Ghana is endowed with diverse plant, animal, and insect species across its regions and agroecological zones. This rich diversity of biological resources is an important precursor to the country’s development of an effective and sustainable bioeconomy. Over the years, Ghana has demonstrated the important role that science, technology, and innovation can play as critical drivers for socio-economic development and for the development of a bioeconomy. Currently, Ghana’s bioeconomy-related activities are centered on agriculture, forestry, renewable energy resource management, and waste management. It has established a wide range of industries for cocoa, cashew, and shea and for the by-products of these crops. This, in turn, provides a strong foundation for scaling up its emerging bioeconomy to other sectors, including energy and waste. This case study identifies the current state of the country’s bioeconomy—what it has done right in terms of institutional and policy innovations and what programmatic interventions it has initiated to accelerate bioeconomy development. It highlights the positive impacts of some of these policies and programs and the opportunities they present for local and international collaboration in the development of a sustainable bioeconomy. If brought to scale, the initial interventions to develop a bioeconomy have the potential to transform a broad range of sectors.
INSTITUTIONAL INNOVATIONS

Scientific research for bioeconomy: The Ministry of Environment, Science, Technology and Innovation and the Council for Scientific and Industrial Research

Biomass-rich African countries, including Ghana, are increasingly acknowledging the economic potential and sustainability of the transition to a bio-based economy. Over the last two decades, the Government of Ghana (GoG) has introduced several interventions to help transition Ghana into the global bioeconomy. The current institutional framework in Ghana facilitates the optimal and sustainable exploitation of these emerging and potential opportunities for the successful development of a bioeconomy. Although there is no single institution responsible for overseeing the bioeconomy, the Ministry of Environment, Science, Technology, and Innovation (MESTI) plays a prominent role. It is tasked with advancing Ghana's socioeconomic development using environmentally friendly, scientific, and technological practices and techniques. To achieve this goal, MESTI's key task is to craft a sound enabling environment to support the growth of national science and innovation frameworks. This Ministry oversees six semi-independent national agencies, of which three—the Council for Scientific and Industrial Research (CSIR), the Environmental Protection Agency (EPA), and the National Biosafety Authority (NBA)—are directly linked to promoting Ghana's bioeconomy. In addition, the Biotechnology and Nuclear Agricultural Institute overseen by Ghana Atomic Energy Commission at MESTI, also conducts R&D to explore the application of isotope, ionizing radiation and other nuclear techniques and related biotechnologies for increased agricultural and economic development.

Working alongside MESTI and its agencies are the Cocoa Research Institute of Ghana and COCOBOD, specializing in both, upstream and downstream development of cocoa value chains. CRIG, in particular, has a long history of research on tree crops of economic importance to Ghana, including cocoa, coffee, kola, and cashew. These research institutions drive the formal public sector innovation in agriculture in Ghana.

Collaboration at the helm: Council for Scientific and Industrial Research

CSIR is Ghana's principal national research institution. Established prior to the country's independence and known then as the National Research Council, CSIR has undergone a number of fundamental structural changes since 1958. Its current configuration is the outcome of the adoption of the CSIR Act 521 in 1996. CSIR is overseen by a Statutory Governing Council that is composed of representatives from:

- the Ministries of Food and Agriculture (MoFA); Health; Trade and Industry; Education; and Environment, Science, Technology and Innovation;
- universities;
- commercial associations representing mining, industry, commerce, and engineering;
- the Ghana Academy of Arts and Sciences; and
- the National Development Planning Commission.

The inclusion of representatives of the MoFA on the board of CSIR ensures that agricultural research carried out at the institutes is aligned with national agricultural policies. Equally importantly, the CSIR Act requires that 40 percent of CSIR membership is drawn from the private sector, a structure that is designed to foster collaboration across stakeholders. Not only is CSIR mandated to conduct and coordinate research into scientific and technological innovations for national development, it is also charged with commercializing research outputs in partnership with the private sector and other stakeholders. This was made possible by a revision of its mandate in 1996 which has allowed CSIR to commercialize outputs from publicly funded research. In the early 2000s, CSIR created a commercial wing called CSIR+ as a limited liability company to promote business ventures that would market products with public benefits and enable CSIR to continue operating within the bounds of law. Different sectors of the economy have benefitted from various programs and activities of the CSIR, including agriculture, industry, energy, health, education, and the private sector. CSIR also plays an advisory role to the Minister (MESTI) on emerging scientific and technological advances that are relevant to Ghana's national development.

The Council is composed of 13 research institutes,10 of which are engaged in agriculture-related research activities. A large share of their bioeconomy-related activity is focused on enhancing the productivity of their relevant subsectors using biotechnology applications. Each institute has a management board that is headed by a director who is responsible for its daily operations. Five-year strategic plans for each institute are developed in consultation with different sectors of the economy.

