Crop stubble burning in the North of India contributes to the country's poor air quality. Starting with a simple solution of using mushrooms to biodegrade the crop stubble, founders of **Dharaksha Ecosolutions** discovered the use of mycelium-based material to create biodegradable packaging to addresses the plastic pollution problem of dumped polystyrene (Styrofoam and thermocol). Although polystyrene is recyclable, the process is expensive, and it can have detrimental impacts when improperly disposed leaching chemicals into the environment polluting water sources. Moreover, waste pickers find the bulky lightweight polystyrene, 95 percent air, uneconomical to collect and it ends up in landfills.

Founded in 2020 by Arpit Dhupar (30 years old) and Anand Bodh (30 years old), the company is an environmentally conscious firm which specializes in the creation of biodegradable and sustainable alternatives aimed at curbing crop stubble burning and plastic pollution.

**Innovation:** The company collaborated with John Deere, the US manufacturer of agriculture and heavy machinery equipment, to acquire baler machines to compress and stack the crop stubble. The farmers benefit greatly from the efficiency of the balers which clear fields faster than fire and the company accesses ready supply of raw material for processing. Dharaksha employs aggregators to assist farmers in baling stubble and this also facilitates economical transportation of the raw material. The process from raw material to final product involves chopping, steaming, and preparing for packaging within a span of ten days.

Through a bio-fabrication process biodegradable packaging that mimics polystyrene packaging is manufactured. This material evolved from their initial use of mushrooms to degrade the stubble. As the mycelium (fruiting body of the mushroom) grew on the waste it transformed into a material with an interlocked structure, rendering it strong without the need for added resin. The mushrooms are neutralized when the mix is placed in an oven and the final result is a material which is flame-proof, can tolerate laser engravings, and withstand high moisture conditions, making it suitable for various applications. Compared to polystyrene this material is also of superior strength, finish and is cost competitive. The company also developed a nutrient medium called Somra which fastens the growth of fungus.

**Challenges and successes:** The founders successfully navigated the initial challenge of securing startup funds and was self-funded by an injection of Rs 4.5 million (USD 54 000) into the business from their savings.

The demand for its products heavily outweighs their current supply and production rate. The innovative material takes seven-ten days to grow and be finalised and this puts them at a disadvantage with insufficient capacity to match the production rates of polystyrene.

However, despite this obstacle, the start-up managed to achieve a turnover of Rs 2.5 million (about USD 30 000) in 2022, by producing 200 tonnes of packaging material, using over 250 tonnes of paddy stubble from 100 acres of farmland in Punjab and Haryana. The farmers are paid a rate of Rs 2 500 (about USD 30) per acre, for the material that they previously burnt and earn nothing from. Dharaksha Ecosolutions can produce 0.8 tonnes of packaging material for every tonne of crop stubble waste.

The work of their strong research team led by experienced scientists, innovators and entrepreneurs earned the company global recognition. Dhupar, one of the founders and engineer, was named by Forbes in 2018 one of the 30 under 30 social entrepreneurs and by the United Nations the 2018 Young Champion of the Earth for Asia and the Pacific Regions. The company was also recognized as one of the 30 most promising startups of 2022.

**Potential for scaling:** The company recognize the need to increase production rates to meet the demands of industries. At present, the manufacturing unit of the company is a 50-member team, which incorporates the manufacturing task force, with 40 percent of its members being female employees. Their current output is 20 000 pieces of packaging per month, and they aimed to increase the monthly amount of packaging produced to 200 000 by the end of 2023.

By continuously refining their processes, Dharaksha Ecosolutions has the potential for scaling their operations to make a more significant impact in the bioeconomy sector. They are currently exploring partnerships and opportunities with other industries beyond glass industries to expand their reach and impact. For example, the company aims to produce thin-film polymers using mushroom metabolites as an alternative to medium density fibre board (MDF) wood and plastic bags. They also plan to extend the material use to furniture construction which would help reduce deforestation.

While they have encountered challenges, their success in establishing a manufacturing unit and achieving a considerable turnover demonstrates the viability of their businesses.

**Success factors:**

- Collaboration with John Deere to supply baler machines to India for efficient clearing of fields.
- Mutually beneficial relationship between farmers and the business.
- Early establishment of their own manufacturing unit to process the stacks of stubble.



- The commitment of the founders, along with the dedication of a robust research team consisting of young scientists, innovators, and entrepreneurs.
- Engineering and entrepreneurial knowledge and experiences of the founders.

## 8. KENYA – BIOPRODUCTS FROM BANANA STEMS AND FRUITS

**Situation/problem overview:** In large banana farming areas of Kenya, waste banana stems are left to rot on the farm after harvest, and this produces greenhouse gases. Ziada Solutions aims to address the issue by producing biogas and other by-products from decorticated banana stems.

Andrew Ndungu Njoroge (24) is the founder of Ziada Solutions, a start-up initiative that utilizes the whole banana plant to produce their own energy to process bio-products, such as flour and fibre for basketry. The by-product from the biogas system is used to produce fertilizer generating additional income. The idea of producing biogas to fuel the banana drier was inspired while working with Criou Energy, a company that specialises in the development of emission reduction projects across East Africa. There Andrew observed a biogas setup that was used to dry fruits.

