Diversifying revenue in rural Africa through circular, sustainable, and replicable biobased solutions and business models

Research and Innovation Action (RIA)
Grant Agreement 101000762

D7.4: Bioeconomy Policy Briefs

Issued by:	African Agricultural Technology Foundation (AATF)
Issue date:	08/01/2025
Due date:	30/05/2024
Work Package Leader:	FBCD

Start date of project: 01 June 2021
Duration: 48 months

Document History		
Version	**Date**	**Changes**
1.0	15/05/2024	Internal review by AATF
1.1	27/05/2024	Internal peer review (WP1)
2.0	8/1/2025	Updated version to address the comments received from the project review

Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the EC Services)	
RE	Restricted to a group specified by the consortium (including the EC Services)	
CO	Confidential, only for members of the consortium (including the EC)	

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This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 101000762.

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AFAAS	:	African Forum for Agricultural Advisory Services
AfCFTA	:	Africa Continental Free trade area
ANADER	:	L'Agence Nationale d'Appui au Développement Rural
APIX	:	Promotion des Investissements et Grands Travaux
EPA	:	Environmental Protection Agency
FBCD	:	Food & Bio Cluster Denmark
FDA	:	Food and Drugs Authority
GSA	:	Ghana Standards Authority
INP-HB	:	Institut National Polytechnique Félix HOUPHOUËT-BOIGNY
LPDSE	:	Energy Sector Development Policy Letter
MoF	:	Ministry of Finance
MOFA	:	Ministry of Food and Agriculture
SavaNet	:	Savanah Young Farmers Network

EXECUTIVE SUMMARY

This report presents Bioeconomy Policy Briefs developed in the context of the Bio4Afria project funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762 corresponding to D7.4 (M36) led by AATF. The Bio4Africa project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. The technologies promoted by the project in four African countries included installation of a Green Biorefinery (Uganda and Ghana); the production of fish pellets from crop residues (Ghana) production of Biochar from crop residues using the Brazilian kiln for water purification and soil conditioning (Ghana, Senegal and Ivory Coast), the production of bioplastics from cashew apple juice (Ivory Coast) and pelletising to produce livestock feeds (Ivory Coast and Ghana) and the production of Fuel briquettes and biogas from Animal manure and crop wastes (Senegal). As these technologies are being rolled out and as Africa increasingly builds its Bioeconomy base, it is critical to establish an enabling environment composed of policies, strategies, regulations, guidelines, and standards that will facilitate the development, deployment and adoption of Bioeconomy technologies, techniques, and practices. The policy environment is critical to create sufficient incentives for the emergence and sustaining of markets and value chains that are critical to enhance the development of a sustainable bioeconomy. The policy briefs presented in this report capture the key challenges that hinder the development of the bioeconomy. In Uganda, it emerged that although the import duty for machinery for production of livestock feeds are zero-rated under the EAC common tariff, some parts are taxable. The private also lacks sufficient incentives such as tax breaks, subsidies to invest in renewable energy and bioeconomy related production. Also, there are generally no standards for most products from biobased technologies while enforcement of quality standards for bio-based products is weak owing to limited number of enforcement officers. In Ivory Coast, the development and commercialization of Biobased technologies faces challenges related to research and development, prohibitive tax regimes, poor coordination, inadequate capacity, weak enforcement of standards and discriminatory land tenure. There is also limited adoption of products generated rough biobased technologies because of low awareness from users. In cases where the quality standards have been set, there is limited dissemination leading to low awareness by traders and consumers. In Ghana, stakeholders in the bioeconomy face challenges related to taxation, limited

enforcement of quality standards, limited private sector incentives, land tenure biased against youth and women, limited funding for local research and development for biobased solutions. Finaly, in Senegal development and commercialization of biobased technologies faces challenges related to research and development, prohibitive taxation regimes, weak coordination, inadequate capacity, enforcement of standards and discriminative land tenure systems. The report further suggests policy options for prioritization towards addressing these challenges. Separate from this report, four policy briefs have been developed, one for each country and will be used for individual country advocacy and policy engagement.

This report is public and aims to reach different audiences, including the public, scientific community, industry, and policymakers with the objective to maximize project results and disseminate the outputs throughout project duration.

1. INTRODUCTION TO THE OBJECTIVES

1.1 Background on the Policy Context under the Bio4Africa Project

Africa will need to feed over 2 billion people by 2050 while coping with unprecedented demographic, socioeconomic, environmental, climatic and health transitions. Meanwhile, undernourishment is still on the rise, affecting almost 20% the population. Ensuring Africa's food security becomes imperative, with the bioeconomy promising to play a leading role. The bioeconomy is a tool that can be applied in a cross-sector strategy to facilitate economic development. This is necessitated by the need to increasingly replace fossil-based raw materials in the economy with bio-based resources as a way of embracing environmental sustainability principles.

It is against this backdrop that that the European Union's Horizon 2020 Research and Innovation Programme is funding the BIO4AFRICA project to support the development and deployment of bio-based solutions and business models in four African Countries: Uganda, Ghana, Ivory Coast and Senegal. The project is being implemented through a consortium of 25 partners (13 African and 12 EU based organizations) who are engaging in solid multi-actor collaboration with rural communities and government, co-developing novel sustainable value chains driven by circular business models and supporting deployment while safeguarding agronomic, environmental, social, and economic sustainability. The EU funded Bio4Africa project is focused on deploying simple, small-scale, and robust bio-based technologies adapted to local biomass, needs and contexts (green biorefinery, pyrolysis, hydrothermal carbonisation, briquetting, pelletising, bio-composites, and bioplastics production). In doing so, the project has empowered farmers to sustainably produce a variety of higher value bio-based products and energy (animal feed, fertiliser, pollutant absorbents, construction materials, packaging, solid fuel for cooking and catalysts for biogas production), significantly improving the environmental, economic, and social performance of their forage agri-food systems. Through the project, 4 pilot cases with over 8 testing sites in the target countries were established, offering more than 300 farmers and farmer groups of all sizes (including small dairy and lower-income farmers, women farmer groups and transhumant pastoralists among others) the opportunity to test them in real productive conditions.

As these technologies are being rolled out and as Africa increasingly builds its Bioeconomy base, it is critical to establish an enabling environment composed of policies, strategies, regulations, guidelines, and standards that will facilitate the development, deployment and adoption of Bioeconomy technologies, techniques and practices. The policy environment is critical to create

sufficient incentives for the emergence and sustaining of markets and value chains that are critical to enhance the development of a sustainable bioeconomy.

1.2 Objectives of the Bioeconomy Policy Review and Briefs

The overall objective of this report is to present policy briefs that outline the key policy related gaps identified in each project country as well as suggestion on policy options that need to be prioritized to address the policy gaps. The policy briefs are the outcomes of a policy review and policy dialogue processes that were implemented in the past 36 Months. The objective of the policy review was to assess the policy and regulatory environment relevant for the Bio-economies in Senegal, Uganda, Corte d'Ivore and Ghana. The task sought to answer the following questions: (i) What are the strategies that Governments of the target countries pursuing to enhance development of a sustainable Bioeconomy? (ii) What are the key features of the Bio-economy Policy and regulatory environment tools and are they sufficient to match the needs based on the candidate technologies? (iii) What are the gaps in the National Bio-economy Policies, Strategies, Regulations, and other legal and legislative instruments relevant for the Bioeconomy. Further, stakeholders were engaged through high level round table policy dialogue events to provide another comprehensive assessment of the policy environment and validate the challenges identified through the policy review.

2 METHODOLOGY

To achieve the objectives of this task, two major approaches were used. First, the policy instruments at country and regional level were subjected to content analysis. This was followed by a series of policy dialogue events in the project countries. Here we present the methodologies used in each approach.

2.1 Content Analysis of Policy Documents

The current task used the *content analysis* method on several documents that contain information on Bioeconomy related policies, strategies and guidelines. The study relied on documents available online backed by outcomes from stakeholder consultations held in the four Bio4Africa project countries. These documents included specific Bio-economy policies and strategies, but in cases where these were not available, we analyzed other sectoral documents that are relevant for the Bioeconomy. The review presented an overview of the policy documents that govern the Bioeconomy in the four target Countries and at regional level along three criteria: Policy context, Policy text and Policy Consequence.

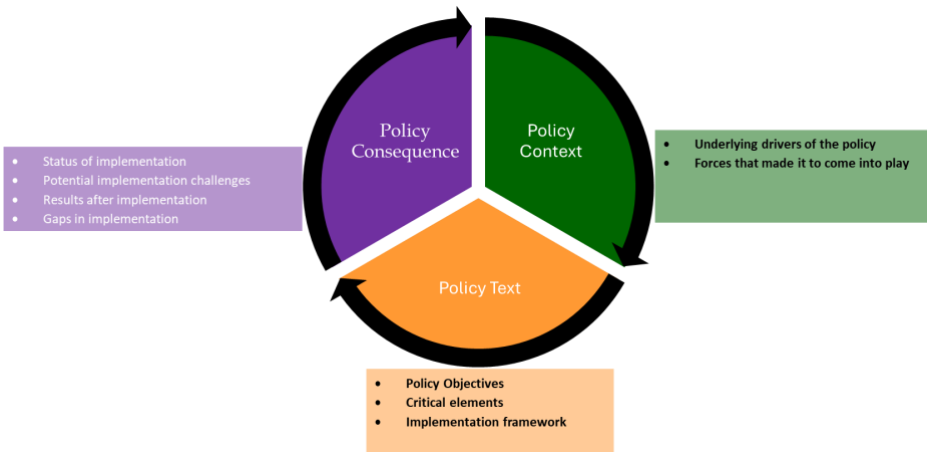

Figure 1. Policy Content Analysis as a method for policy analysis

The Policy context aspect focuses on highlighting the underlying factors that led to the formation of the policy. Critically it looks at the socio-political environment and the political economy forces that catalyzed the policy formation. Understanding the policy context is critical because it has a bearing on its operationalization, implementation, and sustainability. The Policy text sphere focuses on qualitative analyses of the text to pick critical anecdotes underlying the contents of the policy. It focuses on picking key words, statements and phrases in the policy and identify main patterns which can help to enhance the understanding on the goal and values that the policy seeks to advance. Analysis of the policy text will also help to assess whether all the critical components in the Bio-economy value chain[1] are addressed. Under the policy consequence aspect, we assess the extent to which the policy instruments have been implemented towards achieving the policy goal. It further

[1] Research, production, processing, markets and consumption.

diagnoses the policy to identify any potential issues that can affect the implementation of the policy, that could be related to the policy structure and related processes.