---

1 The research institutes comprising the CSIR include: Animal Research Institute (ARI), Crops Research Institute (CRI), Soil Research Institute (SRI), Oil Palm Research Institute (OPRI), Food Research Institute (FRI), Forestry Research Institute of Ghana (FORIG), Plant Genetic Resources Research Institute (PGRI), Savanna Agricultural Research Institute (SARI), Water Research Institute (WRI) and Science and Technology Policy Research Institute (STEPRI).

2 The research institutes comprising the CSIR include: Animal Research Institute (ARI), Crops Research Institute (CRI), Soil Research Institute (SRI), Oil Palm Research Institute (OPRI), Food Research Institute (FRI), Forestry Research Institute of Ghana (FORIG), Plant Genetic Resources Research Institute (PGRI), Savanna Agricultural Research Institute (SARI), Water Research Institute (WRI) and Science and Technology Policy Research Institute (STEPRI).
key stakeholders including policymakers, sector ministries, and the private sector. Strategic plans are also linked to the CSIR’s long-term plans; these are, in turn, aligned with the national development agenda, with donor programs, and with the broader research needs of the country. Although some programmatic collaboration occurs among institutes, this would benefit from intensification.

CSIR is Ghana’s main agency for agricultural R&D. It receives about 50 percent—the largest share—of public agricultural R&D expenditure, and public funds underpin as much as 80 percent of CSIR’s total annual budget. This is both a boon and a curse, however, as funding fluctuates in line with annual public spending. Long-term research planning is therefore a challenge and the capacity to make capital investments in, for example, laboratory equipment is impacted. A large share of CSIR’s annual budget is in fact expended on direct costs such as salaries, and it is expected that any shortfalls in disbursed funds should be covered by international partners. Despite this, CSIR has been almost solely responsible for the identification and generation of agricultural technology in the country, even if its commercialization is limited. MoFA is the primary disseminator of agricultural research outputs generated by CSIR.

Advancing food bioeconomy: Food Research Institute

Within CSIR, the Food Research Institute (FRI) also supports bioeconomy development. Its mandate is to support the food industry by addressing research questions related to food processing and preservation, food safety, storage, marketing, distribution and utilization, and national food and nutritional security; it also advises the government on food policy. To be successful in achieving its aims, FRI works closely with entrepreneurs, food processors, the local food industry, the Food and Drugs Authority, and the Ghana Standards Board. An internal evaluation of FRI revealed that the institute benefits from high quality, and technically proficient staff, who have a multi-disciplinary approach to work; well-equipped laboratories and good access to machinery and other equipment; high quality work on nutrient analysis and food technology; and proven track record on commercial uptake of results. However, there are growing overlaps between FRI and other institutions that are challenging its continued success. Despite this, FRI has successfully introduced a variety of new products and technologies, For example, FRI engaged with farmers, processors, consumers, and policymakers to enhance the production, processing, marketing, and consumption of Ghana’s edible and medicinal mushrooms. It also provides stakeholders in the food industry with support in primary food processing and equipment. The FRI has developed several technologies on food value addition, enhanced food processing technologies, and Hazard Analysis and Critical Control Points (HACCP) systems for various food processing lines. These include technologies for processing fufu flours (yam, cocoyam, plantain), improved kokonte and gari, Banku Mix Powder, fermented maize meal powder, high quality cassava flour, cassava starch, rice- and maize-based cereal (baby weaning food / breakfast meal), and fruit juice. The new technologies have led to a reduction in postharvest losses, particularly in fruits and vegetables. Many small and medium-sized agro-based enterprises have also emerged from technology transfers from these institutions.

Deploying nuclear techniques for agricultural development: Biotechnology and Agricultural Research Institute

The Biotechnology and Nuclear Agricultural Institute (BNARI) was established in 1993 to support the scientific and rural communities to develop improved crop and livestock varieties, to improve food quality and its nutritive value, to raise the level of nutrition by improving food quality, to identify solutions for animal production and health, and to minimize harmful residue in food and other agricultural products. BNARI undertakes scientific and industrial research in collaboration with government agencies, research institutions, universities and the private sector to deploy processes such as irradiation to preserve food, radioisotopic methods and radioimmunoassays to address animal nutrition and reproduction, radiation-induced sterile insect technique to manage pests and diseases, and in-vitro tissue culture and germplasm conservation for plant regeneration. While the R&D programs are approved by the management board, they are financed by funds from the public sector, international organizations and developmental partners. To-date, BNARI established Ghana’s largest functional tissue culture laboratory, where it analyzes and grows explants from selected crops in vivo and in vitro. The institute has been able to develop improved varieties of many food crops, including an improved cassava and a cacao plant resistant to “swollen shoot” disease. BNARI has collaborated with Bioplantlet Company Limited (a subsidiary of the Sea-freight Pineapple Exporters of Ghana) to mass-produce planting materials of a pineapple variety to boost its production for the export market. BNARI also houses one of the few gamma radiation facilities on the continent which enables the country to meet export standards and reduce quarantine periods in importing countries. It has developed standards for irradiated food. Previously, BNARI collaborated
with the Animal Research Institute at CSIR (CSIR-ARI) to deploy sterile insect technology for the eradication of tsetse flies.13