**Innovation:** The production facility is located in the Taita-Taveta county, Kenya's second largest banana farming area, where a significant amount of banana stem waste can be accessed. The raw materials is sourced on a daily basis directly from the farmers at K Sh 15 (USD 0.10) per stem. They also hire a motorbike or tuk-tuk to transport the stems from the farms to their factory. The stems are fed into a decorticator which extracts the fleshy part of the stem leaving the fibre which is then dried and sold. The fleshy waste, also called pulp, is fed into an anaerobic digestion system to create biogas which is used as a heat source to dry the fibre as well as banana fruits. Using a solar milling machine the dried fruits are then milled and turned into flour which is sold in the local market.

The bio-products give them a competitive edge over more conventional products (sisal grass, and wheat flour), as banana fibre is significantly cheaper to produce and drying the bananas helps preserve the fruit until off peak season when farmers can get better market prices. The biogas system also produces a by-product which is called a digestate fertilizer. It contains nutrients and micronutrients, including nitrogen, phosphorus and potassium which enhances plant growth and soil quality. This business incorporates circular principles and employs an innovative process to convert banana stems into valuable resources such as natural fibres, fertilizer and biogas. The resource optimization process contributes to environmental sustainability.

**Challenges and successes:** Although the company was not yet officially established, Andrew currently works with five business partners vested in its success. The team faced several challenges which included, lack of skilled labour, appropriate pricing, reliable transportation of the stems from the farms to the processing plant, reliable power connection, and good record-keeping. They overcame these challenges by gaining knowledge and skills through trainings in basic record-keeping, held meetings with farmers to agree on appropriate pricing, and now shares an energy source with a neighbour for additional power at the production facility.

Another challenge Ziada Solutions faces is securing steady markets for their products. Currently they sell about 1 000 litres of bio fertilizer to local farmers a month at K Sh 20 (USD 0.13) a litre. The banana flour is mostly sold to locals at K Sh 100 (USD 0.67) a kilo and they sell on average 20 kgs of flour per month. The biogas system produces quality products, drying about 10 kgs of fresh bananas in 10 hours. At the moment Ziada Solutions processes 200 kg of fresh bananas into 30 kg of flour per month, which they sell to local wholesalers. The fibre products are yet to generate income.

The support network of the team members, new partnerships and mentoring by organizations and private sector entities played crucial roles in getting the business operational. Criou energy provided oversight of the project, capital for all basic structures and advised the team. Biogas international donated a biogas system for temporary use while their daily operational costs were covered by Micro Enterprises Support Programme Trust (MESPT). Andrew further noted that “Mr Daniel Mungai, a local, was kind enough to let us set up our plant on his farm. A friend helped design the decortivating machine at a small fee and family supported indirectly through purchasing flour and aiding in marketing and logistics of the deliveries in the capital Nairobi since we are located in Taveta” (A. Njoroge, personal communication, 2023).

Although the team has been successful in creating good quality bio-products and additional income stream through the digestate fertilizer they underestimated the amount of gas needed to run a commercial scale drier and size of the biogas system required to increase their capacity and break even. The cost of food processing equipment was also underestimated and was more expensive than anticipated. Without accurate financial projections of expenditures and ready markets for all their products to generate revenue the company's growth will be restricted. The key takeaway from this experience is the importance of conducting thorough market analysis before making any investment in an operation. By evaluating the market and comprehending consumer needs and how they are currently being addressed by existing businesses, potential growth opportunities can be identified.

**Potential for scaling:** Ziada Solutions has the potential for growth and Andrew is positive about its future. Securing a market for the fibre and a larger one for flour would make the business viable. To secure a market they sent out fibre samples to potential customers that use them for basketry and have been receiving more enquiries about their products.

There is potential to scale the model, but for success, a stable customer base, additional investment to install a bigger biogas system, investment in office equipment and more efficient logistics from farm to the processing plant are required. Growth and expansion of the business will also require trained machine operators and food handlers providing new jobs to the community. The company plans to set up a loom to produce fabric from the banana fibre, diversifying their product offerings. They may also explore the production of new products made from pineapples which has equally fibrous waste stems and the ability to be sold as dried fruit snack.

**Success factors:**

- Innovative idea to use a single raw material to create multiple products as well as the energy source for the said production.
- Benefits of collaboration – partnership and mentoring facilitated more efficient and improved operations.
- Investment through partnership and funding.
- Lesson: Market analysis to be conducted first before investments are made operation.
- Diversification of products and markets.

## 9. KENYA – HAIR EXTENSIONS FROM BANANA FIBRES

**Situation/problem overview:** According to the International Union for Conservation of Nature (IUCN, 2023) 73 percent of all plastics waste generated in Kenya is uncollected and of the 27 percent collected, eight percent is recycled with the remainder disposed in unsanitary landfills. The hair industry in Kenya contributes significantly to the plastic waste problem with indiscriminate disposal of non-decomposable plastic synthetic wigs, weaves and extensions.

Margaret Muriuki, a young banker turned entrepreneur from Kenya, seized the opportunity to address the environmental hazard caused by plastic hair through her creation of natural hair extensions from agricultural waste. Margaret established **Eco Braids Kenya** in 2022 and provides employment opportunities to youth and women in the rural areas where she employs four youth between the ages of 24 to 30 years old.

**Innovation:** Margaret first gained interest in banana fibres when her cows died after feeding on banana stems. The veterinarian confirmed to her that the stems had many strong fibres which were thread-like and that gave her the idea to embark on her research. At the Kenya Industrial Research and Development Institute (KIRDI) she conducted her research on banana fibre hair development and followed an incubation program until she produced the final product. There, she learnt how to process the raw banana fibre into hair braids with different dyeing and finishing effects.

