



United Nations  
Office for South-South Cooperation



Center for Strategic Studies and Management  
*Science, Technology and Innovation*

## **SOUTH-SOUTH AND TRIANGULAR COOPERATION ON THE BIOECONOMY** in light of the Paris Agreement and the 2030 Agenda for Sustainable Development



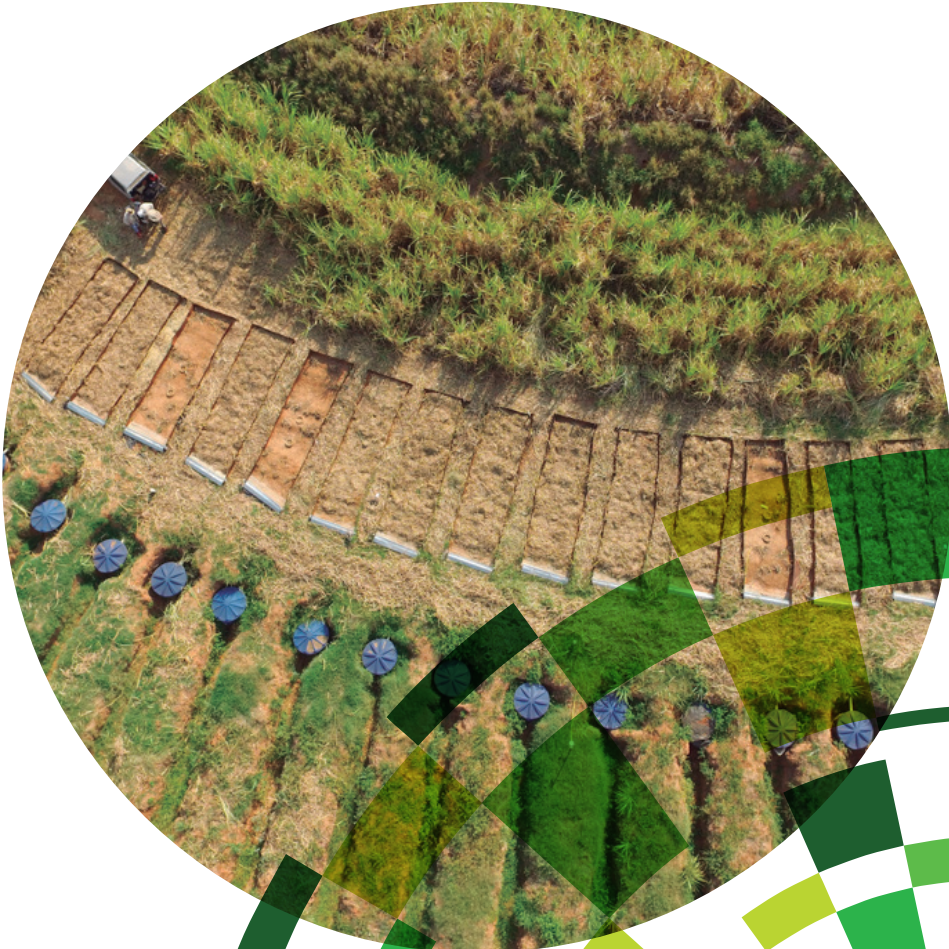
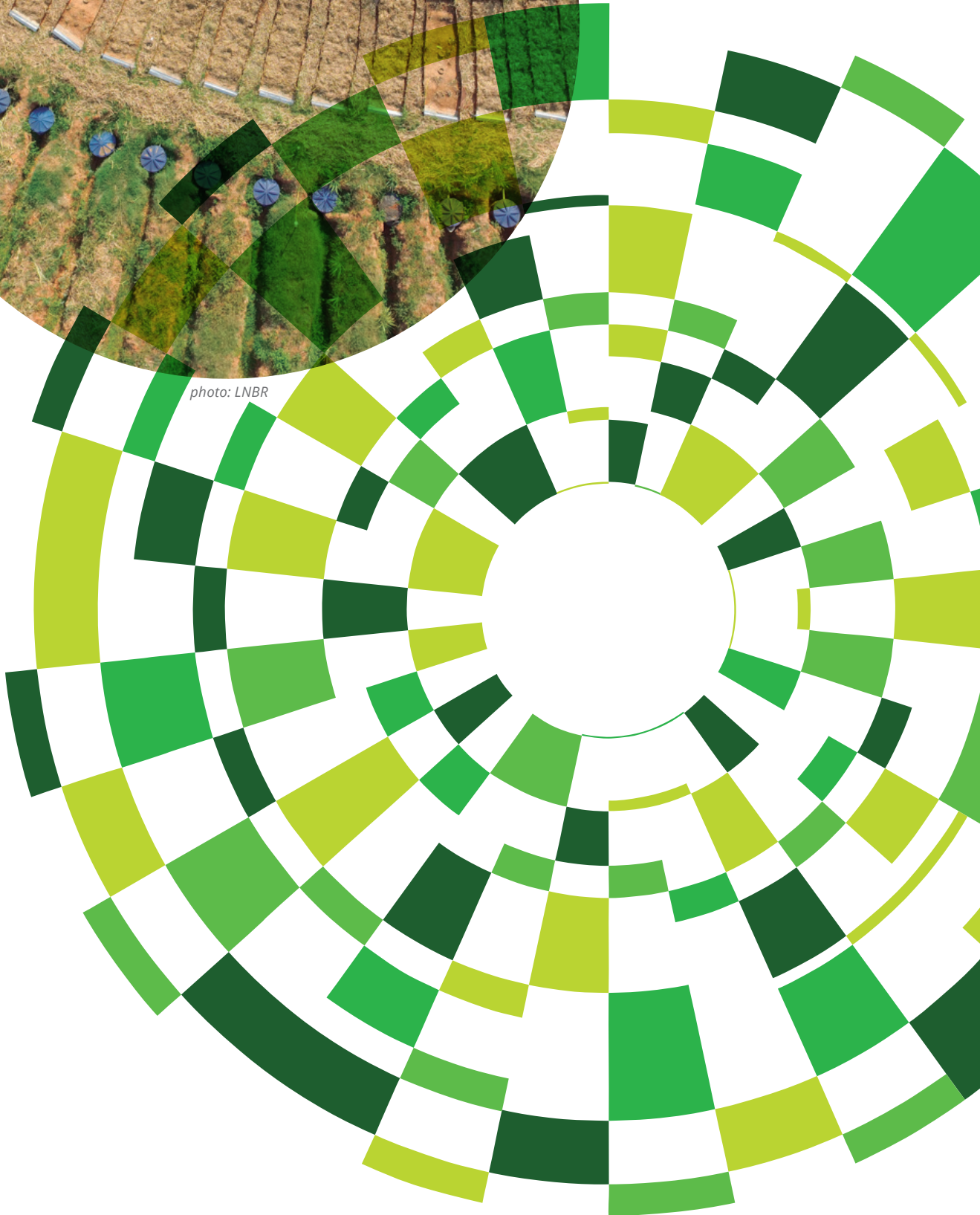


photo: LNBR



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## Foreword by Marcio de Miranda Santos, President of the Center for Strategic Studies and Management

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The principal aim of the Center for Strategic Studies and Management (CGEE) is to generate technical subsidies for Brazil's National System of Science, Technology and Innovation (SNCTI), while informing high-level decision-makers on topics related to science, technology, education and innovation. CGEE activities are focused on future studies, with an emphasis on forecasts and the strategic evaluation of medium-and-large size programmes at national and international levels that use state-of-the-art tools and methods to design methodologies. Such methodologies aim to involve key stakeholders in the analysis of paramount issues.

Since its inception, CGEE has conducted a significant set of studies reflecting the interests of the governmental, academic and business constituencies. The themes include strategic areas of international current interest, such as those dealing with the opportunities arising from the low-carbon economy, the exploration of positive climate change agendas and the role that advanced technologies might play in innovation as they pertain to biofuels industrial chains.

Climate change is definitively impacting the nature and density of the global research and development agenda. All countries must take consistent and concerted action to dramatically reduce the global emissions of greenhouse gases (GHG) until the second half of the twenty-first century, limiting the increase of the average temperature on the earth's surface to around 2°C. To this end, one must find the right balance between the sustainable use of natural resources and development at large. Decarbonization of the global economy is an unavoidable commitment, which depends on greater investments in research, development and innovation (RD&I) in sectors more likely to have significant impacts at the global level.

Recognizing the opportunities to transition to a low-carbon economy coupled with sustainable development, Brazil ratified the Paris Agreement confirming its Nationally Determined Contributions (NDC), and set its national targets for the Sustainable Development Goals (SDGs). These provide a framework in relation to which countries will find their most significant ways to contribute for the benefit of the future global society. Moreover, being a country of continental dimensions and rich in renewable natural resources, Brazil has a high potential to effectively promote economic growth and well-being, combined with its strategic global insertion based on the substitution of nonrenewable fossil resources and pursuing low-carbon standards in all sectors of the Brazilian economy.

The concepts and practices of the circular bio-based economy represent a new paradigm for promoting development, one that focuses on the sustainable use of the world's biodiversity and the energy and materials produced from renewable sources, through the consistent substitution of fossil raw materials. In this regard, a key priority is to add value to end products based on advanced materials obtained from biological sources. Bioeconomy, a term that summarizes what is affirmed henceforward, can reinforce this positive agenda, at the same time, allowing climate change mitigation strategies, while improving economic performance to accomplish broader societal needs.