2.1.1 Analysis of Policy Documents for Uganda

The Policy framework relevant for the bioeconomy sector in Uganda is composed of the Biomass Energy Strategy (2007); Renewable Energy Policy (2007) and Vision 2040 among other policies. However, a Draft National Bioeconomy Strategy (2020), has been developed, that once finalized will be the primary overarching policy framework for the country's entire bioeconomy. The draft Bioeconomy policy is the most recent and is more encompassing and comprehensive. Consequently, the review will focus more on this document. The implementation of the policy will be coordinated by the Ministry of Science, Technology and Innovation (MoSTI) working closely with the relevant Ministries, Departments and Agencies such as Electricity Regulatory Authority (ERA), National Environment Management Authority (NEMA), Directorate of Water Development (DWD), Uganda National Bureau of Standards (UNBS), Centre for Research in Energy and Energy Conservation (CREEC), Centre for Integrated Research and Community Development Uganda (CIRCODU) and Uganda National Renewable Energy and Energy Efficiency Alliance (UNREEEA). The policy and regulatory environment relevant for the Bioeconomy is mainly driven by global trends and the need to fulfil national goals such as economic development and enshrined in the Constitution. Specifically, the policy was developed to addresses Vision 2040's aspirations of having "a transformed Ugandan society from a peasant to a modern and prosperous country within 30 years". It is also line with National Development Plan (NDP) III's aim of increasing household incomes and improving the quality of life of Ugandans.

The goal of the policy is to "*optimally utilise biological resources, their products and services for sustainable national development. This will be achieved through providing an enabling environment for harnessing bio-resources; promoting research; strengthening institutional and human capacity; leveraging new and emerging technologies; and awareness creation*". The goal is clear on critical elements that are necessary for the development of a robust Bioeconomy such as research, capacity building and institutional framework. The policy seeks to enhance the development of the Bioeconomy as a tool for sustainable development as well as reversing market failures and transforming several economic sectors. The Bioeconomy policy lays emphasis on the need for translating biosciences' research and innovations into industrial and commercial enterprises, with

greater participation of the private sector. The Bioeconomy policy provides for the establishment of the Bioeconomy research and development Act, bio-innovations regulatory Act, regulations for access and benefit sharing, intellectual property, biosecurity, bioethics in cooperation with relevant lead agencies, policy incentives for promotion of emerging and catalytic bio-based industries such as nutraceuticals, banana industry, starch, bio-textile, bioplastics and biopharmaceuticals among others. The policy seeks to strengthen the Ministry of Science, Technology and Innovation (MoSTI) as a lead institution in Bioeconomy development. The policy seeks to establish a bio-innovations research fund (20% of the innovation fund) to support public and private sector research and innovations. The Bioeconomy policy is still at draft stage and needs to go through the prerequisite steps towards adoption. Its implementation will depend heavily on the establishment of the necessary Acts of Parliament and regulations that are critical for the implementation of the policy. Meanwhile, the elements of the Bioeconomy are currently also regulated through other relevant policies/strategies. **The Renewable Energy Policy, 2007 that sought to** increase the use of modern renewable energy from 4% in 2007 to 61% of the total energy consumption by the year 2017. However, by 2021, GIZ estimated that Uganda had approximately 2000MW installed capacity of renewable energy, which is about 37% of the 5,300 MW renewable energy power generation potential. The Bio-economy policy recognizes the need to harmonize its implementation with the East African Community Bio-economy strategy.

2.1.2 Analysis of Policy Documents for Senegal

Although Senegal doesn't have a specific policy on Bioeconomy, the renewable energy sector is regulated through the Energy Sector Development Policy Letter (LPDSE 2019-2023) which represents the action plan for the energy sector. The LPDSE seeks to guide implementation of actions in the energy sector to achieve four objectives; (i) Establishing the prerequisites for local oil and gas production and securing the country's hydrocarbon supply logistics; (ii) Universal and sustainable access to low-cost electricity services (gas to power, renewables and grid extension); (iii) Securing the supply of sustainable and optimal cooking energy to households and (iv) Complete the reform of the legal and regulatory framework of the energy sector and improve the steering, regulation and monitoring-evaluation system. The LPDSE has a huge emphasis on renewable energy. Further, Senegal established the National Biofuels Strategy in 2016, as part of the Ministry of Agriculture's larger strategy, the "Retour Vers l'Agriculture". The National Bioenergy Strategy (2006) aims to use plant species such as Jatropha for biofuel production as well as the generation of Biogas from the

fermentation of organic waste. The National Biofuel policy was mainly triggered by the West Africa Biofuel Strategy (German Bioeconomy Secretariat, 2015). Under the strategy, the government aims to plant a total of 320 000 hectares of jatropha by 2012, with each of 320 rural communities planting 1 000 hectares of jatropha seedlings provided by the government. These seeds will be used to produce a total of 1.2 billion Litres of oil to meet petrol and diesel needs. Senegal is one of the most advanced countries in West Africa and sub-Saharan Africa in the adoption of renewable energy. After the launch of the Biofuel Policy, the Government of Senegal has made substantial strides in the Bioeconomy development. The most recent development is the launch of the BioStar project is aiming to boost the availability of biofuels for SMEs in the region. Earlier, Senegal launched the 158 MW Taiba N'diaye wind farm which has been instrumental in the supply of renewable energy in the country.

2.1.3 Analysis of Policy Documents for Ghana

Ghana doesn't have a dedicated strategy /policy for Bioeconomy. However, the green economy and related biobased activities are managed through various legislative instruments, strategies and policies such as the Renewable energy Act (Act 832) (2013), Strategic National Energy Plan, National Energy Policy (2009), National Energy Strategy (2010) and Ghana National export Strategy for Non-Traditional Sector (2012) (Ali et al., 2021).

2.1.4 Analysis of Policy Documents for Côte d'Ivoire

Like many countries in Africa, Côte d'Ivoire doesn't have a specific Policy on Bioeconomy. However, elements of the Bioeconomy are regulated through specific strategies and policy documents that were analyzed. These include the National Action Plan for Bioenergy of Côte d'Ivoire, (*Plan d'Action National de la Bioénergie de la Côte d'Ivoire (2020-2030*) (See link) and the National Conservation Strategy and Sustainable use of Biological Diversity from IVORY COAST (Link). Most of the policy documents in Ivory coast were however not available online.

2.2 Policy dialogue events

One day round table policy dialogue events were organized in each project country facilitated by AATF and the local partner in each country: SavaNet (Ghana); AFAAS (Uganda), INP-HB (Cote D' Ivoire) and UASZ (Senegal). These dialogues were attended by stakeholders drawn from all the relevant stakeholders as shown in Figure 3. Participants were drawn from Ministries (Agriculture, Environment, Finance, Energy); Government departments and agencies responsible for Quality standards, Tax administration and revenue collection; private sector players involved in processing of biobased materials and importation/sale of processing equipment; representatives of farmers and farmer cooperatives. Finally, research institutions including public and private Universities were invited to represent the research component.

Figure 2: A Policy Dialogue group session in Senegal

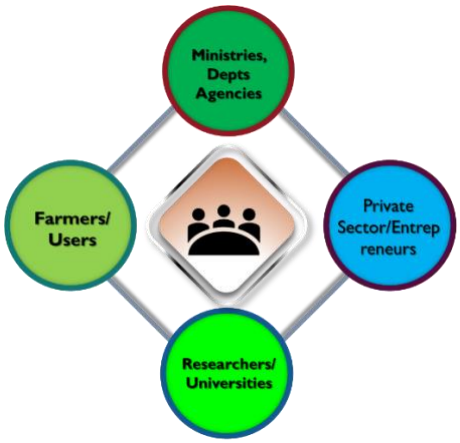

Figure 3. Relevance of economic factors limiting business activity of sample addressed in Uganda

The dialogues were used to achieve three objectives: First, the stakeholders were familiarized with the key challenges that the Bio4Africa aimed at tackling using the project and the biobased solutions that the project is promoting in each country. Second, the stakeholders were exposed to

policy related challenges identified through the context analysis and those identified during the interviews with stakeholders under Task 1.1 and captured in Deliverable 1.1(Contexts and needs of African rural communities). The objective of this exercise was to engage stakeholders in validation of these challenges and identify any additional challenges to ensure that the challenges /gaps were as comprehensive as possible. Third, the participants ranked each of the policy gap on a scale of 0-5 (where 0 was the least important and 5 was the most important). Through this ranking process it was possible to categorize the challenges in the order of importance. Finally, the stakeholders identified potential policy options that can facilitate solutions to the identified challenges.

2.2.1 Objectives of the Policy Dialogue Workshops

1. Familiarize key policy makers and other stakeholders on the BIO4AFRICA interventions.
2. Validated and prioritized the policy gaps and actions.
3. Discuss and build consensus on country specific potential options (legal, financial, tax, social, etc.) that could facilitate adoption of bio-based technologies.

2.2.2 Expected outcome and deliverables

The workshops aimed at creating consensus among all relevant policy stakeholders concerning the policy gaps relevant for the bioeconomy, potential policy actions and their relative importance. At the end of the workshops the following deliverables were achieved:

1. A final list of policy related challenges hindering the development of the Bioeconomy in each country.
2. Priority actions that each country needs to implement to address the policy issues
3. A joint *communique* capturing the priority actions and call for commitment of stakeholders to implement actions to address policy gaps.

2.2.3 Structure of the Workshops

The initial plan was to organize two cycles of policy dialogue events in each country. The first cycle was to be used as an opportunity to create awareness of the policy makers and other stakeholders on the Bio4Africa project and the technologies deployed in each country. The second cycle was to be used for the validation and prioritization of policy challenges and actions to remedy the issues affecting the development of the Bioeconomy in each country. However, owing to resource limitations, only one cycle of the policy dialogue events was organized. The dialogues, which took

the form of moderated workshops, converged 10-15 participants in each country, drawn from Government entities (policy makers), private sector and farmer representatives. The **one-day** meeting was facilitated by AATF and the local partner in each country: SavaNet (Ghana); AFAAS and KRC (Uganda), INP-HB (Côte d'Ivoire) and UASZ (Senegal). Table 1 presents details on the policy dialogue events organized in each country.