The company sources banana stems from banana farmers in Kirinyaga County in Kenya. The fibres are extracted and manually processed into biodegradable hair braids as a substitute to synthetic hair. Biodegradable hair braids created from banana stem fibres are natural, do not cause skin sensitivity or irritation, and can be re-used, unlike synthetic hair that should only be used once to prevent fungal and bacterial infections.

**Challenges and successes:** Although the business is in its early phase, growth has been challenged by access to finance, logistical support to transport stems from the farms to the point of extraction and limited manufacturing time due to the lack of ownership of requisite machinery (extractor machine).

One pack of Margaret's eco braids weighing 100 grams cost around USD 40 which is more expensive than the synthetic extensions, but they can be used several times and can remain for an extended period in clients' hair. She factors in her additional cost for manual production and expenses for logistics to transport the stems. The manufacturing process takes one month to produce five kilograms of hair and she promotes her products via door-to-door marketing, social media and referrals. Her client base continues to grow but due to limited resources her business is not yet commercial.

Despite the challenges the business is profitable, and partnerships forged with women, youth and persons with disabilities from Ndia, Kirinyaga County has contributed to its success. They farm bananas and sell the stems (that otherwise would give them no income) to her. Margaret noted that "I pay farmers on average USD 1.08 per stem, depending on size and quality, which gives me approximately 7 kg of unprocessed fibres. This is quite a favourable business position for making profits. I source the raw materials weekly depending on the market demand thus reducing daily expenses" (Margaret Muriuki, personal communication, 2023). Other key factors that contribute to her success in the bioeconomy sector is the large availability of raw materials (banana stems), existing and growing demand for the eco-braids and the environmental sustainability of the venture.

**Potential for scaling:** The business has the potential to grow as the hair extension market continues to expand and farmers in the country continue to cultivate bananas, making raw material readily available. According to the statistics from the Global Market Insights (GMI, 2024), in 2023 the hair wig and extension market was valued USD 7.10 billion with projected compound annual growth rate 4.7 percent (CAGR 2024-2032) to grow to market value of USD 10.56 Billion. The demand for Kenya hair extensions will see a complementary upward trend. The plans of the Kenyan Government to implement its 'Sustainable Waste Management Act' to address the plastic waste problem are also expected to contribute to boosting demand for her products.

For the company to scale, increase production and become more efficient, funding and investments are required to procure an extractor machine as well as for skills training. Eco Braids intends to expand to other communities by educating farmers on the use of the banana stems after harvest. The company can also provide extractor



services for raw materials. In addition to becoming a service provider she would like to expand her skillset to weaving with banana fibre, to diversify her product range by adding woven products such as baskets.

Given the trajectory of the hair extension sector and a rising desire for eco-friendly beauty items in Kenya, the prospects for bio-based hair extensions are steadily expanding. This is an opportunity for Margaret to position her business in the upcoming market as a solution to help address the plastic waste issue in Kenya.

The company is also working on product diversification strategies and have developed Eco Sanitary pads from the banana pulp. This product has a high absorption rate, is eco-friendly and price competitive. The target customers for this product are vulnerable schoolgirls in the society.

**Eco Braids Kenya employee with the raw material and the final hair extensions from banana fibre.**

© Eco Braids Kenya

#### **Success factors:**

- Investment in research and development of the product.
- Readily available raw material (banana stems).

- Core business is her own processing of hair/braids which seems profitable.
- Potential to also work as a service provider to convert banana stems into raw material biodegradable products.
- Successful partnerships with women, youth and persons with disabilities.
- Growth opportunity if investors support the start-up.

## 10. KENYA – PET FOOD FROM BLACK SOLDIER FLY LARVAE

**Situation/problem overview:** At present, the negative environmental footprint of pet food is critically being debated as the demand for more premium petfood inclusive of more meat is increasing. Alternatively, there is also a growing trend towards incorporating sustainable ingredients such as alternative protein with lower footprints. The debates also address the concerns about conventional dog food which may be less nutritious for pets as the majority contain preservatives and low-quality ingredients or fillers.

**Loop Pet Food**, a youth-led company based in Kenya created a solution and Laura Stanford (35), the owner, explains that “the core business revolves around harnessing the power of insects to convert organic waste into locally produced and competitively priced sustainable dog food” (L. Stanford, personal communication, 2023). She further elaborated the reason why the company is seeking net positive solutions for the environment through their dog food and stated “If our furry friends formed a separate country, it would rank fifth in global meat consumption behind China, the US, Brazil and Russia. Feeding dogs and cats create the equivalent of around 64 million tons of carbon dioxide in the US each year. That’s roughly the same impact as 13.6 million cars on the road” (L. Stanford, personal communication, 2023).

**Innovation:** The company identified a gap in the pet food market and created the first insect based Kenyan dog food. The primary protein for their product is black soldier fly larvae (BSFL). The company also aims for zero waste and utilizes unsold or damaged produce from farmers as pet food ingredients or feed source for the insects. Implementing circular economy principles such as recycling, upcycling, and minimizing waste helps to reduce environmental impact.

Their raw materials are sourced from a range of farmers spanning smallholder farmers to large scale producers. The low carbon footprint and the use of grain and gluten free fresh, natural, locally produced ingredients gives the product its competitive edge in the domestic marketplace. Emphasizing locally sourced, and sustainable ingredients is core to the business identity as natural ingredients offer all the nutrients that pets require, and local sourcing equates to a lower carbon footprint.