The bioeconomy is a harbinger of the nature of the future global economy and is being developed by generating new knowledge and transforming mindsets. The Brazilian experience also highlights the importance of public-private initiatives for its effective implementation. The government and private sector should jointly embrace the new agenda in order to effectively support science in all areas and to direct technology and innovation development, as much as possible, to this future-oriented global development strategy.

CGEE is pleased to have partnered with the United Nations Office for South-South Cooperation (UNOSSC) in producing this publication. It brings together the experiences and best practices related to bio-based solutions generated by and applicable in developing countries, which the public and decision-makers now have access to. In addition, trends, good practices and barriers to South-South and triangular cooperation (SSTC) on the bioeconomy are discussed briefly. Different sectors and regions are showcased thereby providing different views on the multi-dimensional impacts and benefits and the main elements of SSTC on the bioeconomy. Finally, the publication explores the advantages and implications of existing synergies between mitigation, adaptation and sustainable development in the context of the bioeconomy pathways, thereby helping the formulation of strategies for competitive insertion in this transition phase of the global economy.



**Foreword by Jorge Chediek, Envoy of the United Nations Secretary-General on South-South Cooperation and Director of the United Nations Office for South-South Cooperation**

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2019 has been a landmark year for South-South and triangular cooperation, with the conclusion of the Second High-level United Nations Conference on South-South Cooperation (BAPA+40), held in Buenos Aires, in March 2019. By means of the adoption of the Conference outcome document (UN 2019, annex), the global community, including United Nations entities and other stakeholders, highlighted the immense potential of South-South and triangular cooperation (SSTC) to contribute to the achievement of the 2030 Agenda for Sustainable Development.

The final document of the BAPA+40 acknowledges that SSTC is increasingly taking “different and evolving forms, including technical cooperation, the sharing of knowledge and experience, training, capacity-building and technology transfer on mutually agreed terms, aimed at achieving sustainable development through the promotion of, inter alia, economic cooperation, including trade, investment, infrastructure development and connectivity, agriculture and rural development, food security and nutrition, food safety, health, energy, disaster risk reduction, addressing climate change, as well as mutual learning and the coordination of development policies and strategies among developing countries” (UN 2019, para. 18). Most of the areas mentioned are closely related to the bioeconomy, which is the fascinating subject of this publication, prepared by the United Nations Office for South-South Cooperation (UNOSSC), in partnership with the Center for Strategic Studies and Management (CGEE), Brazil.

The development of innovative bio-based technologies around the world is leading to less fuel emissions, and to the production of bio-based materials and renewable chemicals that are replacing fossil-based products, with significant positive impacts related to climate change and to the Sustainable Development Goals (SDGs). Given that the Global South has abundant biomass and a great variety of approaches and technologies to use biomass, opportunities related to the bioeconomy have a large potential to produce low-emission energy solutions, enhance food security and generate jobs.

SSTC has become a dealmaker for development in the South and an enabler to achieve the global 2030 Agenda for Sustainable Development and the Sustainable Development Goals.

By highlighting the importance of knowledge-sharing on technologies, practices and experiences to foster the use of bio-based solutions in developing countries, I am certain that this report can provide insights into practical and effective development solutions to be undertaken by Southern countries, and be a relevant resource to inspire, replicate and upscale SSTC on the bioeconomy.

## Disclaimer

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This report, entitled 'South-South and Triangular Cooperation on the Bioeconomy in light of the Paris Agreement and the 2030 Agenda for Sustainable Development,' is a joint publication of the United Nations Office for South-South Cooperation (UNOSSC)<sup>1</sup> and the Center for Strategic Studies and Management (CGEE)<sup>2</sup>.

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3. <https://www.unsouthsouth.org/south-south-cooperation-action-plan-for-climate-change-engagement-strategy-2017-2021>.

## Acronyms

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<b>2030 Agenda</b>	2030 Agenda for Sustainable Development
<b>AFOLU</b>	Agriculture, Forestry and Other Land Use
<b>AMF</b>	Arbuscular mycorrhizal fungi
<b>BAPA</b>	Buenos Aires Plan of Action
<b>BECCS</b>	Bioenergy with carbon capture and storage
<b>BICSA</b>	Bakery and Food Technology Incubation Centre of South Africa
<b>CABBIO</b>	Centro Argentino Brasileño de Biotecnología (Argentine-Brazilian Center of Biotechnology)
<b>CGEE</b>	Center for Strategic Studies and Management
<b>CNPEM</b>	Centro Nacional de Pesquisa em Energia e Materiais (Brazilian National Center for Research in Energy and Materials)
<b>COPPE</b>	Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa em Engenharia, Universidade Federal do Rio de Janeiro (Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Federal University of Rio de Janeiro)
<b>Embrapa</b>	Empresa Brasileira de Pesquisa Agropecuária (Brazilian Agricultural Research Corporation)
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>GEF</b>	Global Environment Facility
<b>GHG</b>	Greenhouse gas
<b>ICBR</b>	International Center for Bamboo and Rattan
<b>ICIPE</b>	International Centre of Insect Physiology and Ecology
<b>IEA</b>	International Energy Agency
<b>IFAD</b>	International Fund for Agricultural Development
<b>INBAR</b>	International Bamboo and Rattan Organisation
<b>IPCC</b>	Intergovernmental Panel on Climate Change
<b>KMUTT</b>	King Mongkut's University of Technology Thonburi
<b>LAC</b>	Latin America and the Caribbean
<b>LDCs</b>	least developed countries
<b>LLDCs</b>	landlocked developing countries
<b>LNBR</b>	Laboratório Nacional de Biorrenováveis do Brasil (Brazilian Biorenewables National Laboratory)

<b>LPG</b>	liquid petroleum gas
<b>MCTIC</b>	Ministério da Ciência, Tecnologia, Inovações e Comunicações do Brasil (Ministry of Science, Technology, Innovation and Communication of Brazil)
<b>MDGs</b>	Millennium Development Goals
<b>NAM</b>	Non-Aligned Movement
<b>NDC</b>	Nationally Determined Contributions
<b>NEPAD</b>	New Partnership for Africa's Development
<b>ODA</b>	official development assistance
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>SANBio</b>	Southern Africa Network for Bioscience
<b>SCOPE</b>	Scientific Committee on Problems of the Environment
<b>SDGs</b>	Sustainable Development Goals
<b>SIDS</b>	Small island developing States
<b>SMEs</b>	small- and-medium enterprises
<b>SSC</b>	South-South cooperation
<b>SSTC</b>	South-South and triangular cooperation
<b>SUCRE</b>	Sugarcane Renewable Electricity
<b>THU</b>	Tsinghua University
<b>UFRJ</b>	Federal University of Rio de Janeiro
<b>UNEOSG</b>	United Nations Executive Office of the Secretary-General
<b>UNFCCC</b>	United Nations Framework Convention on Climate Change
<b>UNIDO</b>	United Nations Industrial Development Organization
<b>UNOSSC</b>	United Nations Office for South-South Cooperation
<b>USTTB</b>	University of Sciences, Techniques and Technology of Bamako
<b>VHD-SSF</b>	very high density-simultaneous saccharification and fermentation



## EXECUTIVE SUMMARY

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**The scale of the challenges associated with sustainable development and climate change are global in nature.** 2015 was a landmark year for charting a new era of sustainable development with the world embracing the 2030 Agenda for Sustainable Development (2030 Agenda) with its 17 Sustainable Development Goals (SDGs) and adopting the Paris Agreement under the United Nations Framework Convention on Climate Change (Paris Agreement) to accelerate and intensify climate action.

**Tackling climate change and fostering sustainable development are two mutually reinforcing sides of the same coin.** A shift to economic, environmental and social sustainability is a prerequisite for addressing climate change, while at the same time low-emission climate-resilient development is required for achieving the SDGs.

**Relying only on North-South development cooperation models will not be sufficient for developing countries to achieve the bold ambitions of the Paris Agreement and the SDGs.** While developed countries reconfirmed their obligation to provide support to developing countries under the Paris Agreement and for the realization of the 2030 Agenda, there is also a growing recognition of the importance and potential of new partnerships among, and with, developing countries through South-South and triangular cooperation (SSTC). At the global level, SSTC is now also clearly aligned with the SDGs through the recent adoption of the Buenos Aires outcome document of the second High-Level United Nations Conference on South-South Cooperation (BAPA+40 outcome document) in March 2019 (UN 2019).

**South-South cooperation does not substitute, but complements North-South development cooperation as an important means through which developing countries can voluntarily assist each other in undertaking climate action and pursuing the achievement of the SDGs.** Many countries from the Global South are rich in indigenous knowledge and traditional technologies that are crucial for adapting to the adverse impacts of climate change. There are also many new technologies for climate change adaptation and mitigation originating from developing countries, which are likely to be more suitable and cost-effective for other developing countries as they are well attuned to similar geo-climatic, cultural and/or socioeconomic conditions.

**The central theme of this report is how developing countries are working together on fostering bioeconomy solutions, and how these solutions can contribute to the implementation of the Paris Agreement and the achievement of the SDGs.** SSTC on the bioeconomy is not only increasing at the policy level with developing countries working together to define regional and national bioeconomy strategies, but also at the implementation level with a growing number of SSTC projects in the area of the bioeconomy being carried out across the globe. Most importantly, developed and developing countries increasingly recognize alike that the bioeconomy needs to be guided by sustainability principles, if its potential for contributing to the SDGs, while reducing greenhouse gas (GHG) emissions and increasing the climate resilience of countries and communities, is to be harnessed.

**The report highlights the importance of knowledge-sharing on technologies, practices and experiences to foster the use of bio-based solutions in developing countries.** The Global South has an abundant biomass and a great variety of approaches and technologies to use biomass for low-emission energy solutions, increasing resource efficiencies in agriculture and industry, enhancing food security, generating jobs and reducing gender inequalities. However, some of these approaches or technologies only exist in one country or region and require SSC for their broader application.