Table 1: Specific details on the implementation of the Policy Dialogue events

Country	**Venue**	**Date**	**Number of participants**	**Institutions represented**
Senegal	UASZ, Ziguinchor	25.04.2023	14	• Revenue Authority Representative • Agri entrepreneurs-middle men/processors/aggregators for the feedstock • Farmers cultivating feedstocks to be used for the biotechnology. • Livestock keepers-intensive, semi-intensive and pastoralists • Women Cooperative group leaders/ Farmer associations representative • Policy regulators-quality standard regulator • Officials from Agriculture, livestock and Trade and

				Industrialisation Department representation • Private agro dealers for extension
Côte d'Ivoire	INP-HB Yamoussoukro	03.05.2023	14	• Ministry of Agriculture and sustainable development • Ministry of animal and halieutic production • Ministry of professional teaching and training • FIRCA (Fund for Agricultural Research and Advice) • ANADER (National Research results Spreading Agency) • Autonomous District of Yamoussoukro • CI-PME (Small and Medium-sized enterprises promoting organization) • Cooperative 1 (Rice) • Cooperative 2 (Coffee & Cocoa) • Cooperative 3 (Rubber tree) • Cooperative 4 (Cashew) • University of Man • INP-HB-Yamoussoukro
Ghana	Gariba Lodge, Tamale	28.04.2023	18	• Ministry of Food and Agriculture – MoFA (Sagnarigu Municipal and Walewale Municipal) • Ministry of Environment, Science, Technology, and Innovation (MESTI) – Tamale. • Fish Farmers Association of Ghana • Peasant Farmers Association of Ghana • Business Resource Centre (Sagnarigu Municipal) • Tamale Metropolitan Assembly (Ministry of Local Government,

				Decentralization and Rural Development). • University for Development Studies (UDS) Faculty of Biosciences.
Uganda	Kampala	31.08.2023	17	• Office of the President • Ministry of Agriculture, Animal industries and Fisheries • Ministry of Science and Technology. • Ministry of Water and Environment • National Agriculture Research Organization. • Uganda National Farmers Federation • Uganda Revenue Authority • Ministry of Trade • Kampala Capital City Authority • Uganda Manufacturers Association • Makerere University • Uganda National Bureu of Standards • Private Sector actors • Private innovators

Figure 4: Section of Participants during the Policy Dialogue Event in Corte d'Ivoire

3 RESULTS : Country specific policy briefs

The outcomes of the three processes were packaged into country specific policy briefs which are presented in this section. These briefs were also packaged into standalone briefs that will be used for advocacy in each individual country. See attachments in the Annex session.

3.1 Uganda

The policy brief for Uganda was developed under the title "**Elimination of policy bottlenecks will boost utilization of bioproducts for better incomes and cleaner environment.**"

3.1.1 Summary of policy context in Uganda

Uganda has a potential to tap into economic and environmental benefits through enhanced production and marketing of biobased products. Some of the products that the Bio4Africa project is promoting in Uganda include high quality processed cattle, fish poultry and pig feeds from grass and crop residues. The key issues that have been identified for prioritization to boost the development of the biobased sector in Uganda include delays in the finalization of the National Bioeconomy Policy and its associated regulations, low awareness of the biobased products and disincentives for the private sector to invest in the sector. This brief recommends policy options to address these challenges to boost the development and commercialization of biobased products.

3.1.2 The potential for the bioeconomy in Uganda

Uganda will need to feed 55.9 Million more people by 2029 while coping with unprecedented demographic, socioeconomic, environmental, climatic and health transitions [8]. Undernourishment is still on the rise, considering that currently about 3 in every 10 children in Uganda suffer from undernutrition [13]. The bioeconomy can play a critical role in dealing with food security and environmental sustainability challenges. The development of the bioeconomy is increasingly becoming important as Countries across the world apply biological principles and processes in all sectors of the economy. The utilization of biological resources and crop residues that would otherwise be waste to produce livestock feeds, fuel and soil fertility management products can play a critical role in boosting farmer incomes and create cleaner environments. Given the good climatic condition ion Uganda with rainfall almost throughout the year, Uganda has a high production of biomass. Further, Uganda has a huge production of biproducts from agriculture and the food industry. Wastes from *Matooke* are estimates at 60 Kg/Person/year [22]. The plant-based biomass and wastes can be turned into useful products and earn farmers extra

income. These benefits can be achieved through the development of Uganda's Bioeconomy. The Bio4Africa project is one of the initiatives that aim at working towards optimizing the benefits that farmers generate from the Bioeconomy. This brief highlights the Bio4Afroca approach and technologies that the project is promoting in the country. Further, some of the challenges that stakeholders working in the bioeconomy face in the country as well as policy options to deal with these challenges are highlighted.

The Bio4Africa project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. In Uganda, the project is promoting the installation of a Green Biorefinery, the production of fish pellets from crop residues and the production of Biochar from crop residues.

3.1.3 Biobased technologies promoted in Uganda

The Bio4Africa project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. In Uganda, the project is promoting the installation of a Green Biorefinery, the production of fish pellets from crop residues and the production of Biochar from crop residues.

Figure 5: Green Biorefinery installed at KRC, Fort Portal-Uganda

A green bio-refinery was installed in Fort Portal at the Kabarole Research & Resource Centre (KRC). The facility which features technology and equipment from Grassa, a Dutch biotech company is used to refine green matter, mainly elephant grass, which is then processed into three products: protein concentrate (for pig and poultry feed), the press cake (for dairy cow feed) and whey juice (for piglet feed). The plant

can also utilize Gamba grass, the wild-growing leucaena tree and crop residues from local legumes, vegetables, cereals and tuber crops. This technology leads to reduced cost of livestock feeds, higher incomes for farmers from the sale of crop waste and access to low cost livestock feeds. A Green Biorefinery has the advantage of being a multi-productive system that produces low-price feedstock that is available in large quantities [2].

Pelletizing is a technique that utilizes a machine, called an extruder pelletization mill, for the production of livestock feeds pellets. This machine can be fed with crop residues from local legumes, vegetables, cereals and tuber crops. Waste products like cassava peels can be processed into High quality cassava peels (HQCP) which then are used to produce pellets for fish and poultry feeds. These products help to reduce cost of livestock feeds and also to higher incomes for farmers from the sale of crop waste and access to low-cost livestock feeds.

Pyrolysis is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450-600 ^{0}C) leading to the formation of charcoal like product called biochar. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads top cleaner environment and environmental sustainability.

3.1.4 Challenges in Uganda's bioeconomy

Through research and policy dialogues, bioeconomy stakeholders in Uganda have identified some issues that need to be addressed to enable communities in Uganda access full benefits from the Bioeconomy. The following are the key issues:

1. Although the import duty for machinery for production of livestock feeds are zero-rated under the EAC common tariff, some parts are taxable.
2. The private sector needs sufficient incentives such as tax breaks, subsidies to invest in the renewable energy and bioeconomy related production.
3. There is generally no standards for most products from biobased technologies.

4. Owing to limited number of enforcement officers, there is insufficient capacity for quality control to enforce quality standards for bio-based products.
5. There is limited **adoption** of products generated rough biobased technologies as a result of low awareness from users.
6. In cases where the quality standards have been set, there is limited dissemination leading to low awareness by traders and consumers.
7. **Limited technical advice** and external services to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.
8. Weak **linkages between actors** in the innovation ecosystem and entrepreneurs who scale the production of outputs from the bioeconomy.
9. **Limited funding** on renewable energy and Bioeconomy research

3.1.5 Recommendations for addressing policy related Bioeconomy challenges in Uganda

Towards addressing the identified challenges, we recommend the following:

1. The relevant Government organs need to fast track the finalization of the National Bioeconomy Policy (NBP) and the supporting regulations and guidelines to create an enabling environment to drive research, commercialization and development of bioeconomy.
2. The Uganda Revenue Authority and other relevant ministries should introduce tax breaks, waivers and subsidies on bioeconomy and renewable energy to encourage private sector investments.
3. The demand for biobased products can be boosted through sensitization and awareness creation campaigns on the use of biobased products accompanied by technology transfer initiatives. This can be boosted through institutionalization of trade shows and exhibitions on biobased technologies.
4. Where applicable there is need for Value Added Tax (VAT) exemption for equipment used for Biobased equipment such as briquet making machines.
5. Investment in capacity building and equipping the Uganda National Bureau of Standards (UNBS) including capacity strengthening through hiring and training of more standards officers.
6. Policy reforms towards establishment of waste management facilities and promoting waste segregation.
7. Encourage stakeholders to engage Uganda National Bureau of Standards (UNBS) to develop standards for new bio-based technologies and products and translate existing of standards into

local languages for ease of dissemination.

8. Increased mobilization of accessible research funds for bioeconomy innovation both from government and external sources.
9. Provide business incubation to researchers to support them though commercialization.
10. Extension of services to hard-to-reach areas using mobile based extension tools.
    Establishing a lead agency to coordinate innovation and commercialization in the bioeconomy.

3.2 Côte d'Ivoire

The policy brief for Côte d'Ivoire was developed under the title "**Hope for rural communities as innovations transformation tons of wastes into useful products and income.**"

3.2.1 Summary of policy context in Côte d'Ivoire

Côte d'Ivoire faces challenges related to environmental pollution from plastics, scarcity of livestock feeds and soil degradation. There is a potential to tap into economic and environmental benefits through enhanced production and marketing of bio-based products. The Bio4Africa project is promoting Biochar production from crop residues such as cocoa husks, production of bioplastics from cashew apple juice and livestock pellets from crop residues. The development and commercialization of these technologies however faces challenges related to research and development, prohibitive tax regimes, poor coordination, inadequate capacity, weak enforcement of standards and discriminatory land tenure. This brief recommends policy options to address these challenges.

3.2.2 The potential for the bioeconomy in Côte d'Ivoire

The agriculture sector accounts for 22% of gross domestic product and more than 75% of exports in Côte d'Ivoire [4]. Despite this, the World Bank reports on a widening urban/rural gap and only a modest reduction in rural poverty over the past few decades. Annual production of agricultural waste is estimated at 17 million tons. If not well managed, these wastes become are an environmental challenge due to the pollution they cause in the rural and urban communities. Some of these wastes can be however converted to saleable products that can help to create a new source of income in rural settings. Like other developing countries, Côte d'Ivoire faces the challenge of plastic pollution where more than 10% ends up in terrestrial and aquatic environments [12]. Compared with fossil-based

plastics, bio-based plastics have a lower carbon footprint and exhibit advantageous materials properties [17]. Regarding soil fertility management in the country, it has been reported that most soils suffer from chemical and biological impoverishment due to succession without appropriate organomineral restitutions, the consequences of opening up new land through deforestation [11]. Development of the livestock sector in Côte d'Ivoire needs strengthening of the feeds sub-sector, and especially enhanced production of local feeds to address the challenge of high cost of feeds. Against this background, the Bio4Africa project-initiated activities in the country to contribute in the development of the circular economy through the testing, development and deployment of biobased technologies.