The company constantly researches and develops innovative formulations that maximize nutrition while minimizing environmental impact. This involves using products that would otherwise end up in landfill, incorporating sustainable alternative proteins, and experimenting with novel and sustainable packaging options.

**Challenges and successes:** Loop Pet Food encountered several challenges during the establishment of the company. One challenge is the negative perception customers may have about insects in particular maggots. The company places high value on consumer education and engagement to raise the customer awareness of the negative environmental impacts of pet food and the positive environmental impact and nutritional profile of insects. The founder noted that, educating consumers about the importance of sustainability in pet food choices and engaging them in the company's mission fosters brand loyalty, advocacy and ultimately makes the planet a greener place.

The company values the feedback of its customers and launched their Minimum Viable Product (MVP) in August 2022 in the market to receive feedback from pet owners within three months. The feedback is considered as the backbone on which they build their business as they are creating products for other people and therefore seek the customer’s opinion to ensure that the product aligns with their needs and desires.

Typical to many other start-ups, finance was an initial challenge where the company was personally funded by the founders who did not earn a salary for 18 months while building the company. Heavy reliance was placed on organic growth and word of mouth to increase sales. The company reports that it broke even in October 2023 (without paying the founders salaries) and experienced 380 percent growth from the first quarter of 2023 to the

first quarter of 2024 selling a total of 3.8MT of dog food and treats. They expanded their market and had its first export to Rwanda selling their products through Pride Farms. To support such growth, they also expanded their staff from three to ten full time employees and will facilitate a formal capital fundraise for increased exponential growth.

As an entrepreneur with a new venture, Laura honed all her soft skills which enabled her to wear many different hats within the business. She describes it as “an incredibly fun and rewarding existence but... it does require bravery.”

**Potential for scaling:** The global market for insect-based pet food, including black soldier fly larvae, is expected to reach over USD 17 billion by 2030 (Future Market Insights, 2023). Loop Pet Food is experiencing the growth trend as company sales are growing monthly.

Loop Pet Foods products have a shelf life of over nine months, which the young entrepreneurs see as a scaling methodology and a safeguard to be able hold stock in case they experience any shocks (e.g. a machine breakdown). As they are growing, they aim to hold an inventory of at least 500 kg at any time. A bag of 2.5 kg sells for K Sh 2 998 (USD 21; USD 8.40 per kg), which is a bit higher than the price of imported pet food (approx. USD 6.40 per kg). In May 2023, the company produced and sold over 850 kg of dog food.

Although they established an online presence to market their products, they prioritize word of mouth and attending markets where people can meet them in person, which has shown to be the most effective marketing and promotion strategy. Their products are sold in local stores and through an online retailer who delivers countrywide. Sixty percent of their sales are direct to door and 40 percent through retailers which they forecast will change significantly during this year.

The company is fully self-funded and to scale further they are planning to fundraise in 2024 to upgrade their machinery. They are forecasting to produce and sell over 3MT of pet food per month by December 2024. They completed their initial export to Rwanda and are expecting to fulfil a second order in May 2024. Given that their product was so well received in Rwanda they are researching to launch their unique approach in more developed market from Q4 2024 onwards to the United Kingdom of Great Britain and Northern Ireland, the European Union, and the United States of America.

**Success factors:**

- Raised awareness about turning insects into an income opportunity.
- Zero waste, promotion of a circular economy applications.
- Increased demand for more sustainable pet food options.
- Drive and determination of the founder to promote the product.

## 11. MEXICO - BIOPLASTICS FROM AVOCADO SEEDS

**Situation/problem overview:** With an annual production of around 300 million tons, the world continues to grapple with a grave plastic waste crisis which threatens the environment, human health, and wildlife. While bioplastics emerged as a solution, concerns about resource allocation amidst persistent hunger arose as over 80 percent of bioplastics originated from food sources such as corn and potatoes. The company, **Biofase**, was established to address these challenges by offering an innovative solution that repurposes discarded materials. Scott Munguía, a young entrepreneur and founder of Biofase, developed a sustainable solution to the global plastic waste crisis by creating bioplastics and other bioproducts from discarded avocado seeds.

**Innovation:** Munguia applied his chemical and environmental engineering knowledge and experience to conduct extensive experiments with various raw materials which led him to avocado seeds. He recognized the untapped potential of avocado seeds, often discarded as waste, to create bioplastics and other bioproducts. His strategy involves grinding avocado seeds into fine powder to extract natural polymers through chemical processes. This biopolymer serves as a foundation for various products, including cutlery, straws, bags, and packaging. Biofase's patented technology makes it the only biopolymer production company in Mexico that uses avocado seeds as a sustainable resource. With decomposition occurring within 240 days, the environmentally friendly products

replace polystyrene, polypropylene, and polyethylene. The journey from ideation to market launch took about 12 months.

**Challenges and successes:** Munguía's approach was not without its challenges. Securing funding to start the company and scale production was one of his biggest hurdles. The initial extraction process which was labour-intensive and costly hindered scaling. The establishment of a reliable supply chain for avocado seeds presented another challenge. He overcame these obstacles by attracting investor funding and forging long-term partnerships with local avocado producers, ensuring a steady seed supply. The avocado seeds are sourced from 30 Mexican companies that commercialize and process avocados. Their avocado waste can satisfy up to eight times the national demand for bioplastics. Biofase obtains the raw material for free or even sometimes gets paid from producers to collect the waste material which reduces the company's production costs significantly.

Biofase is leading the production of biopolymers in Latin America and its success in reducing plastic waste and promoting a more circular economy has earned the company five national and two international awards.