**The report is intended to serve as a knowledge resource to inspire, replicate and upscale SSTC in the bioeconomy** by providing insights into practical and effective development solutions undertaken by Southern countries. Nine case studies from Africa, Asia and Latin America are presented here as a reference source for other developing countries and for developed countries that wish to support SSC in this area through triangular cooperation. The case studies provide an illustrative overview of the ways in which SSTC initiatives on the bioeconomy are being undertaken by and in developing countries, and how these initiatives make tangible contributions to the achievement of the SDGs and the implementation of the Paris Agreement.

**The case studies show that SSTC on the bioeconomy is increasing through the use of traditional and new cooperation modalities.** From the limited sampling of case studies on SSTC on the bioeconomy that has been covered in this report, it is evident that Southern partners view SSTC as a valuable way of sharing experiences and learning from each other, based on mutual trust, partnership and understanding. The case studies also show that there is a broad spectrum of stakeholders involved in fostering a sustainable bioeconomy in developing

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countries, including national and local authorities and affiliated institutions, multilateral organizations, research institutions, business incubation centres, farmers, local communities and small, medium and large businesses.

**However, comprehensive information on the scope and scale of SSTC on the bioeconomy is difficult to obtain.** This is due to the fact that information on South-South cooperation projects is often not made publicly available or, if published, is limited to a brief description of outcomes without reference to further information. This report aims to contribute to closing the information gap. In addition, UNOSSC has recently launched the South-South Galaxy<sup>4</sup>, a consolidated South-South solutions platform for anyone involved in SSTC, including on the bioeconomy, to access information, exchange knowledge and foster partnerships.

**While SSTC on the bioeconomy is increasing, additional efforts are needed to promote political momentum and broader support for new and enhanced partnerships.** The success of SSTC initiatives depends on high-level political support and the commitment to such cooperation by the partners involved. SSTC mechanisms and institutional arrangements need to be further enhanced and supported. One of the challenges in advancing SSTC, both in the past and currently, continues to be the relatively weak organizational and institutionalized technical support, both at the international level and within most developing countries. In many cases, national and intergovernmental institutions of the Global South that have been set up to advance SSTC continue to require greater levels of institutional capacity and human and financial resources. However, this situation is now rapidly changing with the rise of new Southern institutions and the strengthening of existing ones, the establishment of national agencies to undertake SSTC, and a more pronounced priority placed by the United Nations system and its specialized agencies on supporting SSTC.

**Realizing the Global South's drive to lead the world towards a sustainable bioeconomy will require more concerted efforts and the scaling-up of South-South and triangular cooperation** with technical and financial support from developed countries, multilateral, regional and bilateral financial and development institutions and the private sector.

**Future South-South and triangular cooperation on the bioeconomy should focus on creating enabling environments,** ecosystems for innovation, sharing of knowledge and expertise, inclusive business models and policies to promote the use of the bioeconomy also as a driving force for job creation and poverty reduction.

**Triangular cooperation on a sustainable bioeconomy can be of great mutual benefit for developed and developing countries.** While developed countries are also increasingly pursuing a bioeconomy, some are still in the process of defining or refining their national approaches and solutions. Supporting South-South cooperation in regard to a sustainable bioeconomy, including projects involving global bioeconomy leaders from the Global South, can provide valuable new insights for developed countries that can be of great relevance for their own national development contexts.

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4. <http://www.southsouth-galaxy.org>.





## I. INTRODUCTION

## A. Context

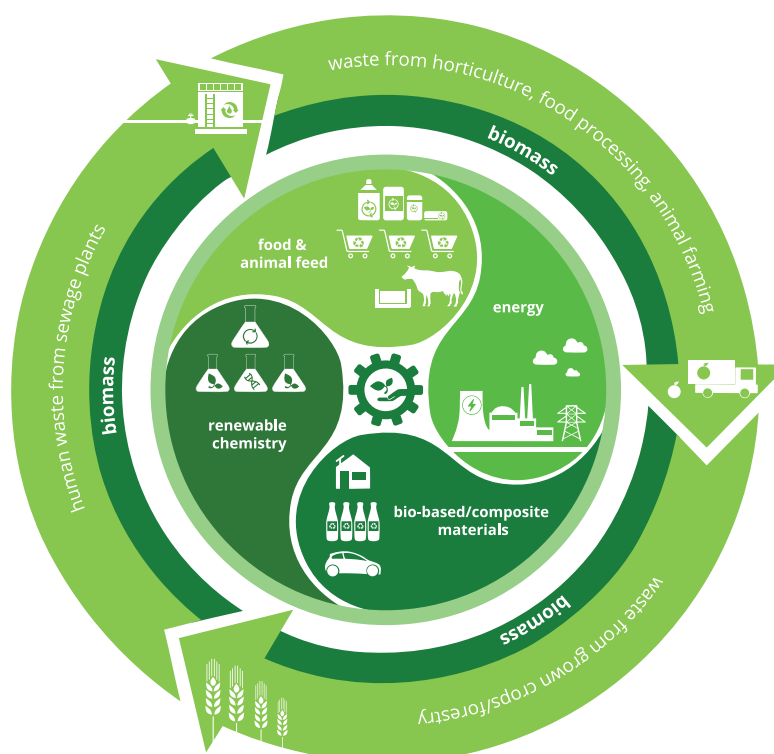
This report is published at a time when South-South and triangular cooperation (SSTC) and the bioeconomy are increasingly recognized as important means for implementing the Paris Agreement (UN 2015a) and the 2030 Agenda for Sustainable Development with its 17 SDGs (UN 2015b). The adoptions of the Paris Agreement and the 2030 Agenda in 2015 represent unprecedented multilateral commitments to tackling the global challenges of addressing climate change and achieving sustainable development. A shift to economic, environmental and social sustainability is a prerequisite for addressing climate change, while at the same time low-emission climate-resilient development is required for achieving the SDGs (GDI 2019, NewClimate Institute 2018; SEI 2017; UNEOSG 2017, WRI 2016). While climate action is emphasized as one of the SDGs, it is also interconnected with all the other SDGs. Therefore, climate action offers a catalytic solution to achieving all the SDGs. Tackling climate change and fostering sustainable development are two mutually reinforcing sides of the same coin.

SSTC on climate change and the SDGs are recognized in the Paris Agreement and by the SDGs as an important means of support, in addition to the obligations of the developed countries. The Paris Agreement makes indirect reference to South-South cooperation, for example in its Article 9.2 by encouraging developing countries to “provide or continue to provide financial resources to assist developing-country Parties with respect to both mitigation and adaptation voluntarily”<sup>5</sup>. In addition, 15 developing countries have highlighted SSTC in their nationally determined contributions (NDCs)<sup>6</sup> as a promising avenue for supporting the implementation of climate actions as a complement to national efforts and international support.<sup>7</sup>

With regard to the SDGs, SDG 17 includes specific targets on finance, technology, and capacity-building that refer to SSTC as a way of strengthening the means of implementation and revitalising the global partnership for sustainable development.<sup>8</sup> In addition, at the global level, SSTC has now also been clearly aligned with the SDGs through the recent adoption of the Buenos Aires outcome document of the second High-Level United Nations Conference on South-South Cooperation (BAPA+40 outcome document) in March 2019 (UN 2019).

More and more developed and developing countries around the world are pursuing national bioeconomy strategies and fostering innovations in bio-based energy, products, materials and chemistry. The bioeconomy does not only offer renewable energy solutions, advances in agriculture and food production, and renewable chemistry, but can also make far-reaching contributions towards low-emission and resource-efficient material solutions in the construction, packaging and automotive industries, as shown in Figure 1 below.

Figure 1: The bioeconomy fosters innovation and low-emission development across industries



5. Other indirect references to SSC can be found in the Paris Agreement Articles 7.7, 11.4 and 12 (UN 2015a).

6. A central element for implementing the Paris Agreement is the NDC of each country. NDCs are national climate plans highlighting climate-related targets, policies and actions every government aims to implement in response to climate change and as a contribution to global climate action. For more information on NDCs and the individual NDCs of countries see: [http://unfccc.int/focus/ndc\\_registry/items/9433.php](http://unfccc.int/focus/ndc_registry/items/9433.php).

7. Afghanistan, Algeria, Benin, Brazil, Chile, China, Colombia, Cuba, Djibouti, Eritrea, the Gambia, India, Mexico, Singapore and South Sudan.

8. Information on all SDGs is available at: <https://sustainabledevelopment.un.org>.



The bioeconomy has a tremendous potential to help shift economic development towards low-emission and climate-resilient pathways in line with the Paris Agreement and to contribute to the achievement of the SDGs. However, if not planned in a sustainable and responsible manner, the increased use of biomass may lead to adverse impacts on ecosystems and communities. Policy coordination and integrated strategies, covering socioeconomic and environmental aspects and engaging a broad range of stakeholders, are therefore required to unlock the positive potential of the bioeconomy.

There are promising efforts underway to ensure that the bioeconomy is guided by sustainable development and climate action as highlighted in this report in the following sections.

## B. Objectives

The objectives of the report are to showcase that SSTC on the bioeconomy can make an important contribution to the implementation of the Paris Agreement and the achievement of the SDGs, as well as to inspire further action in this area. It does so by demonstrating linkages between the bioeconomy, climate action and the SDGs, and presenting case studies of SSTC from developing countries across Africa, Asia and Latin America as examples for emerging good practices and solutions. As such, the report aims to serve as a resource to facilitate SSTC by providing insights into concrete practical and effective development solutions undertaken by Southern countries to promote the bioeconomy in the context of climate action and sustainable development.