Transforming the cocoa sector with biosciences and technology

Cocoa Research Institute of Ghana

The cocoa subsector remains a significant contributor to Ghana’s GDP. In 2020, it contributed US$385 million to GDP and employed about 800,000 farm households, spread over six regions of the country.14 Ghana’s cocoa is considered to be the gold standard in the international market in terms of quality and Ghana is now the second-largest producer of cocoa beans in the world. The Cocoa Research Institute of Ghana (CRIG) was formed out of the West African Cocoa Research Institute (WACRI) after independence. CRIG’s initial mandate was to investigate the pests and diseases that were having a considerable effect on cocoa production. In 1993, a New Products Unit was created at CRIG, mandated to diversify cocoa products and to help farmers generate extra income by processing their produce and by-products. Since then, several new and innovative products have been designed, some of which have been adopted by entrepreneurs for commercial production. For example, Kasapreko Co. Ltd. is a leading manufacturer of alcoholic and non-alcoholic beverages in Ghana. One of its more successful products is cocoa brandy, which it bottles for the local and export market.15

CRIG’s mandate was subsequently expanded to include research on other indigenous and introduced tree crops that produced fats similar to cocoa butter, particularly cashews and shea nuts. Since 2002, cashews have become a mandate crop of CRIG. The institute now conducts research into the development of by-products of cocoa and the other mandate crops with the aim of diversifying utilization and generating additional income for farmers. CRIG’s research activities have led to successes which include: isolation and characterization of the cacao swollen shoot virus and the development of diagnostic methods; identification of fast-growing, exotic, and indigenous shade trees for cocoa; a better understanding of cocoa fermentation and flavor chemistry; the production of by-products from cocoa wastes, including pectin, alcohol and alcoholic beverages, animal feed, soap, and cosmetics. CRIG has won several awards for research achievements both at the local level and at international fairs.1 In conjunction with the Animal Research Institute (ARI) and KNUST, it has produced a number of products from cocoa pod husk (CPH), including animal feed, potash for soaps, and fertilizers;16 it has also successfully developed useful products from the apple and nut of cashew fruits, including wine, vinegar, industrial alcohol, and brandy.17

COCOBOD

The success of Ghana’s cocoa sector can largely be attributed to the programs put in place and managed by the state-run marketing board, COCOBOD,18 which was established in 1947 as the Cocoa Marketing Board. It was mandated to support the production, research, extension, marketing, and quality control of Ghana’s cocoa, coffee, and shea nut outputs. Although CRIG leads science and technology inputs for the cocoa industry, COCOBOD works through CRIG to develop and introduce a new curriculum for extension and offers training to these extension agents. COCOBOD, through specialized divisions, also oversees both pre- and postharvest elements of the value chain. It is responsible for the regulation of the domestic purchasing of cocoa, coffee, and shea nut in such a way that the most favorable outcomes are secured in the purchase, grading and packaging, certification, and sale and export of the three crops. It is also responsible for the export of cocoa products from Ghana, which are graded under the Cocoa Industry (Regulation) Act, 1968 N.L.C.D. 278.19

COCOBOD and the broader cocoa sector in Ghana have undergone three significant structural changes since the colonial period. Its current fourth phase seeks to balance the economics with social and environmental outcomes. COCOBOD currently has five subsidiaries/divisions: Cocoa Research Institute, Seed Production Division, Cocoa Health and Extension Division, Quality Control Division, and the Cocoa Marketing Company. The Quality Control Division—since renamed the Quality Control Company—remains responsible for ensuring that the overall quality of the beans is kept to a high standard. It conducts quality checks of cocoa beans at different collections points, including in villages, at district-level depots, and at ports immediately before export. The Quality Control Company is solely responsible for the inspection and certification of storage sheds across the country; no grading or sealing or storage of any cocoa is allowed anywhere without prior certification by the QCC. QCC is also responsible for fumigation and disinfection.20 The Cocoa Marketing Company (CMC) remains the only exporter of Ghanaian cocoa,21 while COCOBOD operates as the sole buyer in the domestic market. QCC samples and certifies (“purity certificate”) cocoa prior to shipment for export.