**Potential for scaling:** The company has grown rapidly since its founding in 2012, when Munguia was only 22 years old. By 2013, he had the process patented and by 2016 the company started producing in a second plant. Today the company exports bioplastics to 26 countries across the world and has 150 employees. The growing demand for bioplastics as a sustainable alternative to traditional plastics positions Biofase favourably in the market. Munguía is now focusing on his next steps, which include expanding Biofase's production capabilities and developing new products.

The company experienced rapid growth, achieving a valuation exceeding USD 1 million within its inaugural year of operation. Munguía secured his first substantial backing from the state of Michoacán, Mexico, further accelerating the company's trajectory. As Biofase gained heightened prominence within the industry, it became an attractive investment destination for a diverse array of stakeholders. Private investors, venture capitalists, and additional governmental grants fuelled the company's expansion.

**Success factors:**

- Innovative business idea.
- Sound scientific and technology background of the innovator.
- Growing demand for bioplastic.
- Access to raw materials through positive relationships and contracts with avocado processing companies.
- Access to finance due to investments.

## 12. MOROCCO – LUXURY LEATHER PRODUCTS FROM FISH WASTE

**Situation/problem overview:** Morocco is one of the top fishing countries in Africa with substantial catch and export volumes. This industry generates significant revenue for the country and conversely significant waste, including fish skins, which are typically discarded. The country also has a high rate of youth and female unemployment.

The textile industry in Morocco also contributes to national revenues with leather being an important export product. However, the leather industry uses a lot of water and there are no enforced regulations for proper disposal of harmful chemicals. The production of conventional leather uses arsenic, sulphates and chromium which have serious environmental impacts.

Motivated by these problems and the determination to be part of the solution, Nawal Allaoui started **Seaskin**, a company that recycles fish skins into luxury leather products through sustainable and environmentally friendly processes. Based in Casablanca, Morocco, Seaskin reduces waste, creates employment opportunities, and promotes sustainable practices within the fashion industry.

**Innovation:** Applying her knowledge from the School of Textile and Clothing industries (ESITH) in Morocco, Nawal experimented at home and at the ESITH laboratories to come up with a process to convert fish skins into leather. This method includes a dry tanning technique which utilizes considerably less water (95 percent) than the conventional tanning techniques and incorporates henna, an organic product. The natural tanning or

protective oils used in the process replaces the fish oils in the skin taking away the fishy scent. The end product is high quality fashionable leather.

Through collaboration with local restaurants and fish processing plants the company ensures a consistent supply of fish skins. The hiring of women who also work at the local markets cleaning and processing fish, ensures the selection of the best fish skins required for processing.

**Challenges and successes:** At the beginning of entrepreneurial journey progress was hindered by a lack of infrastructure and equipment to process fish skins into leather, and limited knowledge and awareness about the potential of fish skin as a material for producing leather. The company found it difficult to find investors who believed in the idea and later overcame these challenges by partnering with experts in leather production and investment in equipment and infrastructure. The company also collaborated with local restaurants and fish processing plants to collect fish skins and received support from various organizations that believed in the initiative, such as the Fund for Youth Employment.

The innovative business perfected its art and manufactures luxury fashion products such as wallets, card holders, key holders, and Moroccan shoes commonly known as babouche. With this accomplishment the company started gaining recognition and attracted funding. In 2018, Narwal was the recipient of USD 10 000 grant at the Africa Youth Conference which awards innovative youth-led African social entrepreneurs. She was also one of the three winners of the BeChangeMaker, an acceleration program for social entrepreneurship in 2019.

**Potential for scaling:** Although the current market for fish skin leather is relatively small, Seaskin operates in a niche segment with growing interest. The global market accounts for less than one percent of total leather sales and Seaskin's strategic positioning within this niche, combined with increasing awareness of sustainability, positions the company for potential growth.

Moreover, the endorsement and promotion of fish leather by international organizations like FAO provide a supportive ecosystem for Seaskin's expansion. In its publication, The State of World Fisheries and Aquaculture, FAO noted the fashion industry's innovative and increased use of aquatic resources to create new opportunities. Fish leather is noted as a value addition product that can boost the incomes of fishing communities and reduce the demand for leather from endangered species like snakes and alligators (FAO, 2022).

**Success factors:**

- Partnerships with experts in leather production.
- Available finance: access to funding targeted at youth Fund for Youth Employment.
- Creation of additional income for women already working within the fisheries sector.
- Collaboration with local restaurants and fish processing plants to collect fish skins.

### 13. UGANDA – FLOOR TILES FROM RECYCLED EGGSHELLS AND PLASTIC

**Situation/problem overview:** The poor disposal of polythene bags and eggshells prompted the idea to recycle the waste as material for floor tiles. This was a research topic for Sengonzi Godfrey's final year project at Makerere University. He struggled to find a place to do his internship which drove him to create his own employment opportunity by developing a product to sell. He created durable floor tiles as a substitute for terrazzo, an Italian 16th century floor tile style, which experienced a revival in recent years.

Lisa Anena, a 24-year-old entrepreneur and Managing Director of **Sego Industries** met the founder, Sengonzi Godfrey, during the Youth Connekt Summit in Rwanda in 2022. Sego Industries is a small business that aims to tackle the problem of poor waste management in Uganda. The company's innovation of recycling eggshells and polythene bags to manufacture floor tiles has economic and environmental benefits.