## C. Structure

The report is structured in four sections. Following this introductory section (Section I), Section II outlines the evolution of SSTC to date and its role in the implementation of the 2030 Agenda and the Paris Agreement. It also highlights opportunities and challenges posed by the bioeconomy for sustainable development in the Global South. Section III illustrates diverse experiences and good practices relating to the bioeconomy drawn from SSTC projects across Africa, Asia and Latin America. The case studies highlight concrete examples, involving different stakeholders, in the areas of energy, agriculture and industry, demonstrating how SSTC on the bioeconomy is contributing to low-emission climate-resilient development and the achievement of the SDGs. Section IV draws conclusions and reflects on the way forward.

## D. Methodology

This report was conceptualised and developed by UNOSSC, in partnership with the CGEE, following a joint event on “Opportunities and challenges of South-South cooperation on the bioeconomy in light of the Paris Agreement and the 2030 Agenda,” held on the sidelines of the BAPA+40 conference in Buenos Aires in March 2019. Case studies were identified through an open call for inputs published on the UNOSSC website and in an online survey conducted by the UNOSSC and CGEE from June to October 2019. In addition, an in-depth desk research project and consultations with Member States and United Nations entities were undertaken to identify additional case studies in order to ensure broad coverage of different geographic regions, cooperation modalities and focus areas. The case studies were co-authored in consultation with contributing governments, organizations, networks and academic institutions. Case studies were also peer-reviewed by the UNOSSC, the CGEE and external experts.

## E. Acknowledged limitations

The sampling of case studies outlined in this report illustrate the range and diversity of activities that developing countries are undertaking in relation to SSTC on the bioeconomy in the context of climate change and the SDGs. It is acknowledged that a multitude of other activities are certainly underway in many developing countries that are not included in this report. Thus, this report presents a comprehensive but by no means exhaustive overview of current SSTC initiatives in this area. Acknowledged limitations in this context include the following ones:

- *Availability of literature:* The report team was generally only able to access information about activities, cases and programmes that was publicly available online. In addition, the literature review was restricted to publications written in English, Spanish and Portuguese.

• *Research strategy:* This report is not intended to be a systematic review. The research team did attempt to be systematic and identify as many relevant reports and papers as possible, but, inevitably, some activities, cases and programmes will have been omitted. There may be additional activities, cases and programmes that are being undertaken but have not been reported on, and therefore they do not appear in this report.

Despite the acknowledged limitations, this report aims to present a common, practical and flexible approach to enable the future incorporation of lessons learned and good practices related to SSTC on the bioeconomy and its impacts in addressing climate change and fostering sustainable development.

## F. Continuous sharing of good practices and experiences on SSTC

Given the mandate and the central role of the UNOSSC as the focal point for promoting and facilitating SSTC for development on a global and United Nations system-wide basis, the UNOSSC is committed to promoting South-South approaches to sustainable development and the provision of support to Member States on building SSTC partnerships, as well as enabling the sharing of good practices and experiences. Therefore, new examples and best practices can be featured on the South-South Galaxy<sup>9</sup>, a global knowledge-sharing and partnership-brokering platform for SSTC, with a view to promoting and scaling-up best practices to benefit developing countries.



photo: INBAR

9. <http://www.southsouth-galaxy.org>.



## II. GLOBAL CONTEXT FOR SOUTH-SOUTH AND TRIANGULAR COOPERATION ON THE BIOECONOMY IN LIGHT OF THE PARIS AGREEMENT AND THE 2030 AGENDA FOR SUSTAINABLE DEVELOPMENT

## A. Evolution of South-South and triangular cooperation: entering a new era guided by the BAPA+40 outcome document

The United Nations Systems defined South-South cooperation (SSC) as “a process whereby two or more developing countries pursue their individual and/or shared national capacity development objectives through exchanges of knowledge, skills, resources and technical know-how and through regional and interregional collective actions, including partnerships involving governments, regional organizations, civil society, academia and the private sector, for their individual and/or mutual benefit within and across regions. South-South cooperation is not a substitute for, but rather a complement to, North-South cooperation” (UN 2016). “Triangular cooperation involves Southern-driven partnerships between two or more developing countries supported by a developed country(ies)/or multilateral organization(s) to implement development cooperation programmes and projects (UN 2016).

The emergence of SSC can be traced to the 1955 Bandung Conference where 25 newly independent African and Asian nations met to foster political and economic cooperation. This evolved into the Non-Aligned Movement in 1961, enabling developing countries to maintain a neutral stance during the Cold War. However, it was the Buenos Aires Plan of Action (BAPA) for promoting and implementing technical cooperation among developing countries, adopted in 1978, that effectively set the stage for the rise of SSC as an instrument for development and as a complement to North–South development cooperation (UN 1978).

SSC has increasingly become an essential element in how developing countries cooperate to support each other’s development. Its principles and concepts serve as important benchmarks for shaping not only South-South but also, to some extent, North-South relations at the global, regional and national levels. This has also influenced the ways in which the countries of the Global South have sought their respective development goals and objectives.

Countries from the Global South further refined the framework and principles for SSC through the Havana Programme of Action in 2000 (G77 2000), the Marrakech Framework of Implementation of South-South Cooperation in 2003 (G77 2003) and the Doha Plan of Action in 2005 (G77 2005).

In 2009, the High-level United Nations Conference on South-South Cooperation, held in Nairobi, Kenya, gave a major political boost to SSTC. The Nairobi Outcome Document (UN 2009) of this conference further defined the rationale, principles and key actors of SSC, and it requested the United Nations System to help ensure that the expectations of Member States were met regarding support for such cooperation.

SSC has grown in relevance in the past decade and has been a subject for discussion at a number of major United Nations conferences and other conferences. This surge in interest is due largely to the increasing economic power of the Global South, the extensive and relevant development knowledge and solutions generated from developing countries and the increasing evidence of the contribution of SSC to development results in many countries.

Taking note that SSC is an important element of international cooperation for development and that it is of growing relevance, and recognizing the increased role of the United Nations in supporting economic and technical cooperation activities among developing countries and other forms of triangular cooperation, in 2017 United Nations Member States decided to convene the Second High-level United Nations Conference on South-South Cooperation in Buenos Aires from 20 to 22 March 2019.

The Buenos Aires outcome document of the Second High-level United Nations Conference on South-South Cooperation (hereinafter BAPA+40 outcome document) reaffirms and updates the rationale and principles of SSC as follows (UN 2019):

*“(...) we reaffirm our view of South-South cooperation as a manifestation of solidarity among peoples and countries of the South that contributes to their national well-being, their national and collective self-reliance and the attainment of internationally agreed development goals, including the Sustainable Development Goals, according to national priorities and plans. South-South cooperation and its agenda have to be set by countries of the South and should continue to be guided by the principles of respect for national sovereignty, national ownership and independence, equality, non-conditionality, non-interference in domestic affairs and mutual benefit.” (UN 2019, para. 8)*

Taking into account these principles, the modalities and mechanisms for promoting SSC can take place in bilateral, regional or interregional contexts, keeping in mind that it is conducted among countries of the South (UN 2019, para. 7). The BAPA+40 outcome document also reaffirms the importance of triangular cooperation and recognizes “that triangular cooperation complements and adds value to South-South cooperation by enabling requesting developing countries to source and access more, and a broader range of, resources, expertise and capacities, that they identify as needed” (UN 2019, para. 12).

Developing countries have continually stressed that SSC is a complement to, and not a substitute for, North-South development cooperation (UN 2019, para. 10). SSC is therefore seen by developing countries as conceptually different from North-South official development assistance (ODA), given the “voluntary, participative and demand driven nature of South-South cooperation, born out of shared experiences and sympathies, based on their common objectives and solidarity” (UN 2019, para. 9).

The BAPA+40 outcome document recognizes that SSTC have become essential elements of international cooperation. It does not only speak to the past and the present of SSTC, but also considers its future. Since the adoption of BAPA in 1978, the increasing economic dynamism of developing countries in recent decades has imparted greater energy to SSC, including through regional integration initiatives across the developing world. Thus, the BAPA+40 outcome document notes that SSC has expanded its number of relevant actors and scope, taken different and evolving forms, provided innovative approaches for collective actions and experienced incremental institutionalization (UN 2019, paras. 16, 18, 19 and 20). At the same time, the document also acknowledges that developing countries continue to face serious development challenges and new and emerging challenges (UN 2019, 17).

While the BAPA+40 outcome document reiterates that every country has the primary responsibility for its own development, it also reaffirms “the key role of the United Nations funds, programmes, specialized agencies, non-resident agencies, UN Regional Commissions, including UN country teams in supporting and promoting South-South cooperation and triangular cooperation” (UN 2019, Paragraph 21), and stresses the need to reinvigorate the United Nations development system in supporting it (UN 2019, para. 27).

Moreover, the BAPA+40 outcome document presents elements that could strengthen and bolster SSTC, enhance its effectiveness and create enabling environments to improve SSTC prospects for the future (UN 2019, paras. 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35 and 36). The outcome document calls on countries and relevant stakeholders to promote economic, social and environmental dimensions of sustainability, including in all SSTC policies and activities. It also calls on multilateral, regional and bilateral financial and development institutions to consider increasing financial resources and technical cooperation to promote SSTC. The United Nations development system is called upon to assist developing countries in building the human and institutional capacity needed to formulate and implement national development policies, strategies and programmes for SSTC. Member States are encouraged to increase the use of triangular cooperation. Countries that have established institutions with leading expertise in science, technical and innovation are called upon to consider providing more scholarships to enable students and young scientists, including women and girls, from Southern countries to gain greater access to such institutions for higher studies and research. Member States are also encouraged to share knowledge, expertise and best practices on public-private partnerships, including risk assessment and regulatory frameworks (UNOSSC 2019).