3.2.3 Biobased technologies promoted in Côte d'Ivoire

Figure 6: The process of preparing Biochar in Côte d'Ivoire

The **Bio4Africa** project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. In Côte d'Ivoire, the project is promoting the installation of a Brazilian kiln for use in production of Biochar for water purification and soil fertility management; the production of bioplastics from cashew apple juice and needs and pelletising to produce livestock feeds.

Biochar is produced through a process called Pyrolysis**.** This is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450-600 ^{0}C) leading to the formation of charcoal like product called biochar. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon (sequestration). Because of better management of crop wastes, this also leads to cleaner environment and environmental sustainability. The production will help

combat deforestation, reduce the intensive use of synthetic fertilizers and improve access to clean water. The Bio4Africa project is already working with Kaptatchiva cooperative for the production of Biochar from Cocoa husks and its utilization for the soil fertility management in Cocoa fields.

A **bioplastic** can be defined as a polymer that is manufactured into a commercial product from a natural source or renewable resource [17]. Bioplastics from natural raw material present a biodegradable alternative to conventional petrochemical-based plastic and are environmentally safe and reducing dependency on fossil reserves. Polymers of biomass such as cellulose and starch are used as a starting material for the conversion of polylactic acids (PLAs), thermoplastic starch, and cellulose acetate (CA). In Corte d'Ivore, bio plastics will be processed from cashew apple juice.

Pelletizing is a technique that utilizes a machine, called an extruder pelletization mill, for the production of livestock feeds pellets. This machine can be fed with crop residues from local legumes, vegetables, cereals and tuber crops. Waste products like cassava peels can be processed into High quality cassava peels (HQCP) which then are used to produce pellets for animal feed to benefit poultry, pig, rabbits and guinea pig farmers. These products help to reduce the cost of livestock feeds by 30% and also to higher incomes for farmers from the sale of crop waste and access to low cost livestock feeds.

3.2.4 Challenges in Côte d'Ivoire bioeconomy

Bioeconomy stakeholders in Côte d'Ivoire have identified the challenges that are hindering the production and marketing of biobased products. Addressing these issues that need urgent interventions to enable communities in Côte d'Ivoire access full benefits from the Bioeconomy. The following are the key issues:

1. The investment of the private sector in bioeconomy and renewable energy is limited by the lack of targeted tax related instruments such as tax breaks and subsidies in favor of renewable energy and bioeconomy related technologies.
2. Due to limited awareness, there is low adoption of products from biobased technologies such as biogas and briquets.
3. Limited access to credit facilities for investors seeking to venture into renewable energy and the production of biobased products hinders market entry.

4. Weak linkages and limited cooperation between different ministries and across Ministries and stakeholders engaged in the bioeconomy hinders effective implementation of important activities such as research and development among others.
5. The Land tenure that limits access to land by disadvantaged groups such as women and youth to produce biobased feedstock.
6. Generally, quality standards for Biobased products are limited and where standards are existing, their enforcement remains a challenge, due to capacity issues.
7. Lack of technical advice and advisory services to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.

3.2.5 Recommendations for addressing policy related bioeconomy challenges in Côte d'Ivoire

Towards addressing the challenges to facilitate the development of the bio-economy and commercialization of products emanating from the biobased innovations, the following options are relevant:

- Implementation of fiscal inmcentives to the private sector such as tax exemption, reduction of custom duties charged on renewable energy equipment and subsidies to private sector players investing in the bioeconomy.
- Facilitation of access to credit facilities through instruments such as establishmet of an investment bank for development projects, establishment of a development fund dedicated to biobased initiatives, establishment of credit guarantee schemes and low interest loans to investors in biobased businesses.
- Awareness and senitization campaigns by the Government and partners to encourage the utilization of biobased products among users as well as showcase investment opportunities in the bioeconomy the private sector. Awareness creation on financing opportunities through carbon credits is also needed to ease financing constraints.
- Redefining of the cooperation policy between different ministries in the framework of development to enhance synergies and eliminate duplication of mandates and enhance efficiency. This could also be strengthened through strengthening of partnership between researchers, the private sector and the government

- Inclusion of agricultural parcels in urban planning to facilitate low cost access to raw materials and design mechanisms for long term lease of land. Focus should also be on securing land tenure through establishing land titles and certificates of ownership, eg: ACD).
- Capacity enhancement for public institutions involved in research and innovation in renewable energy and the bioeconomy in general to encourage local manufacturing of equipment as well as strengthening of the capacities of existing structures such as the Ivory Coast - Agence nationale d'appui au développement rural, ANADER (National Rural Development Support Agency).
- Working through CODINORM, the national standards and certification body, to establish standards for products emanating from Biobased processes and establish regulations to facilitate the enforcement of such standards. CODINORM should also impose basic certificates of analysis to guarantee product quality.

3.3 Ghana

The policy brief for Ghana was developed under the title "**Enhancing supply of low-cost livestock feeds through Biobased solutions in Ghana: What Policy makers need to know.**"

3.3.1 Summary of policy context in Côte d'Ivoire

Ghana's livestock sector continues to face challenges of high cost of feeds and low productivity. The country can potentially tap into biobased solutions to facilitate low-cost feed production. The Bio4Africa project is promoting livestock feed production using a green biorefinery, biochar production from crop residues such as maize and sorghum stover, and production of fish pellets from crop residues. Stakeholders in the bioeconomy face challenges related to taxation, limited enforcement of quality standards, limited private sector incentives, land tenure biased against youth and women, limited funding for local research and development for biobased solutions. This brief proposes some policy options to deal with these challenges and enhance development and commercialization of biobased solutions.

3.3.2 The potential for the bioeconomy in Ghana

More than half of Ghana's population is engaged in agriculture, with women representing around 39% of the labour force on the predominantly smallholder, traditional and rain-fed farm [6]. Due to climate change, farmers are experiencing the negative impact of declining rainfall and soil conditions, rising temperatures and other weather extremes. The supply of livestock feeds fluctuates due to rainfed production systems experienced in the savanna regions where cattle production is a major activity. As a result, livestock keepers turn to purchased feeds, particularly unformulated ruminant feeds such as crop residues (groundnut haulms, cowpea haulms, and pigeon pea residue), agro-industrial by-products (maize, rice and sorghum bran) and fresh grasses and local browse leaves (Ficus sp, Afzelia sp. and Pterocarpus evinacelus) [19]. A recent study [20] identified the need for equipping farmers with knowledge of feed preparation skills to enable them prepare quality feed for their birds as well reduced cost of feed preparation tools and equipment by these stakeholders to address the issue of feed cost and quality. In line with the quest for facilitating the transfer of innovations for low cost biobased livestock feeds, the Bio4Africa project is piloting technologies for the production of cattle press cake and concentrated protein for livestock feeds formulation. Also in the innovation tool kit is the production of Biochar that will be used for soil conditioning and pelletization to produce fish feeds. This brief provides a description of these technologies and their benefits to the farming community in Ghana as well as some of the challenges that could hinder the development and commercialization of these technologies. Finally policy options to deal with these challenges are provided.

3.3.3 Biobased technologies promoted in Ghana

The **Bio4Africa** project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. The Bio4Africa test sites in Ghana are located at Nasia and Yagaba-Kubori in the north-east savannah region of Ghana. The area is characterized by intense transhumant pastoralism activities due to its diverse grasslands and annual rainy season. will test small-scale bio-based technologies with potential to improve the livelihood and food security of transhumant pastoralist communities and help curtail the nomad/farmer conflict over grazing lands and pasture. In the test sites, 45 farmer groups, including small, medium and large-scale farmers, in and are providing local forage species for the test site. The technologies that the project has been promoting are described in detail below.

Figure 7: Biochar prepared from Maize cobs using the Brazilian kiln in Ghana

A **green bio-refinery** was installed at the SavaNet Agriculture Technology Research Center in Loagri. The facility features technology and equipment from Grassa, a Dutch biotech company which is used to refine green matter, mainly Cajanus biomass, which is then processed into three products: protein concentrate (for pig and poultry feed), the press cake (for dairy cow feed) and whey juice (for piglet feed). A Green Biorefinery has the advantage of being a multi-productive system that produces low-price feedstock that is available in large quantities [3]. The extraction of proteins from leaves was found to be a highly favourable alternative to the high dependency on soy imports in Europe [1]. The plant can also utilize Gamba grass, the wild-growing lucaena tree and crop residues from local legumes, vegetables, cereals and tuber crops. This technology leads to reduced cost of livestock feeds, higher incomes for farmers from the sale of crop waste and access to low-cost livestock feeds.

Pyrolysis is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450-600 ^{0}C) leading to the formation of charcoal like product called biochar. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize

stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhance soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads top cleaner environment and environmental sustainability. When added to farms, this helps to enhance soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads to environmental sustainability [16].

Pelletizing is a technique that utilizes a machine, called an extruder pelletization mill, for the production of livestock feeds pellets. This machine can be fed with crop residues from local legumes, vegetables, cereals and tuber crops. Waste products like cassava peels can be processed into High quality cassava peels (HQCP) which then are used to produce pellets for animal feed to benefit poultry, pig, rabbits and guinea pig farmers. These products help to reduce cost of livestock feeds by 30% and also to higher incomes for farmers from the sale of crop waste and access to low-cost livestock feeds.

3.3.4 Challenges in Ghana's bioeconomy

Bioeconomy stakeholders in Ghana have identified the challenges that are hindering the production and marketing of biobased products. Addressing these issues that need to be prioritized to enable communities in Ghana access full benefits from the Bioeconomy. The following are the key issues:

1. Weak alignments between national strategies with regional and international frameworks such as the Africa Continental Free trade area (AfCFTA).
2. Due to limited awareness, there is low adoption of products from biobased technologies such as biogas and briquets.
3. The investment of the private sector in bioeconomy and renewable energy is limited by the lack of targeted tax related instruments such as tax breaks and subsidies in favor of renewable energy and bioeconomy related technologies.
4. There is limited enforcement of quality standards by the Ghana Standards Authority (GSA), Environmental Protection Agency (EPA) and Food and Drugs Authority (FDA) due to resource and capacity issues.
5. The enabling environment regulating the bioeconomy is still weak and needs alignment.