**Innovation:** What makes their products unique and gives them a competitive edge, according to Lisa are “the materials used to manufacture the tiles which are different from others. The fact that we use crush polythene bags to design our tiles makes them stand out” (L. Anena, personal communication, 2023). The addition of eggshells to the base of cement tiles improves its attributes of strength and durability. The founder noted that the calcium carbonate in the eggshells produces calcium hydroxide which increases the stiffness and rigidity of the composite.



The eggshells and poorly disposed polythene bags are collected from the environment, dumping sites, road stands and hatcheries within the area at no additional cost, which provides a financial advantage. They are collected, sorted, ground and crushed using separate crushing machines. The crushed eggshells and polythene bags are added to white cement as a binding agent and the mixture then put in moulds of different sizes and shapes. The tiles are left to cure for a few days, then polished and finished with a sealant with crushed polythene bags added as design. One tile consists of half a kilo of eggshells and four polythene bags. A box of 12 tiles (25 cm by 30 cm) recycles 48 polyethylene bags and six kilograms of eggshells and is sold for U Sh 30 000 (USD 8.30). The tiles are unique and affordable.

The company is currently experimenting with another innovative idea of creating liquid fertilizer from the white membrane removed after crushing the eggshells. Tests on banana plantations, beans and tomatoes have proven to be successful as an effective and sustainable alternative to synthetic fertilizers.

#### Showing sample tiles.

© Sego Industries

**Challenges and successes:** Limited capital, which hindered their ability to invest in machinery and expand production, people's limited knowledge and negative perception of the product, limited market, and competition from big brands like Good Will were significant challenges for the company. They overcame these obstacles and developed into a profitable business through continuous research and development to create and perfect a unique product. The company also leveraged partnerships like the Youth for Business portfolio of United Nations Development Programme (UNDP) to secure funding of USD 5 000 which were primarily used for market research, product design and making prototypes.

The challenges of the business helped develop a variety of Lisa's soft skills such as teamwork, time management, communication, patience, network building and self-awareness which enhanced her ability to be an effective managing director.

**Potential for scaling:** The company created a niche market supplying more affordable and locally produced cement tiles from their small workshop in Kampala. Customers originate from Kiteezi, Gayaza, Lusanja, and other places within the country's capital. The tiles are marketed and advertised locally on display in front of their workshop and through social media platforms like LinkedIn and Facebook. With the aim to expand their market even further, they also participate in local market days such as the Tubayo Market Day and the Omwoleso x Quonnect market day, which are platforms for creators and small business owners to showcase their products, network and sell.

Currently, the company processes 285 kg of eggshells and 2 280 polythene bags per month. The demand for the tiles is growing due to their unique designs, affordability, and sustainable nature. In the long-term they plan to expand the market for the tiles to hardware stores but to increase production and marketing of the product, they are looking for adequate capital to buy machinery and more moulds. To diversify and scale the business, Sego Industries also plan to further explore the liquid egg membrane fertilizer product.

Since its establishment in 2016, the company employed five persons, both men and women. That number remained stable due to low sales and the negative impact of the COVID-19 pandemic restrictions on the business. Recently, in 2023, the company recovered and now employs eight persons of which six are young persons between the ages of 19 to 25 years.



**Success factors:**

- Innovative idea to recycle eggshells and dumped plastic bags.
- Commitment to continuous research and development and adapting to challenges.
- Leveraging partnerships like the Youth for Business portfolio of UNDP for funding.
- Tenacity of the Founder and Managing Director.
- Creation of a unique product that is competitive in price to regular concrete tiles.