Last but not the least, as the world moves towards the implementation of the 2030 Agenda and the achievement of the SDGs, the BAPA+40 outcome document reaffirms the significant role to be played by SSTC in this regard (UN 2019, paras. 1, 2, 6, 17, 23, 24, 27, 28 and 31). Furthermore, the outcome document also recognizes the increasing importance of SSTC in addressing challenges that transcend borders faced by the entire world, but that disproportionally impact the Global South, such as climate change.



## B. South-South and triangular cooperation in the context of sustainable development and climate change

In the overall context of multilateralism SSTC is vital to confronting the challenges of the South. It makes a valuable contribution to development efforts, and, as such, needs to be strengthened. It is an essential strategy to sustain the development efforts of developing countries, particularly in the context of the significant changes that have been taking place in international political and economic relations in recent decades.

Uncertain global, regional and domestic economic conditions, combined with the adverse effects of climate change and environmental degradation, as well as old and new social challenges, including efforts to eradicate poverty, present both significant risks and opportunities for enhanced SSTC.

Given the risks of weaker sustained economic growth, a net outflow of financial resources, a greater level of global income inequality and greater development challenges related to social and environmental dimensions, developing countries could limit or reduce the resources that may be made available for SSTC.

On the other hand, opportunities for enhanced SSTC may arise if developing countries, in the face of weakening levels of multilateral cooperation between developed and developing countries, focus on international cooperation efforts that involve working with each other. Nevertheless, one should point out that SSTC must not be regarded as a substitute for North-South cooperation.

The confluence of the impact of climate change, environmental degradation, rising inequalities within and among countries and uncertain global economic conditions point to the need for enhanced international and South-South cooperation, including the provision of financial resources, technology and capacity-building support; and for such cooperation to be substantially scaled-up and channelled to developing countries, especially those particularly vulnerable to the current challenges.

SSC has been seen as an important element of international cooperation for development that offers viable opportunities for developing countries in their individual and collective pursuit of sustained economic growth and sustainable development.

There have been progressive steps towards multilateral cooperation on sustainable development in recent years, and the year 2015 was an important milestone in this regard, as can be seen in the figure below. The challenge, however, is for the global community and for the South to be able to generate the sustained and high-level political will necessary to address the systemic structural issues that adversely affect social and environmental standards at the global and regional levels, and to enable greater cooperation to address weak economic conditions and other developmental barriers.

Figure 2: Important Multilateral Conferences in 2015



The 2030 Agenda recognizes that in an interconnected world, development goals and challenges need to be addressed through international cooperation. The 17 SDGs with a total of 169 targets highlight and showcase the interlinkages between the economic, social and environmental dimensions of sustainable development and the ways these interlinkages can be used to create positive synergy between the actions under each dimension.

SDG 17, in particular, calls on the Member States of the United Nations to “strengthen the means of implementation and revitalize the global partnership for sustainable development.” The goal has specific targets for international cooperation linked to it, which include targets on the mobilization and provision of finance to developing countries; technology cooperation, facilitation, development and transfer; capacity-building (including a reference to North-South, South-South and triangular cooperation); increasing international trade from developing countries; and addressing systemic issues (including enhancing policy and institutional coherence, global partnerships and data monitoring and accountability).

The 2030 Agenda urges the international community to take urgent action to combat climate change and its impacts by means of its SDG 13. The other key global instrument on climate change is the Paris Agreement, adopted under the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC is the primary multilateral framework for international cooperation on climate change. Since its entry into force in 1994, the development of this multilateral policy regime has gone through various phases designed to trigger greater levels of action and ambition among the Parties to combat climate change in a cooperative manner (e.g. the Kyoto Protocol adopted in 1997). In 2015, the Conference of the Parties to the UNFCCC at its twenty-first session adopted the Paris Agreement. As a related legal instrument to the UNFCCC, the Paris Agreement, “in enhancing the implementation of the Convention, including its objective, aims to strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty” (UN 2015a, Art. 2.1 chapeau).

The Paris Agreement seeks to accelerate and intensify the actions and investment needed for a sustainable climate-resilient and low-emission future. Its central aim is to strengthen the global response to the threat of climate change in the context of sustainable development and efforts to eradicate poverty, including by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels, and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. The Paris Agreement also aims to strengthen the ability of countries to deal with the impacts of climate change.

It is widely recognized that climate change will disproportionately impact those countries in the Global South, particularly vulnerable populations in the least developed countries (LDCs), landlocked developing countries (LLDCs) and small island developing States (SIDS) (IPCC 2007). Climate change scenarios generally predict increasing geophysical changes such as high surface and ocean temperatures, a global rise in sea levels and increased ocean acidification over the course of the twenty-first century, together with increased or more intense extreme weather events, with the most severe effects being felt in tropical areas where most developing countries are located. These changes “are likely to cause an increase in poverty incidence and inequalities by slowing down economic growth and exacerbating food insecurity, health problems and heat stress; and to result in surface-water scarcity and increased exposure to storms and precipitation extremes, coastal flooding, landslides, air pollution and droughts. They may also induce displacement of people and involuntary migration, among other hardships” (UNDESA 2016).

The Paris Agreement clearly states that it “will be implemented to reflect equity and the principle of common but differentiated responsibilities and respective capabilities, in the light of different national circumstances” (UN 2015a, Article 2.2). The Paris Agreement represents an international consensus to enhance individual and collective actions to address climate change, including on the reduction of greenhouse gas emissions, adaptation to adverse impacts of climatic changes, provision of the means of implementation for developing countries (finance, technology and capacity-building), exchange of information, periodic reviews of the actions taken and facilitating compliance.

The Paris Agreement, building on the framework of the Convention, lays the foundation on which future action can be initiated and incentivized, a baseline from which more ambitious action must flow. There are mechanisms in place in the Paris Agreement, such as the global stocktake, that can be used to encourage countries to raise their ambition level. The Agreement seeks to encourage greater levels of international cooperation on climate change through a bottom-up approach that allows each country to choose its nationally determined contribution towards combating climate change, but also ensuring that these actions “will represent a progression over time, while recognizing the need to support developing country Parties” (UN 2015a, Arts. 3 and 4).

In the context of implementing the Paris Agreement, South-South cooperation is implicitly seen as a means through which developing countries could voluntarily assist each other in undertaking their climate change actions, in the context of sustainable development and poverty reduction (UN 2015a, Arts. 7, 9, 11 and 12).

North-South development cooperation models will not be sufficient on their own for countries to achieve the bold ambitions of the SDGs and the Paris Agreement. A more diverse landscape for international cooperation is required that can bring together new partners and new approaches to complement long-standing North-South international development cooperation.

While North-South cooperation is the main modality for development cooperation, in the past few decades it has been noted that SSC has expanded its scope, facilitated regional, subregional and interregional integration, provided innovative approaches for collective actions and strengthened its contribution to sustainable development in its three dimensions (UN 2019, para. 16).

SSC complements North-South development cooperation in areas like climate change, helping to broaden the range and scope of the development partnerships in which developing countries can engage to pursue their national sustainable development priorities and objectives. The recent evolution of SSC and the rising prominence of such cooperation on climate change provide important lessons about its role in enhancing ownership and strengthening the capacity of developing countries, both in their national development efforts and in cooperating in mutually supportive and beneficial ways.

SSC is a means through which developing countries can voluntarily assist each other in undertaking their climate change actions in the context of sustainable development and poverty reduction. In addition to multilateral coordination, for example in the UNFCCC negotiations, many developing countries have been pursuing SSC on climate change on the ground (UNEOSG 2017).

These trends are reflected in the BAPA+40 outcome document, which not only welcomes all these instruments and recalls other relevant major United Nations conferences and summits in the economic, social and related fields, but makes clear that the overarching theme of such a conference is the 'Role of South-South cooperation and implementation of the 2030 Agenda for Sustainable Development: Challenges and opportunities' (UN 2017).

The BAPA+40 outcome document recognizes "that South-South and triangular cooperation contribute to the implementation of the 2030 Agenda for Sustainable Development and to achieving the overarching goal of the eradication of poverty in all its forms and dimensions, as it shares the comprehensive vision of development contained in the 17 Sustainable Development Goals, that balance the three dimensions of sustainable development – the economic, social and environmental" (UN 2019, para. 6).

Moreover, the document acknowledges that "that developing countries continue to face serious challenges, as well as new and emerging challenges, in the implementation of the 2030 Agenda for Sustainable Development", and it is recognized "the need to enhance capacity in developing countries by enhancing resources, and by building local capabilities, institutions, expertise, human resources, where appropriate, in contribution to national development priorities, at the request of developing countries"(UN 2019, para. 17).

## **C. Global sustainable development landscape and the bioeconomy**

There is no common definition of the bioeconomy. Nicholas Georgescu-Roegen initially coined the term bioeconomy, and he also highlighted the biological origin of economic processes and the fact that their dependence on limited and unequally available amounts of resources posed significant challenges to humanity (Georgescu-Roegen 1975 and 1977).