6. There is lack of sufficient incentives for women and youth to venture in biobased related businesses. Land tenure that emphasizes on land ownership and control by men disadvantages women and the youth them.
7. Lack of technical advice and advisory services to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.
8. Local research entities including Universities lack sufficient resources and capacity to engage in long term research in biobased innovations. The Curriculum of most universities also doesn't have sufficient orientation towards support of biobased Universities.
9. There are weak linkages between actors in the bioeconomy that are necessary for enhancing complementarities in research and development as well as commercialization of biobased innovations and products.

3.3.5 Recommendations for addressing policy related bioeconomy challenges in Ghana

Towards addressing the challenges to facilitate the development of the bio-economy and commercialization of products emanating from the biobased innovations, the following options are relevant:

- There is need to align Ghana's trade initiatives and policies with the African Continental Free Trade Agreement (AfCFTA) to enable the private sector benefit from the provisions that could reduce the cost of importation of equipment and trading of their products regionally.
- Need for awareness creation among private sector companies and users of biobased products. This can be supported by technology demonstrations and the setting up of technology parks.
- Establish relevant bi-laws, regulations, and guidelines to facilitate commercialization of biobased technologies.
- Government programmes to incentive women and youth to engage in Biobased enterprises.
- Enhance the enforcement of quality standards by Ghana Standards Authority (GSA), Environmental Protection Agency (EPA) and Food and Drugs Authority (FDA). GSA should be sufficiently resourced to play its role effectively. Set up sufficient standards for emerging biobased products in the context of Ghana's and ISOs.

- Establish mechanisms to foster collaboration between actors in the biobased sector players including market linkages and establishment of common interest platforms.
- Create Incentives for the private sector including tax exemptions and subsidies to incentivize investment.
- Enhance research and development to boost local solutions including research grants to local R&D partners.
- The Fiscal incentives in the sector including duty exemptions spearheaded by Ministry of Food and Agriculture (MOFA) and Ministry of Finance (MoF).
- Capacity building on Biobased technologies including adoption of Biobased focused curriculum in institutions of Higher learning.
- Increased funding for biobased research including low interest loans. Create a biobased fund that investors can access for investment.
- Encourage joint research between public institutions of higher learning and private companies to boost research and innovation.

3.4 Senegal

The policy brief for Senegal was developed under the title: **Clean energy solutions promise a better future for rural communities in Senegal: Why action is needed now**

3.4.1 Summary of policy context in Senegal

Nearly 40% of Senegal's primary energy is drawn from biomass most of which non-renewable Communities in Senegal stand a chance to access cleaner energy that will lead to better environmental and economic outcomes. The Bio4Africa project is promoting Biochar production from crop residues such as maize and sorghum stover, production of biogas from biowastes and a technology that utilizes special equipment to compact numerous types of waste biomasses to produce fuel briquets. The development and commercialization of these technologies, however, faces challenges related to research and development, prohibitive taxation regimes, weak coordination, inadequate capacity, enforcement of standards and discriminative land tenure systems. This brief suggests policy options to deal with these challenges.

3.4.2 *The potential for the bioeconomy in Senegal*

Nearly 40% of Senegal's primary energy is drawn from biomass most of which non-renewable, mainly firewood and charcoal supplemented by kerosene and LPG gas [5]. The number of people relying on traditional biomass for cooking grew by 50% from 6.5 million in 2000 to 12.5 Million in 2023 [9]. This puts pressure on the country's forest resources and the impact on households is already being experienced given higher prices of firewood and charcoal in major urban centers. Intensified efforts to promote the development and use of environmentally safe energy sources are necessary. Although Senegal doesn't have a specific policy on Bioeconomy, the renewable energy sector is regulated through the Energy Sector Development Policy Letter (LPDSE 2019-2023) [7] which outlines the action plan for the energy sector and will soon be replaced by the ten-year Integrated Low-Cost Plan (*Plan Intégré à Moindre Coût* PIMC) and the next LPDSE (2). These policy frameworks seek to guide implementation of actions in the energy sector to achieve facilitate access and sustainable utilization of energy in Senegal. As Senegal gears towards the implementation of its policies, it will be critical for the country to prioritize clean cooking programmes overall and renewable energy sources, while borrowing experiences from other countries in Africa and elsewhere [9]. The current interventions by the Bio4Africa project seeks to provide options for cleaner energy in the country. Further the proposed solutions support environmental management through utilization of crop residues and other wastes for energy and soil conditioning products. This brief provides profiles of proposed solutions and identifies challenges that may hinder their development and commercialization as well as suggest policy options to deal with these challenges.

3.4.3 *Biobased technologies promoted in Senegal*

The **Bio4Africa** project supports the deployment of the bioeconomy in rural Africa via the development of bio-based solutions and value chains with a circular approach to drive the cascading use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass, needs and contexts in Africa. In Senegal the project has been championing for three technologies: Fuel briquettes, biogas production and biochar production.

The **Briquetting technology** utilizes special equipment to compact numerous types of waste biomasses, such as cashew shells, peanut shells and millets/Maize stover, into biomass briquettes.

The compaction of the biomass improves its combustion properties and makes transport, distribution, and storage easier and more cost-effective. The annual demand of the raw materials is estimated at 576 tons for peanut shells, 250 tons for cashew shells and 300 tons for millet/corn stems. The technology will also require 126 tons of wheat flour annually to be used as a binder. The pellets that will be used in improved stoves or gasifiers to meet the energy needs for cooking in households. In addition, this technology allows improvement of the living conditions of women in the households by practicing clean cooking with less risks of contracting respiratory diseases. At the same time the technique enables farmers to earn extra income and reduces green house gas emission [12].

The **bio digester** is a system for producing biogas from biodegradable organic materials such as cow dung, mahogany apples. Biogas is produced from the anaerobic decomposition of organic feedstock such as manure, agricultural residues, agro-industrial by products, energy crops, food waste. These residues are placed into anaerobic digesters (biogas plant) in which specific microorganisms at controlled conditions break down the organic materials producing biogas and digestate. Pre-treatment technology (i.e, mechanical devices, trace elements supplementation, enzymes) can be used to optimize the process. The effluent from anaerobic digestion is called digestate and it is a natural fertilizer. Studies have proven that the installation of biogas plant results in economic, social and health improvements by reducing expenditure of fuel and fertilizer along with time saving and lessen cases of disease [21,14]. It is returned to the land by irrigation ("fertigation") recycling a large fraction of the mineral nutrients and increasing soil carbon levels with soil fertility benefits (organic farming).

Figure 8: Fuel Briquettes produced using Crop residues in Senegal

Pyrolysis is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450-600 ^{0}C) leading to the formation of charcoal like product called **biochar**. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil

conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads top cleaner environment and environmental sustainability [15].

3.4.4 Challenges in Senegalese bioeconomy

Bioeconomy stakeholders in Senegal have identified the challenges that are hindering the production and marketing of biobased products. Addressing these issues that need to be prioritized to enable communities in Senegal access full benefits from the Bioeconomy. The following are the key issues:

1. The high cost of small off grid electricity generation systems as a result of taxes has led to limited access by users.
2. The investment of the private sector in bioeconomy and renewable energy is limited by the lack of targeted tax related instruments such as tax breaks and subsidies in favor of renewable energy and bioeconomy related technologies.
3. Due to limited awareness, there is low adoption of products from biobased technologies such as biogas and briquets.
4. Although the government established Promotion des Investissements et Grands Travaux (APIX), a National Agency responsible for the Promotion of Investment and major Works in Senegal, many investors don't make use of the established mechanisms.
5. The Land tenure that limits access to land by disadvantaged groups such as women and youth to produce biobased feedstock.
6. Lack of technical advice and advisory services to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.
7. Low private sector involvement in renewable energy manufacturing
8. Generally, Senegal does not have quality standards for Biobased products neither does it apply international standards such as the Global Gap to facilitate quality control and standardization of products emanating from Biobased technologies.
9. Limited funding on renewable energy research.

3.4.5 Recommendations for addressing policy related bioeconomy challenges in Senegal

Towards addressing the challenges to facilitate the development of the bio-economy and commercialization of products emanating from the biobased innovations, the following options are relevant:

- Establish a renewable energy fund and other policy support instruments for renewable energy such as tax breaks, subsidies and incentives for the investment in solar energy and other renewable energy.
- Waive taxes on the equipment or Zero rate the import duty on renewable energy related equipment to encourage the importation of such equipment at low cost.
- Popularize the National Agency for the Promotion of Investments and Major Projects (APIX) through awareness creation campaigns and linkages with investors.
- To facilitate the access to low-cost credit to finance investments in the bioeconomy and green energy, the Government of Senegal is encouraged to establish an investment guarantee fund.
- Establish a policy to support the formulation and commercialization of bio-based fertilizers.
- Enhancing the flexibility of existing guarantees to facilitate access to land by disadvantaged groups such as women and youth.
- Intensify and diversify the agricultural production through strategies that encourage production of certified seeds and adoption of hybrid varieties to boost the production of feed stock.
- Establish easy to access, low cost and permanent standardization structures for bio-based technologies/products.

4 CONCLUSIONS AND NEXT STEPS

This report has presented the policy briefs that emanated from policy review and dialogues conducted in Ivory Coast, Uganda, Ghana and Senegal. The report presents the objectives of the task, the methodology followed and key highlights of the results. Following the development of the Policy briefs, it is critical that these documents are disseminated among the high-level policy decision makers in the respective countries. The project will schedule advocacy missions in the respective countries. These policy briefs will feed into the EU-Africa Policy Roundtable in Brussels (10-15 participants) with relevant policy makers and stakeholders, organised by FBCD to share and exchange our knowledge, stimulating a constructive debate. The debate will drive the fine tuning of the initial briefs to create the project's "Policy recommendations" (M44), including practical steps, case studies and policy measures that African policy makers could deploy to promote the replication of bio-based models and solutions for diversifying the income of farmers in rural Africa.