## Annex 2. Additional information

Table A2. Links to additional information about each case

	Country	Name of company/initiative	Additional information
1	Benin	AfriCereal Group	<ul style="list-style-type: none"> <li>• <a href="https://africerealgrou.com">https://africerealgrou.com</a></li> </ul>
2	Colombia	Spora Biodesign Studio	<ul style="list-style-type: none"> <li>• <a href="http://www.sporastudio.co">www.sporastudio.co</a></li> </ul>
3	Costa Rica	Hemoalgae	<ul style="list-style-type: none"> <li>• <a href="http://hemoalgae.com">http://hemoalgae.com</a></li> </ul>
4	Egypt	Chitosan	<ul style="list-style-type: none"> <li>• <a href="https://we4f.org/innovator-news/breaking-barriers-with-shahira-yahia">https://we4f.org/innovator-news/breaking-barriers-with-shahira-yahia</a></li> <li>• <a href="https://chitosaneg.com/Chitolab">https://chitosaneg.com/Chitolab</a></li> <li>• <a href="https://www.unido.org/news/meeting-climate-targets-through-circular-bio-based-solutions">https://www.unido.org/news/meeting-climate-targets-through-circular-bio-based-solutions</a></li> <li>• <a href="https://we-fi.org/wp-content/uploads/2020/03/Women-Who-Inspire-Us.pdf">https://we-fi.org/wp-content/uploads/2020/03/Women-Who-Inspire-Us.pdf</a></li> <li>• <a href="https://thestartupscene.me/BehindTheStartup/This-Egyptian-Bio-tech-Startup-Is-Turning-Shrimp-Shells-Into-Fertilisers">https://thestartupscene.me/BehindTheStartup/This-Egyptian-Bio-tech-Startup-Is-Turning-Shrimp-Shells-Into-Fertilisers</a></li> <li>• <a href="https://www.youtube.com/watch?v=sjLm3z33hBU">https://www.youtube.com/watch?v=sjLm3z33hBU</a></li> </ul>
5	Ghana	Bamboo Bicycle Initiative	<ul style="list-style-type: none"> <li>• <a href="https://www.weforum.org/agenda/2014/03/bamboo-bikes-ghanas-women-riding-high/">https://www.weforum.org/agenda/2014/03/bamboo-bikes-ghanas-women-riding-high/</a></li> <li>• <a href="https://ghanabamboobikes.org/who-we-are/">https://ghanabamboobikes.org/who-we-are/</a></li> <li>• <a href="https://unfccc.int/climate-action/momentum-for-change/women-for-results/ghana-bamboo-bikes-initiative">https://unfccc.int/climate-action/momentum-for-change/women-for-results/ghana-bamboo-bikes-initiative</a></li> <li>• <a href="https://www.weforum.org/agenda/2020/07/ghana-bamboo-bike-cycling-sustainability/">https://www.weforum.org/agenda/2020/07/ghana-bamboo-bike-cycling-sustainability/</a></li> <li>• <a href="https://interestingengineering.com/innovation/bamboo-as-a-replacement-to-steel">https://interestingengineering.com/innovation/bamboo-as-a-replacement-to-steel</a></li> </ul>
6	India	Nexus Power	<ul style="list-style-type: none"> <li>• <a href="https://circuitdigest.com/interview/nikita-baliarsingh-cofounder-and-coo-of-nexus-power-on-how-their-company-is-making-ev-batteries-from-crop-residue">https://circuitdigest.com/interview/nikita-baliarsingh-cofounder-and-coo-of-nexus-power-on-how-their-company-is-making-ev-batteries-from-crop-residue</a></li> <li>• <a href="https://www.thehindu.com/sci-tech/technology/nexus-power-odisha-startup-bio-batteries-from-crop-residue-nikita-and-nishita-baliarsingh/article34474655.ece">https://www.thehindu.com/sci-tech/technology/nexus-power-odisha-startup-bio-batteries-from-crop-residue-nikita-and-nishita-baliarsingh/article34474655.ece</a></li> <li>• <a href="https://www.youtube.com/watch?v=a2gUT02uHUY">https://www.youtube.com/watch?v=a2gUT02uHUY</a></li> <li>• <a href="https://www.investindia.gov.in/team-india-blogs/indias-ev-economy-future-automotive-transportation">https://www.investindia.gov.in/team-india-blogs/indias-ev-economy-future-automotive-transportation</a></li> <li>• <a href="https://fame2.heavyindustries.gov.in">https://fame2.heavyindustries.gov.in</a></li> </ul>
7	India	Dharaksha Ecosolutions	<ul style="list-style-type: none"> <li>• <a href="https://www.dharaksha.com">https://www.dharaksha.com</a></li> <li>• <a href="https://www.thebetterindia.com/312922/delhi-engineer-innovates-biodegradable-thermocool-from-crop-stubble">https://www.thebetterindia.com/312922/delhi-engineer-innovates-biodegradable-thermocool-from-crop-stubble</a></li> <li>• <a href="https://packagingsouthasia.com/application/cosmetics/dharaksha-replace-thermocool">https://packagingsouthasia.com/application/cosmetics/dharaksha-replace-thermocool</a></li> <li>• <a href="https://packaging360.in/news/to-turn-the-sky-blue-again-iit-grads-biodegradable-thermocool-prevents-stubble-burning">https://packaging360.in/news/to-turn-the-sky-blue-again-iit-grads-biodegradable-thermocool-prevents-stubble-burning</a></li> <li>• <a href="https://timesapplaud.com/dharaksha-ecosolutions-the-faridabad-based-startup-thats-leading-the-way-in-eco-friendly-packaging">https://timesapplaud.com/dharaksha-ecosolutions-the-faridabad-based-startup-thats-leading-the-way-in-eco-friendly-packaging</a></li> <li>• <a href="https://borgenproject.org/indias-solution-to-pollution">https://borgenproject.org/indias-solution-to-pollution</a></li> </ul>
8	Kenya	Ziada Solutions	<ul style="list-style-type: none"> <li>• <a href="https://criouenergy.com/">https://criouenergy.com/</a></li> </ul>
9	Kenya	Eco Braids	<ul style="list-style-type: none"> <li>• <a href="https://www.kirdi.go.ke">https://www.kirdi.go.ke</a></li> <li>• <a href="http://www.iucn.org">www.iucn.org</a></li> <li>• A new plastics waste deal can help Kenya contain pollution - Business Daily (<a href="http://businessdailyafrica.com">businessdailyafrica.com</a>)</li> <li>• <a href="https://www.standardmedia.co.ke/business/business/article/2001256257/the-fake-beauty-that-has-won-rich-and-poor-women-s-love-and-cash">https://www.standardmedia.co.ke/business/business/article/2001256257/the-fake-beauty-that-has-won-rich-and-poor-women-s-love-and-cash</a></li> </ul>