After the sector reforms of the early 1990s, the structure and functioning of the internal market saw the farmgate procurement of cocoa delegated to a growing
number of private licensed buying companies (LBCs), with COCOBOD being responsible for issuing their licenses. LBCs entered the domestic segment of the cocoa supply chain as competitors, but they were required to pay producers amounts that were equal to, or greater than, the announced prices. This institutional change re-energized the cocoa industry then and has resulted in greater innovation in the sector.

In the 2000s, a renewed effort to further boost growth in the cocoa sector took place. COCOBOD implemented a Hi-Tech program and a Cocoa Diseases and Pest Control (CODAPEC) program to reverse declines in yield and raise production to a target level of 1 million metric tons (Mmt) of beans. The policies implemented since 2001 have generated a remarkable turnaround in land productivity. Over the years, COCOBOD has implemented or supported the implementation of various cocoa-related programs to enhance either yields or quality. These include mass spraying, cocoa sector development strategies, and cocoa high tech (fertilizer subsidy) programs, all of which have resulted in a growth in production. Growth in yields has accounted for 80 percent of the growth in cocoa production between 2001 and 2010, with annual growth in land productivity at 5.5 percent per year over the period.

More recently, efforts have been made to enhance the processing of cocoa beans and the conversion of cocoa by-products into useful products through value addition. The objective in the cocoa sector is to achieve up to 50 percent processing (value addition) of the annual cocoa production. To that end, in 2019 the Ghana Cocoa Board signed a memorandum of understanding (MoU) with the China-Africa Development Fund and China’s Genertec International Corporation for the establishment of a US$100 million cocoa processing factory at Sefwi Wiawso, the main cocoa producing area in Ghana. It is expected that, upon completion, the factory will have a capacity to process 450,000 metric tons (mt) annually; this will boost Ghana’s exports, improve value addition and increase domestic cocoa consumption. As of the 2018/2019 cocoa season, Ghana’s cocoa grindings were estimated at 300,000 mt, which represented about 37 percent of the country’s cocoa bean production. The cocoa pod husks will be processed into animal feed, potash for soft soap manufacturing, compost and organic fertilizer; cocoa “sweatings” (pulp juice) will be processed into soft drinks, wine, vinegar, alcohol and pectin. Discarded cocoa beans can be processed into cocoa butter soap and into cosmetics that use a cocoa butter base. If the needed investments and institutional support can be guaranteed, these developments in the cocoa sector will propel Ghana’s development toward a successful bioeconomy. As part of the European Green Deal, the cocoa sector will constitute a flagship partnership for its European partners; its aim is to ensure a decent income for farmers and deforestation-free and child-labor-free cocoa production. As part of sustainable cocoa production, Ghana’s European partners, together with the private sector and NGOs, aim to work together to address the various challenges facing the country’s cocoa sector.
Technology transfer and commercialization

The success of bioeconomy development hinges on the availability of, and access to, appropriate technology within the agricultural and food subsectors. The Ghana Regional Appropriate Technology Industrial Service (or GRATIS) Foundation is a government agency that was incorporated in 1999 under the Ministry of Trade and Industry (MoTI). Overseen by a Board of Directors appointed by the Ministry, GRATIS provides support to industries, including those that are bio-based; it helps these industries to design, develop, manufacture, and market appropriate technology-based products and services for small, medium, and micro enterprises (SMMEs), with the aim of facilitating socioeconomic and industrial development in Ghana and other African countries. The main aim is to reduce postharvest losses and ensure value addition through agro-processing, while preserving the environment and improving sanitation. In particular, GRATIS manufactures agro-processing equipment for palm oil extraction and processing, shea butter, fruits, cassava, cereals, and grains. Examples of such equipment include grinding mills, poultry feed mixers, maize threshers, multicrop threshers (for cereals and legumes), cassava graters, fufu processors, chipping machines (for cassava), palm fruit strippers, palm fruit steamers, palm oil expellers, and palm nut crackers. These pieces of equipment are sold to individuals, SMMEs, companies, farmers, and/or farmer groups involved in Ghana's agricultural value chain.

In 2018, MESTI launched the Ghana Innovation and Research Commercialization Centre (GIRC-Centre) to facilitate the commercialization of research findings by strengthening partnerships between the Government, public research institutions, academia, and the private sector. Although the Centre was not operational at the time of writing, it is expected to foster interministerial and international research collaboration; solicit, evaluate and support projects that are aligned to the national development agenda; and institute solid monitoring and evaluation and economic impact assessments; thereby harmonizing innovations and research activities in Ghana.