Since then, the bioeconomy, developed into a concept around innovative, more efficient and sustainable use of biological sources and as such has gained increasing attention around the world as a possible response to global challenges. These include the following: (i) the fact that by 2050 the world population is expected to grow to more than nine billion people and consequently the need to meet the global food demand will be much greater than at present; (ii) the evidence of environmental degradation and significant natural resource depletion and the need to halt these trends, including by enhanced efforts to improve waste management and air and water quality; and (iii) climate change and its adverse impacts will represent major future barriers for sustainable development, requiring a significant reduction in GHG and tremendous efforts in adaptation.

The “bioeconomy” continues to be defined in different ways around the world, as can be seen in Box 1 below.

Despite the notable diversity of bioeconomy in countries around the world, in recent years common aspects of various definitions seem to include science, technology, knowledge and innovation around the production, use and conservation of biological resources, with a focus on replacing fossil fuels in its various applications and creating new materials, value chains and services that foster sustainable development. A common denominator also seems to be the interlinkages between the bioeconomy, the circular economy, climate change and sustainable development, as shown in Figure 3 below.

**Box 1: Selected definitions of the term “bioeconomy”**

**Georgescu-Roegen (1975):** “The term [bioeconomy] responds to the biological origin of the economic process and thus highlights the problem of the existence of humanity with a limited amount of accessible resources, unequally located and unequally appropriate.”

**Organisation for Economic Co-operation and Development (2009):** “The bioeconomy refers to the set of economic activities related to the invention, development, production and use of biological products and processes.”

**European Commission (2012):** “Bioeconomy is an economy that uses the biological resources of land and sea, as well as waste, as inputs for food and feed production, as well as for industrial and energy production. It also covers the use of biological processes in sustainable industries.”

**Trigo et. al (2014):** “Bioeconomy represents a vision of a future society much less dependent on fossil resources for its energy and raw materials’ needs and where biomass produced in a sustainable way plays a critical role in the production of food, health products, feed, fibres and industrial products and energy.”

**Biofuture Platform (2017):** “Bioeconomy is a set of economic activities related to the invention, development, production and use of biological products and/or processes for the production of renewable energy, materials and chemicals.”

**Economic Commission for Latin America and the Caribbean (2017):** “Bioeconomy is an economy based on the consumption and production of goods and services derived from the direct use and sustainable transformation of biological resources, including biogenic waste, generated in the processes of transformation, production and consumption, taking advantage of knowledge of biological processes and principles and technologies applicable to the knowledge and transformation of biological resources and the emulation of biological processes and principles.”

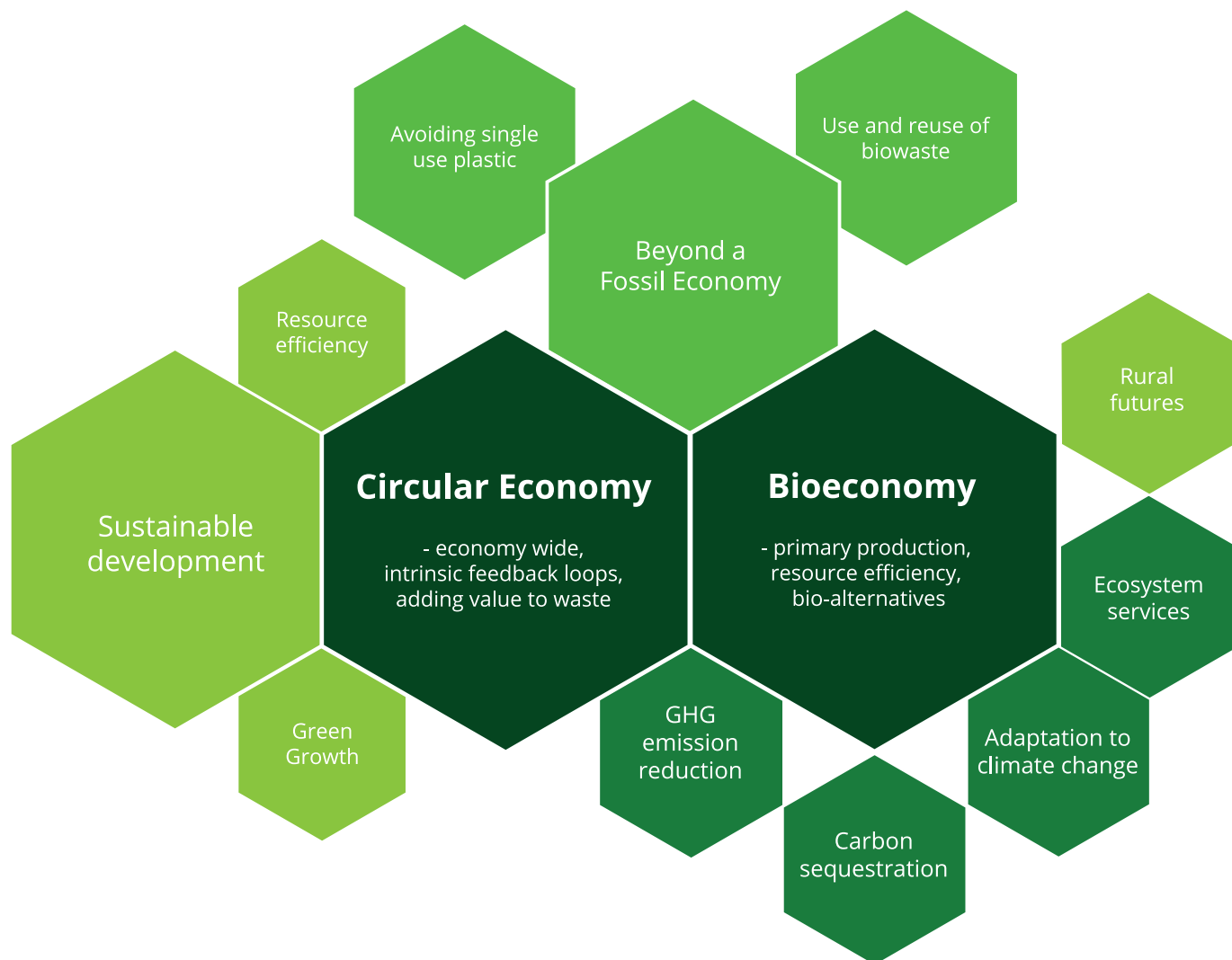
**Global Bioeconomy Summit (2018):** “Bioeconomy is the production, utilization and conservation of biological resources, including related knowledge, science, technology and innovation, to provide information, products, processes and services across all economic sectors aiming toward a sustainable economy.”

**Joint workshop FAO IEA Task 43 (2018):** “The bioeconomy is based on the production of renewable biological resources and the conversion of these resources and waste streams into value-added products, such as food, feed, bio-based products and bioenergy.”

**Brazilian Ministry of Science, Technology, Innovations and Communication (2018):** “Bioeconomy is a set of economic activities based on the use of sustainable biological resources (biomass) to replace fossil raw materials in the production of food, feed, materials, chemicals, fuels and energy through biological, chemical, thermochemical and physical processes for promoting health, development, sustainable growth and the well-being of society.”

While the bioeconomy certainly has a tremendous potential to contribute to the achievement of the SDGs by shifting economies away from fossil fuels and towards greater resource efficiencies, it does require concerted efforts and long-term strategies to ensure that increases and innovation in the production and use of biological resources does not lead to unsustainable trade-offs, for example in the areas of food security, or biodiversity or with regard to overall net GHG emissions.

Figure 3: The bioeconomy, climate change and sustainable development



Source: Bowyer & Allen 2018.





Source: German Bioeconomy Council (2015). *Bioeconomy Policies - Synopsis of National Strategies in the World*

Global and regional initiatives on the bioeconomy include the following ones:

- The **Global Bioeconomy Summit**, a global conference taking place every two or three years, aims to provide “thought leadership in effectively shaping global bioeconomy policy and sharing the global responsibility to contributing to sustainable development”<sup>10</sup>.
- The **Biofuture Platform** was launched at the United Nations Climate Change Conference in Marrakech in 2016 under Brazil’s leadership as a new platform that brings together 20 countries, including 11 developing countries, to advance the low-carbon bioeconomy that is sustainable, innovative and scalable. In particular, the Biofuture Platform aims to support countries with the implementation of their NDCs and the achievement of the SDGs, especially SDG 7 (Affordable and clean energy) and SDG 13 (Climate action), while also contributing to SDG 2 (Zero hunger), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure) and SDG 15 (Life on land).<sup>11</sup>
- The FAO-led **International Sustainable Bioeconomy Working Group** (ISBWG) was established in 2016 as a multi-stakeholder expert group, including 30 members from 14 countries, as well as regional governing bodies, non-governmental organizations, private sector entities, research institutions and intergovernmental organizations. The Working Group, inter alia, acts as an advisory body to FAO’s project regarding the development of Sustainable Bioeconomy Guidelines. See also Box 2 below.<sup>12</sup>

11. <http://biofutureplatform.org>.

12. <http://www.fao.org/energy/bioeconomy/en>.

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• **BioInnovate Africa**, which supports scientists and innovators in Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda to link biological based research ideas and technologies to business and the market. In addition, BioInnovate Africa is in the process of developing an innovation-led **Bioeconomy Strategy for Eastern Africa**<sup>13</sup>.

There is also an increasing number of bilateral initiatives. For instance, Argentina and Brazil established the joint biotechnology capacity-building center CABBIO<sup>14</sup> in 1986. To date the center has held 440 courses, trained 5,500 professionals and supported 145 projects, which have also benefited many other Latin American countries.