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6 Annexes : Country Specific Policy Briefs

BIO4AFRICA

POLICY BRIEF

30th May 2024

Bio4Africa Policy Brief No.001/2024

Côte d'Ivoire

Hope for Rural Communities as Innovations Transforms Tons of Wastes into Useful Products and Income

By Daniel Kyalo Willy and Francis Nangayo

Summary

- Côte d'Ivoire faces challenges related to environmental pollution from plastics, scarcity of livestock feeds and soil degradation.
- There is a potential to tap into economic and environ- mental benefits through enhanced production and marketing of bio-based products.
- The Bio4Africa project is promoting Biochar production from crop residues such as cocoa husks, production of bioplastics from cashew apple juice and livestock pellets from crop residues.
- The development and commercialization of these technologies however faces challenges related to research and development, prohibitive tax regimes, poor coordination, inadequate capacity, weak enforcement of standards and discriminatory land tenure.
- This brief recommends policy options to address these challenges.

Background

The agriculture sector accounts for 22% of gross domestic product and more than 75% of exports in Côte d'Ivoire [1]. Despite this, the World Bank reports on a widening urban/rural gap and only a modest reduction in rural poverty over the past few decades. Annual production of agricultural waste is estimated at 17 million tons. If not well managed, these wastes become are an environmental challenge due to the pollution they cause in the rural and urban communities. Some of these wastes can be however converted to saleable products that can help to create a new source of income in rural settings.

Like other developing countries, Côte d'Ivoire faces the challenge of plastic pollution where more than 10% ends up in terrestrial and aquatic environments [2]. Compared with fossil-based plastics, bio-based plastics have a lower carbon footprint and exhibit advantageous materials properties [3]. Regarding soil fertility management in the country, it has been reported that most soils suffer from chemical and biological impoverishment due to succession without appropriate organomineral restitutions, the consequences of opening up new land through deforestation [4].

Development of the livestock sector in Côte d'Ivoire needs strengthening of the feeds sub-sector, and especially enhanced production of local feeds to address the challenge of high cost of feeds. Against this background, the Bio4Africa project initiated activities in the country to contribute in the development of the circular economy through the testing, development and deployment of biobased technologies.

https://www.bio4africa.eu/

Biobased technologies promoted in Côte d'Ivoire through the Bio4Africa project

The **Bio4Africa** project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. In Côte d'Ivoire, the project is promoting the installation of a Brazilian kiln for use in production of Biochar for water purification and soil fertility management; the production of bioplastics from cashew apple juice and needs and pelletising to produce livestock feeds.

Brazilian Kiln technology for Biochar

Cashew Apple to provide juice to be used in Bioplastic production

Biochar for soil conditioning

Biochar is produced through a process called Pyrolysis. This is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450-600 0C) leading to the formation of charcoal like product called biochar. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon (sequestration). Because of better management of crop wastes, this also leads top cleaner environment and environ- mental sustainability. The production will help combat deforestation, reduce the intensive use of synthetic fertilizers and improve access to clean water. The Bio4Africa project is already working with Kaptatchiva cooperative for the production of Biochar from Cocoa husks and its utilization for the soil fertility management in Cocoa fields.

A **bioplastic** can be defined as a polymer that is manufactured into a commercial product from a natural source or renewable resource [5]. Bioplastics from natural raw material present a biodegradable alternative to conventional petrochemical-based plastic and are environmentally safe and reducing dependency on fossil reserves. Polymers of biomass such as cellulose and starch are used as a starting material for the conversion of polylactic acids (PLAs), thermoplastic starch, and cellulose acetate (CA). In Corte d'Ivore, bio plastics will be processed from cashew apple juice.

Palletizing is a technique that utilizes a machine, called an extruder palletization mill, for the production of livestock feeds pellets. This machine can be fed with crop residues from local legumes, vegetables, cereals and tuber crops. Waste products like cassava peels can be processed into High quality cassava peels (HQCP) which then are used to produce pellets for animal feed to benefit poultry, pig, rabbits and guinea pig farmers. These products help to reduce cost of livestock feeds by 30% and also to higher incomes for farmers from the sale of crop waste and access to low cost livestock feeds.

Challenges in the Bioeconomy of Côte d'Ivoire

Bioeconomy stakeholders in Côte d'Ivoire have identified the challenges that are hindering the production and marketing of biobased products. Addressing these issues that need urgent interventions to enable communities in Côte d'Ivoire access full benefits from the Bioeconomy. The following are the key issues:

1. The investment of the private sector in the bioeconomy and renewable energy is limited by the **lack of targeted tax related instruments** such as tax breaks and subsidies in favor of renewable energy and bioeconomy related technologies.
2. Due to **limited awareness**, there is low adoption of products from biobased technologies such as biogas and briquets.
3. **Limited access to credit facilities** for investors seeking to venture into renewable energy and the production of biobased products hinders market entry.
4. **Weak linkages and limited cooperation** between different ministries and across Ministries and stakeholders engaged in the bioeconomy hinders effective implementation of important activities such as research and development among others.
5. The Land tenure that limits access to land by disadvantaged groups such as **women and youth** to produce bi-obased feedstock.
8. Generally, **quality standards for Biobased products** are limited and where standards are existing, their enforcement remains a challenge, due to capacity issues.
6. Lack of **technical advice and advisory services** to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.

Recommendations

Towards addressing the challenges to facilitate the development of the bio-economy and commercialization of products emanating from the biobased innovations, the following options are relevant:

- Implementation of fiscal incentives to the private sector such as tax exemption, reduction of custom duties charged on renewable energy equipment and subsidies to private sector players investing in the bioeconomy.
- Facilitation of access to credit facilities through instruments such as establishment of an investment bank for development projects, establishment of a development fund dedicated to biobased initiatives, establishment of credit guarantee schemes and low interest loans to investors in biobased businesses.
- Awareness and senitization campaigns by the Government and partners to encourage the utilization of biobased products among users as well as showcase investment opportunities in the bioeconomy the private sector. Awareness creation on financing opportunities through carbon credits is also needed to ease financing constraints.
- Redefining of the cooperation policy between different ministries in the framework of development to enhance synergies and eliminate duplication of mandates and enhance efficiency. This could also be strengthened through strengthening of partnership between researchers, the private sector and the government
- Inclusion of agricultural parcels in urban planning to facilitate low cost access to raw materials and design mechanisms for long term lease of land. Focus should also be on securing land tenure through establishing land titles and certificates of ownership, eg: ACD)
- Capacity enhancement for public institutions involved in research and innovation in renewable energy and the bioeconomy in general to encourage local manufacturing of equipment as well as strengthening of the capacities of existing structures such as the Ivory Coast - Agence nationale d'appui au développement rural, ANADER (National Rural Development Support Agency).

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Acknowledgement

The authors appreciate the participants in the policy dialogue events drawn from Government Ministries, Departments and Agencies, the private sector and farmers and their representatives for the contribution of ideas that culminated to this policy brief. The support from Côte d'Ivoire Bio4Africa project PI and staff of the Institut National Polytechnique Félix HOUPHOUËT-BOIGNY (INP-BH) Yamoussoukro and other project partners is highly appreciated.

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Horizon 2020
European Union Funding
for Research & Innovation

The Bio4Africa project is funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

BIO4AFRICA

POLICY BRIEF

30th May 2024

Bio4Africa Policy Brief No.002/2024

Senegal

Clean energy solutions promise a better future for rural communities in Senegal: Why action is needed now

By Daniel Kyalo Willy and Francis Nangayo

Summary

- Nearly 40% of Senegal's primary energy is drawn from biomass most of which non-renewable.
- Communities in Senegal stand a chance to access cleaner energy that will lead to better environmental and economic outcomes.
- The Bio4Africa project is promoting Biochar production from crop residues such as maize and sorghum stover, production of biogas from biowastes and a technology that utilizes special equipment to compact numerous types of waste biomasses to produce fuel briquets.
- The development and commercialization of these technologies however faces challenges related to research and development, prohibitive taxation regimes, weak coordination, inadequate capacity, enforcement of standards and discriminative land tenure systems.
- This brief suggest policy options to deal with these challenges.

The potential for the Bioeconomy in Senegal

Nearly 40% of Senegal's primary energy is drawn from biomass most of which non-renewable, mainly firewood and charcoal supplemented by kerosene and LPG gas (1). The number of people relying on traditional biomass for cooking grew by 50% from 6.5 Million in 2000 to 12.5 Million in 2023 (2).

This puts pressure on the country's forest resources and the impact on households is already being experienced given higher prices of firewood and charcoal in major urban centers. Intensified efforts to promote the development and use of environmentally safe energy sources are necessary. Although Senegal doesn't have a specific policy on Bioeconomy, the renewable energy sector is regulated through the Energy Sector Development Policy Letter (LPDSE 2019-2023) (3) which outlines the action plan for the energy sector and will soon be replaced by the ten-year Integrated Low-Cost Plan (*Plan Intégré à Moindre Coût* PIMC) and the next LPDSE (2).

These policy frameworks seek to guide implementation of actions in the energy sector to achieve facilitate access and sustainable utilization of energy in Senegal. As Senegal gears towards the implementation of its policies, it will be critical for the country to prioritize clean cooking programmes overall and renewable energy sources, while borrowing experiences from other countries in Africa and elsewhere (2).

The current interventions by the Bio4Africa project seeks to provide options for cleaner energy in the country. Further the proposed solutions support environmental management through utilization of crop residues and other wastes for energy and soil conditioning products. This brief provides profiles of proposed solutions and identifies challenges that may hinder their development and commercialization as well as suggest policy options to deal with these challenges.

Biobased technologies promoted by Bio4Africa in Senegal

The **Bio4Africa** project supports the deployment of the bioeconomy in rural Africa via the development of bio-based solutions and value chains with circular approach to drive the cascading use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small- scale, and robust bio-based techs adapted to local biomass, needs and con- texts in Africa. In Senegal the project has been championing for three technologies: Fuel briquettes, biogas production and biochar production.