Sustainability education and innovation at higher education institutions

Since the early 2000s, the GoG has shown renewed interest in increasing the role of tertiary institutions in developing science and technology to enhance economic development. Several biotechnology programs have been launched at Ghanaian universities, including the University of Ghana Biotechnology Research Centre, the Department of Biochemistry and Biotechnology at the Kwame Nkrumah University of Science and Technology (KNUST), the Molecular Biology and Biotechnology Department at the University of Cape Coast (UCC), and the Department of Biotechnology at the University for Development Studies (UDS). These departments run undergraduate and postgraduate programs in biochemistry, molecular biology, and biotechnology. Although most of the programs still focus on biosciences, recent developments have shown that when given the necessary support and funding, they can play significant roles in training individuals to fulfill the labor requirements of a successful bioeconomy.

These higher education institutions are well positioned to contribute to the Ghanaian bioeconomy. They play an important role in offering solutions to pertinent national sustainability challenges through related R&D, science and technology curricula, teaching, and general engagement with society. Universities are also scaling up demand-driven research that accelerates the growth of Ghana's bioeconomy. In 2010, for example, the Department of Nutrition and Food Science at University of Ghana collaborated with the Cocoa Processing Company Ltd to produce a low-calorie sugar-free chocolate made from a healthy sugar substitute called maltitol. This in turn endorsed the need for support systems to strengthen links with industry.

In 2010, the University of Ghana established an Office of Research, Innovation and Development (ORID) to promote, facilitate, and coordinate cutting edge-research. In addition to grant and research support, ORID also assists with IP and technology transfer through its Technology Development and Transfer Centre (TDTC). In 2012, University of Ghana also launched the Institute of Applied Science and Technology (IAST) to build strategic partnerships between academia and industry. IAST facilitates partnerships through networking opportunities such as exhibitions, symposia, workshops, and seminars to enhance engagement and showcase technologies. These two additions to the University of Ghana serve as a conduit between industry and academia to demonstrate research concepts, commercialize outcomes, and secure the necessary IP.

Growing proficiency in bioeconomy-related subjects also provide a platform for international bioeconomy programs to partner locally. For example, from 2014-2017, the University of Ghana’s Institute of Agricultural Research and Tropical Agricultural Marketing and Consultancy Services (TRAGRIMACS) partnered with the United Nations Industrial Development Organization (UNIDO) to promote neem-based biopesticides in Ghana. While the university oversaw bioefficacy and phytotoxicity studies and field trials, TRAGRIMACS was responsible for raising awareness of the project and establishing

Nature’s Solutions: Policy Innovations and Opportunities for Africa’s Bioeconomy
a production and distribution center. In addition to providing training for stakeholders, the project also transferred the low-cost technology to the University of Ghana to produce neem kernel aqueous extract and standardized technology for seed collection. A study in 2020 conducted by the Savanna Agricultural Research Institute (CSIR-SARI) and other institutions have revealed that the neem-based biopesticides are as effective as synthetic/chemical pesticides in fighting the Fall Armyworm (FAW) in Ghana.

Another successful partnership with international institutions is that with the Open Bioeconomy Lab, which, through the Hive Biolab, serves as a platform for providing training to university students, graduates, and Ghanaian academics in emerging and cutting-edge advances in biotechnology such as synthetic biology, genetic engineering, and DNA technology.

Harnessing indigenous and herbal medicines for bioeconomy

In Ghana, efforts to promote traditional/herbal medicine practice started with the creation of the Ghana Psychic and Traditional Healers Association in the 1960s. These efforts were validated in 2000 when the Traditional Medicine Practice Act 2000, Act 375 was passed. The Act regulates herbal medicines and the practice of traditional medicine. In 2011, herbal clinics were piloted in selected government hospitals nationwide, and in September 2012 the practice of clinical herbal medicine was integrated into Ghana’s main healthcare delivery system by the Ministry of Health. This integration was pushed for by the Ghana Association of Medical Herbalists (GAMH) with support from the Business Sector Advocacy Challenge Fund (BUSAC). The process that eventually led to the integration of herbal medicines into standard healthcare delivery involved the participation of public and private sector organizations and of research and financial institutions, and the drawing up of legislation that backed the activities of all stakeholders, thus demonstrating a process that will be vital for the full development of Ghana’s bioeconomy. Indigenous and herbal medicine in Ghana received a further boost when the Food and Drugs Authority (FDA) approved the first herbal medicine (Cryptolepis sanguinolenta) for clinical trials on COVID-19 treatment.