	Country	Name of company/initiative	Additional information
			<ul style="list-style-type: none"> <li>• <a href="https://www.gminsights.com/industry-analysis/hair-wig-and-extension-market">https://www.gminsights.com/industry-analysis/hair-wig-and-extension-market</a></li> <li>• <a href="https://www.6wresearch.com/industry-report/kenya-human-hair-extension-market-outlook">https://www.6wresearch.com/industry-report/kenya-human-hair-extension-market-outlook</a>)</li> <li>• <a href="https://www.standardmedia.co.ke/business/business/article/2001256257/the-fake-beauty-that-has-won-rich-and-poor-women-s-love-and-cash">https://www.standardmedia.co.ke/business/business/article/2001256257/the-fake-beauty-that-has-won-rich-and-poor-women-s-love-and-cash</a></li> </ul>
10	Kenya	Loop Pet Food	<ul style="list-style-type: none"> <li>• <a href="http://www.looppetfood.com">www.looppetfood.com</a></li> <li>• <a href="https://www.theemptysquare.org/stories/protein-pioneers-hit-the-streets-of-east-africa">https://www.theemptysquare.org/stories/protein-pioneers-hit-the-streets-of-east-africa</a></li> <li>• Future Market insights [accessed 03 August 2023] <a href="https://www.prnewswire.com/ae/news-releases/insect-based-pet-food-market-to-top-us-17-27-bn-amid-surging-demand-for-grain-free-pet-food-fmi-301437887.html">https://www.prnewswire.com/ae/news-releases/insect-based-pet-food-market-to-top-us-17-27-bn-amid-surging-demand-for-grain-free-pet-food-fmi-301437887.html</a></li> <li>• <a href="https://www.ed.ac.uk/global-agriculture-food-systems/gaafs-news/blogs/behind-the-environmental-impacts-of-pet-foods">https://www.ed.ac.uk/global-agriculture-food-systems/gaafs-news/blogs/behind-the-environmental-impacts-of-pet-foods</a></li> </ul>
11	Mexico	Biofase	<ul style="list-style-type: none"> <li>• <a href="https://biofase.com.mx">https://biofase.com.mx</a></li> <li>• <a href="https://www.innovatorsunder35.com/the-list/scott-munguia">https://www.innovatorsunder35.com/the-list/scott-munguia</a></li> <li>• <a href="https://aim2flourish.com/innovations/biofase-the-solution-from-avocado-seed">https://aim2flourish.com/innovations/biofase-the-solution-from-avocado-seed</a></li> <li>• <a href="https://www.forbes.com.mx/30-promesas-2021-emprendedores-biofase-hueso-aguacate-bioplastico">https://www.forbes.com.mx/30-promesas-2021-emprendedores-biofase-hueso-aguacate-bioplastico</a></li> <li>• <a href="https://www.eleconomista.com.mx/arteseideas/Hacen-bioplasticos-de-hueso-de-aguacate-20130428-0042.html">https://www.eleconomista.com.mx/arteseideas/Hacen-bioplasticos-de-hueso-de-aguacate-20130428-0042.html</a></li> <li>• <a href="https://www.gq.com.mx/actualidad/articulos/joven-extraordinario-gq-scott-munguia/5349">https://www.gq.com.mx/actualidad/articulos/joven-extraordinario-gq-scott-munguia/5349</a></li> <li>• <a href="https://lanotapositiva.com/actualidad/scott-manigua-el-mexicano-que-desarrollo-pitillos-biodegradables-con-semilla-de-aguacate_7671">https://lanotapositiva.com/actualidad/scott-manigua-el-mexicano-que-desarrollo-pitillos-biodegradables-con-semilla-de-aguacate_7671</a></li> <li>• <a href="https://mexiconewsdaily.com/news/biodegradable-straws-from-avocado-seeds/">https://mexiconewsdaily.com/news/biodegradable-straws-from-avocado-seeds/</a> <a href="https://www.youtube.com/watch?v=g6PGJB2vYoM">https://www.youtube.com/watch?v=g6PGJB2vYoM</a></li> </ul>
12	Morocco	SeaSkin	<ul style="list-style-type: none"> <li>• <a href="https://africa.unwomen.org/en/news-and-events/stories/2019/02/turning-fish-into-luxury-leather">https://africa.unwomen.org/en/news-and-events/stories/2019/02/turning-fish-into-luxury-leather</a></li> <li>• <a href="https://news.cgtn.com/news/78636a4d33597a6333566d54/share_p.html">https://news.cgtn.com/news/78636a4d33597a6333566d54/share_p.html</a></li> <li>• <a href="https://fundforyouthemployment.nl/morocco-selection-seaskin/">https://fundforyouthemployment.nl/morocco-selection-seaskin/</a></li> <li>• <a href="https://www.statista.com/statistics/1292145/unemployment-rate-in-morocco-by-gender-and-region">https://www.statista.com/statistics/1292145/unemployment-rate-in-morocco-by-gender-and-region</a></li> <li>• <a href="https://www.fao.org/3/cc0461en/cc0461en.pdf">https://www.fao.org/3/cc0461en/cc0461en.pdf</a></li> <li>• <a href="https://hakaimagazine.com/features/the-art-of-turning-fish-into-leather">https://hakaimagazine.com/features/the-art-of-turning-fish-into-leather</a></li> </ul>
13	Uganda	Sego Industries	<ul style="list-style-type: none"> <li>• Facebook: Sengonzi Terrazzo Manufacturers and Construction Company and SEGO industries Uganda limited</li> <li>• <a href="https://fortomorrow.org/explore-solutions/recycled-floors-from-egg-shells-and-plastic-waste">https://fortomorrow.org/explore-solutions/recycled-floors-from-egg-shells-and-plastic-waste</a></li> <li>• <a href="https://www.independent.co.ug/engineer-gets-ugandans-walking-on-egg-shells">https://www.independent.co.ug/engineer-gets-ugandans-walking-on-egg-shells</a></li> <li>• <a href="https://www.undp.org/uganda/news/undp-creates-17000-jobs-through-its-support-youth-innovations">https://www.undp.org/uganda/news/undp-creates-17000-jobs-through-its-support-youth-innovations</a></li> </ul>

Source: Authors' own elaboration.

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