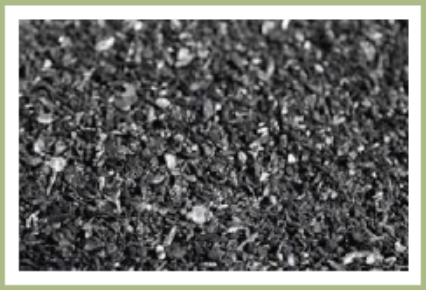
Briquettes for use in improved cooking stoves

Briquettes for use in improved cooking stoves

The **Briquetting technology** utilizes special equipment to compact numerous types of waste biomasses, such as cashew shells, peanut shells and millets/ Maize stover, into biomass briquettes. The compaction of the biomass improves its combustion properties and makes transport, distribution, and storage easier and more cost-effective. The annual demand of the raw materials is estimated at 576 tons for peanut shells, 250 tones for cashew shells and 300 tons for millet/corn stems. The technology will also require 126 tons of wheat flour annually to be used as a binder. The pellets that will be used in improved stoves or gasifiers to meet the energy needs for cooking in households. In addition, this technology allows improvement of the living conditions of women in the households by practicing clean cooking with less risks of contracting respiratory diseases. At the same time the technique enables farmers to earn extra income and reduces green house gas emmission (4).

Biogas production

Biogas production



Biochar for soil conditioning

Biochar for soil conditioning

The **bio digester** is a system for producing biogas from biodegradable organic materials such as cow dung, mahogany apples. Biogas is produced from the anaerobic

decomposition of organic feedstock such as manure, agricultural residues, agro-industrial by products, energy crops, food waste. These residues are placed into anaerobic digesters (biogas plant) in which specific micro-organisms at controlled conditions break down the organic materials producing biogas and digestate. Pre-treatment technology (i.e, mechanical devices, trace elements supplementation, enzymes) can be used to optimize the process. The effluent from anaerobic digestion is called digestate and it is a natural fertilizer. Studies have proven that the installation of biogas plant results in economic, social and health improvements by reducing expenditure of fuel and fertilizer along with time saving and lessen cases of disease (5,6).

It is returned to the land by irrigation ("fertigation") recycling a large fraction of the mineral nutrients and increasing soil carbon levels with soil fertility benefits (organic farming).

Pyrolysis is a technique where green matter is subjected to combustion with- out oxygen at very high temperatures (approx. 450-600 ^{0}C) leading to the formation of charcoal like product called **biochar**. This process utilizes crop- based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads top cleaner environment and environmental sustainability (7).

Bioeconomy stakeholders in Senegal have identified the challenges that are hindering the production and marketing of biobased products. Addressing these issues that need to be prioritized to enable communities in Senegal access full benefits from the Bioeconomy. The following are the key issues:

Challenges in Senegalese Bioeconomy

1. The high cost of small off grid electricity generation systems as a result of taxes has led to limited access by users.
2. The investment of the private sector in the bioeconomy and renewable energy is limited by the lack of targeted tax related instruments such as tax breaks and subsidies in favor of renewable energy and bioeconomy related technologies.
3. Due to limited awareness, there is low adoption of products from biobased technologies such as biogas and briquets.
4. Although the government established Promotion des Investissements et Grands Travaux
5. (APIX), a Na- tional Agency responsible for the Promotion of In- vestment and major Works in Senegal, many investors don't make use of the established mechanisms.

6. The Land tenure that limits access to land by disadvantaged groups such as **women and youth** to produce biobased feedstock.
7. Lack of **technical advice and advisory services** to sup- port acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.
8. Low private sector involvement in renewable energy manufacturing
9. Generally, Senegal does not have quality standards for Biobased products neither does it apply international standards such as the Global Gap to facilitate quality control and standardization of products emanating from Biobased technologies.
10. Limited funding on renewable energy research

Recommendations

- Establish a renewable energy fund and other policy support instruments for renewable energy such as tax breaks, subsidies and incentives for the investment in solar energy and other renewable energy.
- Waive taxes on the equipment or Zero rate the import duty on renewable energy related equipment to encourage the importation of such equipment at low cost.
- Popularize the National Agency for the Promotion of Investments and Major Projects (APIX) through awareness creation campaigns and linkages with investors.
- To facilitate the access to low cost credit to finance investments in the bioeconomy and green energy, the Government of Senegal is encouraged to establish an investment guarantee fund.
- Establish a policy to support the formulation and commercialization of bio-based fertilizers.
- Enhancing the flexibility of existing guarantees to facilitate access to land by disadvantaged groups such as women and youth.
- Intensify and diversify the agricultural production through strategies that encourage production of certified seeds and adoption of hybrid varieties to boost the production of feed stock.

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Acknowledgement

The authors appreciate the participants in the policy dialogue events drawn from Government Ministries, Departments and Agencies, the private sector and farmers and their representatives for the contribution of ideas that culminated to this policy brief. The support from Senegal Bio4Africa project PI and staff of Universite Assane Seck Zinguinchor (UAZ) and other project partners is highly appreciated.

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Horizon 2020
European Union Funding
for Research & Innovation

The Bio4Africa project is funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

BIO4AFRICA

POLICY BRIEF

30th May 2024

Bio4Africa Policy Brief No.003/2024

Uganda

Elimination of Policy Bottlenecks will Boost Utilization of Bioproducts for Better Incomes and Cleaner Environment

By Daniel Kyalo Willy and Francis Nangayo

Summary

- Uganda has a potential to tap into economic and environmental benefits through enhanced production and marketing of biobased products.
- Some of the products that the Bio4Africa project is promoting in Uganda include high quality processed cattle, fish poultry and pig feeds from grass and crop residues.
- The key issues that have been identified for prioritization to boost the development of the biobased sector in Uganda include delays in the finalization of the National Bioeconomy Policy and its associated regulations, low awareness of the biobased products and disincentives for the private sector to invest in the sector.
- This brief recommends policy options to address these challenges to boost the development and commercialization of biobased products

The potential for the Bioeconomy in Uganda

Uganda will need to feed 55.9 Million people by 2029 while coping with unprecedented demographic, socioeconomic, environmental, climatic and health transitions [1]. Undernourishment is still on the rise, considering that currently about 3 in every 10 children in Uganda suffer from under nutrition [2]. The bioeconomy can play a critical role in dealing with food security and environmental sustainability challenges. The development of the bioeconomy is increasingly becoming important as Countries across the world apply biological principles and processes in all sectors of the economy. The utilization of biological resources and crop residues that would otherwise be waste to produce livestock feeds, fuel and soil fertility management products can playa critical role in boosting farmer incomes and create cleaner environments. Given the good climatic condition ion Uganda with rainfall almost throughout the year, Uganda has a high production of biomass. Further, Uganda has a huge production of bi-products from agriculture and the food industry. Wastes from *Matooke* alone are estimates at 60 Kg/ Person/year [3]. The plant based biomass and wastes can be turned into useful products and earn farmers extra income. These benefits can be achieved through the development of Uganda's Bioeconomy. The Bio4Africa project is one of the initiatives that aim at working towards optimizing the benefits that farmers generate from the Bioeconomy. This brief highlights the Bio4Africa approach and technologies that the project is promoting in the country. Further, some of the challenges that stakeholders working in the bioeconomy face in the country as well as policy options to deal wit these challenges are highlighted.

https://www.bio4africa.eu/

Biobased technologies deployed in Uganda

Fish Pellets from Crop residues: High Quality Cassava Peels

Biochar from crop residues to be used as soil amendment product

The Green Biorefinery in Fort Portal, Uganda, turning elephant grass into refined Livestock feeds

Biobased technologies promoted in Uganda

The Bio4Africa project supports the deployment of the bioe-conomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local resources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. In Uganda, the project is promoting the installation of a Green Biorefinery, the production of fish pellets from crop residues and the production of Biochar from crop residues.

A green bio-refinery was installed in Fort Portal at the Kabarole Research & Resource Centre (KRC). The facility which features technology and equipment from Grassa, a Dutch biotech company is used to refine green matter, mainly elephant grass, which is then processed into three products: protein concentrate (for pig and poultry feed), the press cake (for dairy cow feed) and whey juice (for piglet feed). The plant can also utilize Gamba grass, the wild-growing leucaena tree and crop residues from local legumes, vegetables, cereals and tuber crops. This technology leads to reduced cost of livestock feeds , higher incomes for farmers from the sale of crop waste and access to low cost livestock feeds. A Green Biorefinery has the ad- vantage of being a multi-productive system that produces low-price feedstock that is available in large quantities [4].

Palletizing is a technique that utilizes a machine, called an extruder palletization mill, for the production of livestock feeds pellets. This machine can be fed with crop residues from local legumes, vegetables, cereals and tuber crops. Waste products like cassava peels can be processed into High quality cassava peels (HQCP) which then are used to produce pellets for fish and poultry feeds. These products help to reduce cost of livestock feeds and also to higher incomes for farmers from the sale of crop waste and access to low cost livestock feeds.

Pyrolysis is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450- 600 ^{0}C) leading to the formation of charcoal like product called biochar. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads top cleaner environment and environmental sustainability.

Sound Bite

"It's time to stop burning our planet, and start investing in the abundant renewable energy all around us."

António Guterres, Secretary-General of the United Nations

Challenges in Uganda's Bioeconomy

Through research and policy dialogues, bioeconomy stakeholders in Uganda have identified some issues that need to be addressed to enable communities in Uganda access full benefits from the Bioeconomy. The following are the key issues:

1. Although the import duty for machinery for production of livestock feeds are zero-rated under the EAC common tariff, some parts are taxable.
2. The private sector need sufficient incentives such as tax breaks, subsidies to invest in the renewable energy and bioeconomy related production.
3. There is generally no standards for most products from biobased technologies.
4. Owing to limited number of enforcement officers, there is insufficient capacity for quality control to enforce quality standards for bio-based products.
5. There is limited **adoption** of products generated rough biobased technologies as a result of low awareness from users.
6. In cases where the quality standards have been set, there is limited dissemination leading to low awareness by traders and consumers.
7. **Limited technical advice** and external services to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.
8. Weak **linkages between actors** in the innovation ecosystem and entrepreneurs who scale the production of outputs from the bioeconomy.
9. **Limited funding** on renewable energy and Bioeconomy research.

Recommendations

Towards addressing the identified challenges, we recommend the following:

1. The relevant Government organs need to fast track the finalization of the National Bioeconomy Policy (NBP) and the supporting regulations and guidelines to create an enabling **environment** to drive research, commercialization and development of bioeconomy.
2. The Uganda Revenue Authority and other relevant ministries should introduce **tax breaks**, **waivers** and **subsidies** on bioeconomy and renewable energy to encourage private sector investments.
3. The demand for biobased products can be boosted through sensitization and awareness creation campaigns on the use of biobased products accompanied by technology transfer initiatives. This can be boosted through institutionalization of trade shows and exhibitions on biobased technologies.
4. Where applicable there is need for **Value Added Tax (VAT) exemption** for equipment used for Biobased equipment such as briquette making machines.
5. Investment in capacity building and equipping the UBS including **capacity strengthening** through hiring and training of more standards officers.
6. Policy reforms towards establishment of **waste management facilities** and promoting **waste segregation**.
7. Encourage stakeholders to **engage Uganda National Bureau of Standards (UNBS) to develop standards** for new bio-based technologies and products and **translate existing of standards** into local languages for ease of dissemination
8. **Increased mobilization** of accessible research funds for bioeconomy innovation both from government and external sources.
9. Provide **business incubation** to researchers to support them though commercialization.
10. Extension of services to hard-to-reach areas using mobile based extension tools.
11. Establishing a **lead agency** to coordinate innovation and commercialization in the bioeconomy.