Ensuring public safety in bioeconomy

Ghana’s Food and Drugs Authority is another institution that could play a vital role in its potential bioeconomy transition. In order to protect public safety, the Food Division of the FDA ensures food product registration, premises registration, and post-approval market surveillance of food and feed. It is responsible for foodborne disease surveillance and investigation, and serves as the contact point for Ghana’s International Food Safety Authorities Network (INFOSAN). It also organizes training on biosafety, conducts consumer complaints investigations, and is responsible for the approval of drugs (including herbal medicines) for use. Ghana’s FDA is classified as a World Health Organization (WHO) “maturity level 3” regulatory agency, making it only the second African healthcare institution with this classification.

POLICY INNOVATIONS

Over the last one to two decades, the GoG has made tremendous efforts and robust commitments toward enhancing the bioeconomy via a number of policy innovations; the overarching goals have been to alleviate poverty and stimulate accelerated national economic development. While agricultural and forestry policies boost the production and processing of renewable biomass, environmental and waste management policies provide a baseline for ensuring that Ghana’s bioeconomy development is sustainable.

Agricultural and forestry policies to facilitate biomass supply

Developing a sustainable bioeconomy requires adequate production and availability of biomass. This implies that an increase in the productivity of traditional cropping systems is a significant precondition for the successful development of a bioeconomy. Ghana has a vibrant and effective institutional framework with which to drive the formulation, implementation, and development of policies that can contribute to the development of a bioeconomy.

The Ghana Shared Growth and Development Agenda (GSGDA) I (2010–2013) and II (2014–2017) were medium-term policy frameworks that sought to ensure accelerated agricultural modernization and enhance natural resource management, energy development, sustainable employment creation, and income generation, with the primary aim of reducing poverty. The implementation of the agricultural component of GSGDA I and II hinged on strategies to facilitate value chain efficiency; these included improved agricultural productivity, enhanced integration of farmers into domestic and international markets, sustainable natural resource and biodiversity management, and building farmers’ resilience against climate change. While the implementation of the 2002 Food and Agricultural Sector Development Policy I (FASDEP I) emphasized strategies to modernize the agricultural sector, FASDEP II (introduced in 2007)
emphasizes the sustainable utilization of all resources and the commercialization of activities in the sector, with market-driven growth. The implementation of agricultural sector policy reforms led to a steady increase in the average growth rate of the sector, rising from an average of 3.6 percent during the 1993 to 1997 period to an average of 4.9 percent in the 2013 to 2017 period. The additional biomass resulting from the growth in productivity is a key input into Ghana’s emerging bioeconomy.

Alongside agricultural biomass, Ghana’s policymakers have also sought to increase renewable biomass from the forestry sector. In 2015, the GoG initiated the establishment of woodlots and forest plantations on 500,000 hectares (ha) of degraded land, to be cultivated by 2040. As a strategy to promote a bio-based renewable energy agenda, more biomass would be produced from forest residues as off-cuts from timber and as a by-product of the processing of timber or agricultural products. Under the Ghana Forest Plantation Strategy of 2016 to 2040, the country aims to ensure biomass availability from forest residues by:

- Establishing and managing planted forests,
- Promoting forest plantation investment,
- Creating employment and sustainable livelihoods, and
- Increasing investment in research and development.

Deploying climate change policies to foster bioeconomy

In 2013, MESTI introduced the National Climate Change Policy (NCCP). The NCCP looks to integrate a response to climate change, build resilience, and harness the opportunities of green growth across five focus areas: agriculture and food security; disaster preparedness and response; natural resource management; equitable social development; and energy, industrial, and infrastructure development. Updated in 2015, the NCCP outlines specific policy actions for ten multisectoral areas in order to address the multifaceted impacts of climate change across the country and to operationalize the effective development of NCCP objectives. MESTI works on sectoral climate issues with the Ministry of Trade and Industry, MoFA, metropolitan, municipal, and district assemblies, the Ministry of Fisheries and Aquaculture Development, and CSIR; together they lead the implementation of the NCCP’s eight specific sector programs. The Climate-Smart Agriculture and Food Security Action Plan (CSAFSAP), for example, is led by MoFA. It outlines the implementation framework necessary to mainstream climate resilience and adaptation planning into agriculture and food development activities. Totaling US$950 million of both government and international donor funding, the CSAFSAP outlines eight programs and activities: strengthening national climate research and educational services, developing innovative and climate-smart production techniques and systems for agriculture and fishing, supporting smart water management, de-risking the food and agricultural
sector, and improving the productive capacity of farmers and rural communities. Proposed activities include developing extension services; financing research on climate-smart agricultural technologies and processes; expanding sustainable water harvesting, storage, and irrigation systems; and establishing insurance schemes.47,48

The CSAFSAP is further bolstered by the publication of Ghana’s Nationally Determined Contributions (NDCs). In 2021, Ghana submitted its revised NDCs document, in which it highlighted the expected mitigation co-benefits in the agriculture and health sectors delivered through climate-smart agricultural and sustainable land management practices, ecotourism, the Green Ghana initiative, and disease surveillance and climate early warning systems.