Box 2: FAO project, 'Towards Sustainable Bioeconomy Guidelines'

The Food and Agriculture Organization of the United Nations (FAO) has a big role to play in supporting its Members in achieving their national development goals and the SDGs. Its unique mandate and programmes allow for integrated approaches addressing the multiple dimensions of sustainable development, and its comprehensive expertise allows for the best knowledge to be made available to countries. Furthermore, FAO is the custodian of 21 SDG indicators across 6 SDGs, and also contributing to collect evidence on additional SDG indicators, ensuring generation of data and capacitation of national stakeholders for generating and analyzing evidence for informed decisions on policies and programmes.

SSTC, in the context of the 2030 Agenda and the SDGs, can support the scale up of bioeconomy activities and good practices that are sustainable.

Opportunities for SSTC exist for countries involved in the FAO project on sustainable bioeconomy guidelines through knowledge- and experience-sharing related to different project outputs, such as the International Sustainable Bioeconomy Working Group (ISBWG) project, technical reports on available bioeconomy-relevant good practices, monitoring systems and tools and support to Global South countries.

The cross-cutting nature of the bioeconomy offers a unique opportunity to comprehensively address interconnected societal challenges such as food and nutrition security, fossil resource dependence, natural resource scarcity, including threats to biodiversity and climate change, while achieving sustainable economic development.

However, bioeconomy activities are not necessarily sustainable. The development of an economy that is based on biological resources faces several trade-offs. It is crucial that the development of the bioeconomy contributes to sustainability and helps to achieve the SDGs. A paramount concern is that the development of the bioeconomy does not undermine food security, especially in areas with high levels of malnutrition.

Considering these challenges and opportunities, in January 2015, in the Final Declaration of the Global Forum for Food and Agriculture Summit in Berlin, 62 Ministers of Agriculture recommended that FAO coordinate the international work on sustainable bioeconomy. The opportunities for SSTC involve different outputs of the FAO Sustainable Bioeconomy Guidelines project. Some results of the project that have been shared through the ISBWG include:

- *A report on how sustainability has been addressed in more than 20 bioeconomy strategies worldwide.*<sup>15</sup>
- *A list of "Aspirational Sustainable Bioeconomy Principles and Criteria" agreed by the ISBWG at the end of 2016.*<sup>16</sup>
- *A recent report on lessons learned from 26 successful bioeconomy cases from all over the world, including from developing countries and examples of SSTC.*<sup>17</sup>
- *A recent report on existing frameworks and indicators for monitoring and evaluating the sustainability of the bioeconomy.*<sup>18</sup> *The internationally defined "Aspirational Sustainable Bioeconomy Principles and Criteria" are proposed as a framework for developing coherent monitoring systems across countries.*

13. <https://bioinnovate-africa.org/developing-an-innovation-led-bioeconomy-strategy-for-eastern-africa>.

14. <https://www.argentina.gob.ar/ciencia/sepp/cooperacion-internacional/cabbio>.

15. <http://www.fao.org/3/a-i5998e.pdf>.

16. <http://www.fao.org/3/ca5145en/ca5145en.pdf>.

17. <http://www.fao.org/3/ca4352en/ca4352en.pdf>.

18. <http://www.fao.org/3/ca6048en/ca6048en.pdf>.

- *In addition, the project provides the opportunity for developing countries currently supported by the project in the development of their bioeconomy strategy (e.g. Namibia and Uruguay) to receive inputs from and to share their experience with other developing countries as well as other members of the ISBWG.*

The FAO “Sustainable Bioeconomy Guidelines” aim to contribute to the international support needed to ensure that the development of bioeconomy strategies, programmes and projects would be developed sustainably, and to support countries in the development of their bioeconomy strategy. This concerns several SDGs, in particular those related to food security, economic and social development, responsible production and consumption, climate change mitigation and adaptation, increased resilience of communities and ecosystems and other environmental co-benefits, in particular on natural resources management and biodiversity conservation.

The following lessons have emerged so far regarding the development of sustainable bioeconomy strategies and programmes which are relevant to the Global South:

- *Ensuring that the bioeconomy is developed in a sustainable way and will benefit all sections of the population is a necessity, but this will not be easy to achieve. There is no “one-size fits all” in terms of priorities, approaches and how sustainability is mainstreamed into bioeconomy strategies and implementation plans;*
- *Global South countries do not have to start from scratch and should avoid reinventing the wheel. Rather, one should build on the vast body of knowledge, policies, approaches and good practices related to the conventional sectors of biomass production and use (agriculture, forestry, fisheries) and, more recently, modern bioenergy, biochemistry and others. On that basis, one can adapt existing relevant strategies and programmes to develop bioeconomy in a sustainable way, and fill gaps where needed;*
- *They should combine generic aspects and leave enough flexibility to allow for solutions to be tailored to local circumstances;*
- *They should be achieved through a joint effort by a multi-stakeholder partnership; and*
- *They should be supported by a significant communication effort aimed at the general public should support the effort in order to ensure societal acceptance of, and active involvement in, moving towards a bioeconomy.*

Contributing to climate change mitigation through the substitution of fossil fuel-based goods and industrial processes by bio-based ones is often an objective of bioeconomy strategies and operations. Whilst these often refer to greener food chains through the use of bioenergy as an explicit way to achieving this, they more seldom explicitly mention other possible sustainable bioeconomy contributions to mitigate climate change, such as soil carbon sequestration and/or reduced deforestation. Moreover, the links between bioeconomy and climate change adaptation (in terms of increased self-sufficiency in livelihood means and income opportunities through the use of biomass and sale of bio-products) is seldom mentioned.

The results and opportunities for SSTC offered by the FAO project on sustainable bioeconomy guidelines are a good way to address the above-mentioned interconnected challenges. It is another illustration that FAO facilitates subregional, regional and interregional linkages for knowledge- exchange and experience-sharing through its SSTC initiatives.

Source: Gomez San Juan M., Bogdanski, A. & Dubois, O. 2019. Towards sustainable bioeconomy - Lessons learned from case studies. Rome, FAO. 132 pp.

From the point of view of the productive chain, bioeconomy can encompass different sets of activities related to any of the following:

**Biomass:** initiatives on strategic inputs and services for the production of biomass; integrated production systems; use of residues and wastes; high-yield crops; genetically enhancement; agroecological transition; sustainable use of national biodiversity and new biomass; and others.

**Processing and biorefineries:** initiatives on pre-treatment and processing of biomass; technologies for treatment of waste and effluents; technologies and inputs for bio-industries; intensification of processes; demonstration plants; and others.

**Bioproducts:** initiatives on biofuels, biopower, biogas, CO<sub>2</sub> by-product, industrial biotechnology and synthetic biology, renewable chemistry, development and production of microorganisms and enzymes; biomaterials, biocomposites and their uses; and others (MCTIC 2018).

This report aims to promote the exchange of SSTC experiences and knowledge on the development and implementation of innovative approaches to remove barriers to expanding the sustainable use of the Global South's abundant biomass resources, while maximizing economic, social and environmental benefits.

In developing countries, the bioeconomy often relies heavily on bio-based primary sectors such as agriculture, forestry or fisheries. Often, these sectors have considerable potential for promoting sustainable growth if supported by a transfer of knowledge and technology. Transformative processes, such as digitalization and biotechnology, represent opportunities to increase bio-based value creation in many, if not all, economic areas.

The Global South is particularly well placed to both contribute and benefit from the emerging bioeconomy as it is well known for its vast natural resources, in terms of land, water and biodiversity, which are factors of increasing strategic value in the global context of a "bio-based world". Thus, developing countries have the potential to become leaders in, *inter alia*, the exploitation of new agricultural technologies and in the biofuels markets. Some developing countries are increasingly using biomass as a modern source of energy and fuel to a greater extent than many developed countries.

At the same time, the Global South has significant development challenge of its own. Hunger and poverty, although not as dramatic as in the past, are continuing preoccupations in developing countries, especially in the rural areas. Moreover, the harmful relation between poverty and environmental degradation is well recognized, whereas hunger forces poor people to engage in practices that have an adverse impact on the environment as they search for the bare rudiments of survival. Thus, in this context, bioeconomy has a dual set of objectives. At the global level, developing countries have a critical role in contributing to global food, fibre and energy balances, while seeking to improve sustainability from the environmental, economic and social points of view.

By increasing sustainable and biodiversity respectful use of renewable aquatic and terrestrial biomass resources for, *inter alia*, biofuels, bio-based products, and bioenergy, bioeconomy has the potential to stimulate job growth and economic opportunities; promote regional development; support secure and renewable energy; foster sustainable industrial development; and contribute to an improvement in the quality of the environment. Realizing this potential will require the development, demonstration and deployment of several innovative processes, fuels and materials that can meet performance standards while contributing to environmental, social or economic sustainability.



photo: INBAR



Moreover, a sustainable bioeconomy will be crucial in the global fight against climate change, nurturing urgently needed solutions for low-emission and climate-resilient societies and helping countries to reach their NDC targets and achieve the SDGs. Some of the linkages between a sustainable bioeconomy and SDGs are shown in Box 3 below.

Box 3: Linkages between a sustainable bioeconomy and the SDGs

### SDG 1: End poverty in all its forms everywhere

1 NO POVERTY



Agriculture and biomass production are essential components of any poverty and hunger alleviation strategy. Given that the bioeconomy is a way to exploit new opportunities and to increase the aggregation of value to bio-based primary products and to promote economic diversification, especially in manufacturing and the energy sectors, it can be an important tool to eliminate poverty, especially in those countries that heavily depend on the agricultural sector.