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Acknowledgement

The authors appreciate the participants in the policy dialogue events drawn from Government Ministries, Departments and Agencies, the private sector and farmers and their representatives for the contribution of ideas that culminated to this policy brief. The support from Uganda Bio4Africa project PI and staff from the African Forum for Agricultural Advisory Services (AFAAS) and other project partners is highly appreciated.

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Horizon 2020
European Union Funding
for Research & Innovation

The Bio4Africa project is funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.

BIO4AFRICA

POLICY BRIEF

30th May 2024

Bio4Africa Policy Brief No.004/2024

Ghana

Enhancing supply of lowcost livestock feeds through Biobased solutions in Ghana: What Policymakers need to know

By Daniel Kyalo Willy and Francis Nangayo

Summary

- Ghana's livestock sector continues to face challenges of high cost of feeds and low productivity.
- The country can potentially tap into biobased solutions to facilitate low cost feed production.
- The Bio4Africa project is promoting livestock feed production using a green biorefinery, biochar production from crop residues such as maize and sorghum stover, and production of fish pellets from crop residues.
- Stakeholders in the bioeconomy face challenges related to taxation, limited enforcement of quality standards, limited private sector incentives, land tenure biased against youth and women, limited funding for local research and development for biobased solutions.
- This brief proposes some policy options to deal with these challenges and enhance development and commercialization of biobased solutions.

Background

More than half of Ghana's population is engaged in agriculture, with women representing around 39% of the labour force on the predominantly smallholder, traditional and rain-fed farm [1]. Due to climate change, farmers are experiencing the negative impact of declining rainfall and soil conditions, rising temperatures and other weather extremes. The supply of livestock feeds fluctuates due to rainfed production systems experienced in the savanna regions where cattle production is a major activity. As a result, live-stock keepers turn to purchased feeds, particularly unformulated ruminant feeds such as crop residues (groundnut haulms, cowpea haulms, and pigeon pea residue), agro-industrial by-products (maize, rice and sorghum bran) and fresh grasses and local browse leaves (*Ficus sp, Afzelia sp.* and *Pterocarpus evinacelus*)[2].

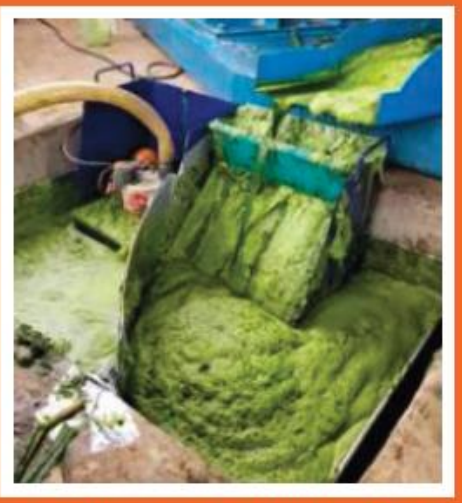
A recent study[3] identified the need for equipping farmers with knowledge of feed preparation skills to enable them prepare quality feed for their birds as well reduced cost of feed preparation tools and equipment by these stakeholders to address the issue of feed cost and quality. In line with the quest for facilitating the transfer of innovations for low cost biobased livestock feeds, the Bio4Africa project is piloting technologies for the production of cattle press cake and concentrated protein for livestock feeds formulation. Also in the innovation tool kit is the production of Biochar that will be used for soil conditioning and palletization to produce fish feeds.

This brief provides a description of these technologies and their benefits to the farming community in Ghana as well as some of the challenges that could hinder the development and commercialization of these technologies. Finally policy options to deal with these challenges are provided.

https://www.bio4africa.eu/

Biochar from Maize cobs in Ghana

Brazilian Kilns installed in Loagri, Ghana



Liquid Whey from the Green Biorefinery for piglet feeds

Bio4Africa Biobased technologies promoted in Ghana

The **Bio4Africa** project supports the deployment of the bioeconomy in rural Africa through the development of bio-based solutions and value chains with a circular approach to drive the use of local re-sources and diversify the income of farmers. The focus of the project is on transferring simple, small-scale, and robust bio-based techs adapted to local biomass. The Bio4Africa test sites in Ghana are located at Nasia and Yagaba-Kubori in the north-east savannah region of Ghana. The area is characterized by intense transhumant pastoralism activities due to its diverse grasslands and annual rainy season, will test small-scale bio-based technologies with potential to improve the livelihood and food security of transhumant pastoralist communities and help curtail the nomad/farmer conflict over grazing lands and pasture. In the test sites, 45 farmer groups, including small, medium and large-scale farmers, in and are providing local forage species for the test site. The technologies that the project has been promoting are described in detail below.

A **green bio-refinery** was installed at the SavaNet Agriculture Technology Research Center in Loagri. The facility features technology and equipment from Grassa, a Dutch biotech company which is used to refine green matter, mainly Cajanus biomass, which is then processed into three products: protein concentrate (for pig and poultry feed), the press cake (for dairy cow feed) and whey juice (for piglet feed). A Green Biorefinery has the advantage of being a multi-productive system that produces low-price feedstock that is available in large quantities [4]. The extraction of proteins from leaves was found to be a highly favourable alternative to the high dependency on soy imports in Europe[5]. The plant can also utilize Gamba grass, the wild-growing lucaena tree and crop residues from local legumes, vegetables, cereals and tuber crops. This technology leads to reduced cost of livestock feeds, higher in-comes for farmers from the sale of crop waste and access to low cost livestock feeds.

Pyrolysis is a technique where green matter is subjected to combustion without oxygen at very high temperatures (approx. 450-600° C) leading to the formation of charcoal like product called biochar. This process utilizes crop-based feedstock such as peanut shells, cashew shells or millet and maize stalks. The finished product is used for soil conditioning. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads top cleaner environment and environmental sustainability. When added to farms, this helps to enhanced soil fertility, reduced acidity and ability of soil to catch and store carbon. Because of better management of crop wastes, this also leads to environmental sustainability [6].

Palletizing is a technique that utilizes a machine, called an extruder palletization mill, for the production of livestock feeds pellets. This machine can be fed with crop residues from local legumes, vegetables, cereals and tuber crops. Waste products like\ cassava peels can be processed into High quality cassava peels (HQCP) which then are used to produce pellets for animal feed to benefit poultry, pig, rabbits and guinea pig farmers. These products help to reduce cost of livestock feeds by 30% and also to higher incomes for farmers from the sale of crop waste and access to low cost livestock feeds.

Bioeconomy stakeholders in Ghana have identified the challenges that are hindering the production and marketing of biobased products. Addressing these issues that need to be prioritized to enable communities in Ghana access full benefits from the Bioeconomy. The following are the key issues:

SavvaNet Ghana CEO, Moses Tia consulting with Livestock keepers

Challenges in the Bioeconomy of Ghana

1. Weak alignments between national strategies with regional and international frameworks such as the Africa Continental Free trade area (AfCFTA).
2. Due to limited awareness, there is low adoption of products from biobased technologies such as bio-gas and briquets.
3. The investment of the private sector in the bioeconomy and renewable energy is limited by the lack of targeted tax related instruments such as tax breaks and subsidies in favor of renewable energy and bioeconomy related technologies.
4. There is limited enforcement of quality standards by the Ghana Standards Authority (GSA), Environ-mental Protection Agency (EPA) and Food and Drugs Authority (FDA) due to resource and capacity issues.
5. The enabling environment regulating the bioeconomy is still weak and needs alignment.
6. There is lack of sufficient incentives for women and youth to venture in biobased related businesses. Land tenure that emphasizes on land ownership and control by men disadvantages women and the youth them.
7. Lack of technical advice and advisory services to support acquisition and maintenance of new and advanced equipment and tools to shift to more innovative approaches.
8. Local research entities including Universities lack sufficient resources and capacity to engage in long term research in biobased innovations. The Curriculum of most universities also doesn't have sufficient orientation towards support of biobased Universities.
9. There are weak linkages between actors in the bio-economy that are necessary for enhancing complementarities in research and development as well as commercialization of biobased innovations and products.

Recommendations

- There is need to align Ghana's trade initiatives and policies with the African Continental Free Trade Agreement (AfCFTA) to enable the private sector benefit from the provisions that could reduce the cost of importation of equipment and trading of their products regionally.
- Need for awareness creation among private sector companies and users of biobased products. This can be supported by technology demonstrations and setting up of technology parks.
- Establish relevant bi-laws, regulations and guidelines to facilitate commercialization of biobased technologies.
- Government programmes to incentive women and youth to engage in Biobased enterprises.
- Enhance the enforcement of quality standards by Ghana Standards Authority (GSA), Environmental Protection Agency (EPA) and Food and Drugs Authority (FDA). GSA should be sufficiently resourced to play its role effectively. Set up sufficient standards for emerging biobased products in the context of Ghana's and ISOs.
- Establish mechanisms to Foster collaboration between actors in the biobased sector players including market linkages a d establishment of common interest platforms.
- Create Incentives for the private sector including tax exemptions and subsidies to incentivize investment
- Enhance research and development to boost local solutions including research grants to local R&D partners.
- The Fiscal incentives in the sector including duty exemptions spearheaded by Ministry of Food and Agriculture (MOFA) and Ministry of Finance (MoF).
- Capacity building on Biobased technologies including adoption of Biobased focused curriculum in institutions of Higher learning.

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Acknowledgement

The authors appreciate the participants in the policy dialogue events drawn from Government Ministries, Departments and Agencies, the private sector and farmers and their representatives for the contribution of ideas that culminated to this policy brief. The support from the Bio4Africa Ghana project PI and staff from the SavaNet and other project partners is highly appreciated.

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Horizon 2020
European Union Funding
for Research & Innovation

The Bio4Africa project is funded from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000762.