**Waste management and recycling**

Ghana’s Solid Waste Management Strategy (SWMS), under the Ministry of Sanitation and Water Resources, seeks to achieve progressive, high quality, and cost-effective SWM service delivery such that it provides environmental, public health, and economic benefits to all.50 This strategy is built around seven pillars: strengthening sector governance; increasing private sector participation; optimizing service delivery and infrastructure; creating positive social action on SWM; enabling effective waste recovery, re-use, and recycling; ensuring effective sector monitoring and evaluation; and establishing sustainable sector financing mechanisms. In line with the second pillar, the Accra Compost and Recycling Plant was established to recycle solid and liquid waste to produce organic compost. This has led to the creation of 500 direct and indirect jobs and a daily capacity of 100 mt of compost.51

**Biomass waste to energy**

In 2010, the Ghana National Energy Policy was promulgated; it seeks to enhance the transformation of waste (including agricultural waste and other biomass) into energy through various technological approaches. To ensure sustainability, the policy offers various bioeconomy opportunities for investments in the renewable energy subsector. Ghana’s Renewable Energy Act, 2011 (Act 832) was particularly effective; it enshrined a feed-in-tariff (FiT) scheme that was instituted for electricity generated from renewable energy sources such as biomass. It was designed to support the target of 10 percent renewable energy in the national energy mix and to ensure that investors obtained a good return on their investments.52 In 2020, as a result of these interventions, four biomass-fired cogeneration plants were operating in Ghana, with a combined installed capacity of 4,034 kW and an average annual production of 12.3 GWh.53 Another important initiative to support the development of the bioeconomy was the GoG’s program to install biomass/waste-to-energy power plants by 2020, with capacities ranging from 50 to 100 MW. As part of this strategy, by 2014 the Ministry of Energy had installed 49 institutional biogas systems.

**PROGRAMMATIC INTERVENTIONS**

A number of Ghana’s existing programmatic interventions support the development of a bioeconomy. These programs focus on a wide range of sectors including agriculture and climate change, energy, biodiversity, and water and sanitation. The following sections present a review of such interventions in Ghana.

**Ghana Agriculture Sector Investment Program**

The Ghana Agriculture Sector Investment Program (GASIP) contributes to bioeconomy development through agricultural investments in increased biomass production. GASIP is a six-year program (2015–2021) with joint funding from the International Fund for Agricultural Development (IFAD), the GoG, participatory financial institutions (PFIs), the Adaptation for Smallholder Agriculture Programme (ASAP), and the program’s beneficiaries. The overall goal of the program was to contribute to poverty reduction in rural Ghana, by raising profitability among smallholder farmers and agribusinesses.54 The program was implemented by the MoFA using a facilitative value chain development approach; this involved developing and facilitating efficient market linkages between agribusinesses (value chain drivers) and farmer-based organizations (FBOs). GASIP strengthens the FBOs, provides them with grants to expand production activities, promotes the adoption of climate resilient practices, and strengthens value chain infrastructure as their support towards the implementation of the partnership agreements. GASIP was initially faced with some implementation bottlenecks, though substantial progress was made vis-à-vis achievement of the project’s results. Across all the major agroclimatic zones of Ghana, it successfully facilitated partnerships between 53 agribusinesses and 1,200 FBOs to produce maize, soya, rice, cassava, and some vegetables. By extending US$13.6 million in grant support to agribusinesses, the program improved farmers’ access to inputs and resulted in a rise in productivity by over 70 percent. The value chain approach to the implementation of GASIP is key to Ghana’s bioeconomy transition, as activities under the program focused not only on food production, but also included value addition through processing and other postharvest activities along the maize, soya, rice, cassava, and vegetables value chains.
Cassava is a major staple crop in Ghana and it has the advantage of being able to produce economic yields even under marginal production conditions. The crop accounts for approximately 50 percent of all root and tuber production in the country and is second only to maize in terms of area planted. It is consumed in all regions and by all ethnic groups, and is therefore considered to be a primary food security crop. Cassava starch can be converted into ethanol production, which is a key ingredient in alcoholic drinks and in pharmaceuticals such as hand sanitizers. The Presidential Special Initiative on Cassava that was commissioned in 2003 was aimed at developing industrial cassava starch production for both the domestic and international markets; it aimed, in the process, to also improve the socioeconomic conditions of Ghana’s smallholders. A new factory, Ayensu Starch, was commissioned in 2004 to supply a growing domestic and global market for starch, in turn creating a market for Cassava growers. The firm, however, was plagued with high operational costs and technological challenges which on two occasions culminated in temporary shutdowns, thus necessitating a more focused and sustainable operational strategy. In 2012, in order to revive the program, the GoG introduced a concessionary excise duty waiver for manufacturers who used local raw materials. Within six months, Ayensu Starch signed an exclusive supply agreement with Guinness Ghana Breweries Limited (GGBL) to supply high quality cassava starch, which the brewery uses to produce one of its brands of beer for the domestic market. This was soon followed by the production from cassava starch of Accra Brewery’s own beer brand, Eagle Lager. Cassava starch has since also found a market in the production of biscuits and other household products. About half of the Ayensu Starch Factory’s cassava is grown on its own farms, while the rest is sourced from about 400 smallholder outgrowers who are issued quality guidelines that they must meet. Waste products from the process of extracting starch, such as peels and pulp, are then sold on to local livestock enterprises, which earns the company additional revenue. The simple intervention to attract private sector players in the use of cassava and starch has kickstarted a revolution in Ghana’s cassava sector, with its products and by-products featuring in food processing, baked products, paperboard manufacturing, domestic plywood outputs, and bioethanol and biogas.

Biogas Technology and Business for Sustainable Growth

Biogas Technology and Business for Sustainable Growth (BTBSG) was a 2013 to 2016 program to assist Ghana’s green industries. It was implemented by UNIDO in partnership with the Ministry of Trade, Industry and Energy (MoTIE) of Korea and the Korea Institute of Energy Technology Evaluation and Planning (KETEP). The BTBSG program builds on empirical evidence on the state of biogas industries in Ghana and on lessons drawn from past and current biogas initiatives in the country. The program’s two main aims are to enhance access to clean energy via the promotion of industrial-scale biogas technologies in the form of an integrated technology transfer, and to support the development of biogas enterprise in Ghana. A number of biogas plants have been created at abattoirs, homes, health and educational institutions, and at various other locations across the country.

CONCLUSION

Ghana’s economy is largely driven by agriculture, and the export of processed wood and raw produce, all of which result in the generation of huge volumes of biomass waste. This waste is usually disposed of by burning, which releases harmful greenhouse gases into the environment. Meanwhile, the availability of these large stocks of biomass makes the country highly suitable for setting up bio-industries and a thriving bioeconomy. Although Ghana, like many countries in Africa, still has no explicit policy on bioeconomy, many past and present government policies and programs—particularly in the agricultural, energy, and forestry sectors—contain components that promote various aspects of a bioeconomy. The development of strategic bioeconomy blueprints will not only help prioritize investments and government interventions in Africa; it will also guide a policy agenda for bio-based economic growth and sustainable development.

Ghana’s current institutional frameworks, policies, and programs that are closely related to bioeconomy development are often linked to agricultural, energy, forestry, technology, and innovation strategies. In order to take advantage of opportunities in emerging bioeconomy sectors, Ghana must make necessary targeted investments in research and innovation, enhance capacity at the institutional level, and improve general governance. For example, as Ghana’s biobased industrial activities and enterprises grow, so will the demand for institutions and services to oversee quality management. There is also an urgent need to build stronger linkages between actors in the innovation ecosystem and entrepreneurs who scale the production of outputs from the bioeconomy. This will help ensure that the benefits that accrue from innovations reach end users and support the financing efforts of research institutions. At the same time, greater internal collaboration among institutes would also attract more projects, deliver greater impacts,
and enhance financial sustainability. Although MESTI has proposed an apex statutory body to coordinate and harmonize the new policy and other national STI programs, the Presidential Advisory Council on Science, Technology and Innovation is not yet operational. Such a council can be an important voice in advancing the development of Ghana’s bioeconomy, and ensuring that the benefits realized from the bioeconomy contribute to sustainable economic growth. It can also support efforts to raise public sector budget allocations to R&D from the current 0.3 percent of GDP to 1 percent, as set out by the African Union.\(^6\)

ENDNOTES


10. CSIR 2020 op. cit.


19. COCOBOD (Ghana Cocoa Board), Objectives and Functions of the Board: Get to know more about the function of our board in helping us achieve our goals and visions, 2022. https://cocabod.gov.gh/objectives-of-board.


24. J. Gockowski, Policy-led intensification and returns to input use among Ghanaian cocoa farmers; Sustainable tree crop program of the International Institute of Tropical Agriculture (IITA), Accra, Ghana, 2012.


13 ECREEE 2015 op. cit.