### SDG 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture

2 ZERO HUNGER



Connecting the smallholder farmers to markets, value chains and agro-bioeconomy opportunities is an important tool in elevating agricultural productivity, decreasing poverty and improving rural livelihoods. High amounts of losses and organic waste are still generated across food supply chains, which could be either avoided or better used in the context of the bioeconomy for the benefit of people and the environment. Moreover, one of the main promising features of the bioeconomy is that it could potentially offer sustainable sources of protein for human and animal nutrition. Food applications are also developed from microorganisms, including microbiome-based solutions.

### SDG 3: Ensure healthy lives and promote well-being for all at all ages

3 GOOD HEALTH AND WELL-BEING



The use of traditional biomass as a source of energy has negative health effects through indoor air pollution. Improved access to alternative energy sources, such as biogas, could help reduce the use of fuel wood in developing countries. Bioeconomy opportunities in the medical and pharmaceutical fields and in the health sector are also promising. However, the potential health impacts of the bioeconomy need to be better understood and communicated to the public at large.

### SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

4 QUALITY EDUCATION



The availability and the quality of education in the field are important factors in generating diverse opportunities for populations in developing countries. The effects of school inclusion for this population and the acquisition of technical skills through education can be felt in the boosting of the economy, with the emergence of new services, jobs and supply chains. This all contributes to social mobility and an improved quality of family life. Knowledge transfer of the bioeconomy can bring important gains in this regard. Supporting the promotion of proven and broadly accepted good practices in the production and the sustainable management of relevant natural resources will significantly contribute to the more efficient use of biological resources for the benefit of society and the planet.

### SDG 5: Achieve gender equality and empower all women and girls

5 GENDER EQUALITY



The participation of women in the development of new bio-based businesses should be encouraged to broaden their economic and social impact. The promotion of an enabling environment for the bioeconomy (e.g. motivating new value-networks among agriculture, forestry, fisheries and bio-based industries and enhancing the use of enabling bio-technologies) that values the role of women as active and central figures in these processes can help to promote female empowerment.



## **SDG 6: Ensure the availability and sustainable management of water and sanitation for all**

Given the close interlinkages between water, energy and food, a water-energy-food nexus approach is needed to address the trade-offs and synergies in their production and/or use.

The bioeconomy has the potential to strengthen this nexus and reduce the impact on natural resources. In addition, an agricultural production free of toxic substances, chemicals and other hazardous materials reduces the chances of water pollution and allows recycling and safe reuse.

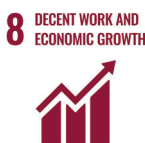
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## **SDG 7: Ensure access to affordable, reliable, sustainable and modern energy for all**

Access to modern energy services is a key component of SDG 7, with an estimated 1.1 billion persons having no access to electricity and nearly three billion people relying on traditional biomass (fuelwood, agriculture residues, animal dung, charcoal) for household energy needs (IEA 2017). Improvements in energy access and reduction or elimination of traditional biomass use thus have benefits across multiple SDGs. Poor and vulnerable populations often expend considerable time (gathering fuel) or use a significant share of household income for low quality energy services. Furthermore, improved energy access contributes to adaptive capacity.

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## **SDG 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all**

The bioeconomy has the potential to be an important driver for sustainable economic activity on a large scale, covering millions of people in a traditional and potentially more harmonious relationship with the environment, especially when there are incentives in this regard. In a future scenario where the bioeconomy is a reality, as land and biomass become more valuable, there will be benefits for farmers, forest owners and associated service providers as they diversify away from feed and tap into economic activities supporting bioenergy, value-added products, the preservation of biodiversity and carbon sequestration (and storage).

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## **SDG 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation**

The bioeconomy can stimulate new value-networks between agriculture, fisheries and bio-based industries. A key driver of bioeconomy innovation is the rapid development in the life sciences, in combination with digitization, and the convergence of key technologies in applications. Promising innovations have for example been developed from genomics, applying big data analysis, artificial intelligence and from biotechnology, neurotechnology and nanotechnology. Such high-tech applications provide huge potential in the various areas of the bioeconomy and for sustainable development. Active bioeconomy-related industrial policies should be encouraged and the relevant experiences shared.

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## **SDG 10: Reduce inequality within and among countries**

The developments in biotechnology and related high-tech areas are dominated by a few innovation centres of excellence, usually located in developed countries, while many countries rich in bio-resources are lacking science and technology investments allowing them to participate in technological developments. In many developing countries, there is an absence of technology and business incubation mechanisms that move bioscience innovations from research and development along the innovation chain to markets. However, an enabling environment that stimulates the application of science and technology to optimize the use and add value to bioresources in developing countries, where they are more abundant, can help to reduce inequality among countries. The promotion of development in rural and coastal areas by motivating new value-networks among agriculture, fisheries and bio-based industries can help to reduce inequalities within countries.

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## **SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable**



The integration of biological principles into urban planning and management has become an important element for achieving “greener cities” that ensure a quality of life and a reduction of GHG emissions. Local production of bio-products, vertical farms, recycling systems and adequate waste treatment are crucial elements of innovative sustainable cities. Sustainable building designs and construction techniques that make reference to biological principles and renewable resources are becoming more common in modern cities.

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## **SDG 12: Ensure sustainable consumption and production patterns**



Responsible production, circular approaches and the functionality-oriented use of resources are part of the bioeconomy approaches that need to be more widely applied, especially in the primary sector. Improvements on the consumption and production side, especially by means of avoiding and/or minimizing losses (e.g. food loss and waste) or better using agricultural and fishery inputs, are of global importance and vital for resource efficiency. Moreover, the bioeconomy can stimulate the development of sustainable materials, including addressing the plastic pollution crises, for instance, food packaging materials made from bio-based materials (e.g. from agrifood residues), instead of fossil-based plastics.

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## **SDG 13: Take urgent action to combat climate change and its impacts**



The acknowledgment of the climate change phenomenon and its adverse impacts as a major future barrier for sustainable development, and the need to adopt GHG mitigation measures, while ensuring energy security through enhancing diversity of energy supply, including through more sustainable uses of biomass, are major components of the concept of the bioeconomy and cannot be separated from it.

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## **SDG 14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development**



Biological resources from the oceans are significant and can be precious inputs for the bioeconomy. Furthermore, the use of traditional fertilisers in agriculture may affect the quality of sea and ocean waters, as well as the biodiversity in these ecosystems. Chemicals are likely to negatively affect the health of seas and oceans, once they are emitted into the sea, as is often the case with untreated sewage. Bio-fertilisers and agroecological systems that are free of toxic substances have the potential to reduce marine pollution arising from land-based activities, such as pollution by nutrients. Moreover, bio-based packing materials can reduce the impact of plastic pollution in the oceans.

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## **SDG 15: Protect, restore and promote the sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, halt and reverse land degradation and halt biodiversity loss**



Desertification, biodiversity loss, deforestation and land degradation are current realities that may worsen in the coming decades due to climate change and human action. Alternatives presented in the context of the bioeconomy – such as sustainable soil management; agroecology and crop, livestock and forestry integration systems; bio-waste as inputs for energy production, etc. – which are productive and sustainable instruments to mitigate and adapt to climate change, can significantly contribute to the protection and restoration of the environment. The bioeconomy has the potential to establish the framework that stimulates the use of sustainable resources in value-networks. Moreover, the bioeconomy can foster the valorisation of biodiversity, not only in monetary terms (e.g. resulting from valuable benefits), but also from the perspective of its intrinsic values and ecological functions. Nevertheless, some bioeconomy activities, such as charcoal production, can be a driver of land degradation, especially if combined with timber harvesting or clearing land for agriculture.

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## **SDG 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels**

To tackle the challenges related to the bioeconomy, more efficient and transparent regulations need to be put in place, including on the regulatory processes for biotechnologies, related to certification, labelling systems and intellectual property law. Governments and policy-makers will need to find more suitable formats for the dialogue among societal stakeholders on how to manage and effectively monitor the application of new biotechnologies.



## **SDG 17: Strengthen the means of implementation and revitalize the global partnership for sustainable development**

Most of the means of implementation (finance; technology; capacity building; trade; policy and institutional coherence; multi-stakeholder partnerships; and data and accountability) are fundamental for the consolidation of the bioeconomy. Experience, science and technology provide the knowledge base for the bioeconomy policy regarding the interdependencies with sustainable development. Capacity-building, including through SSTC, can harmonize the knowledge on bioeconomy activities. Financing of research and development is needed to broaden the innovation agenda, to stimulate fair innovation sharing and to close the science and knowledge gaps in the global bioeconomy. Enabling environments and international collaboration among different stakeholders are required to establish and maintain a state-of-the-art knowledge base for bioeconomy policy and governance. Measuring and monitoring efforts will be important in order to understand and address the impacts of bioeconomy developments, specifically on climate change, food security, health and nature conservation. Reliable and disaggregated data will be crucial to assess such impacts from the economic, environmental and social perspectives.

### **D. South-South and triangular cooperation on the bioeconomy and the need for climate action**

The BAPA+40 outcome document reflects the evolution of SSTC and constitutes a path into the future. It opens up a range of possibilities to further expand the horizons of collaboration, recognizing “that South-South cooperation is conducted among countries of the South, including but not limited to the economic, social, cultural, environmental and technical domains” (UN 2019, para. 7).

SSTC is increasingly taking “different and evolving forms, including technical cooperation, the sharing of knowledge and experience, training, capacity-building and technology transfer on mutually agreed terms, aimed at achieving sustainable development through the promotion of, inter alia, economic cooperation, including trade, investment, infrastructure development and connectivity, agriculture and rural development, food security and nutrition, food safety, health, energy, disaster risk reduction, addressing climate change, as well as mutual learning and the coordination of development policies and strategies among developing countries” (UN 2019, para. 18). Most of the areas mentioned are closely related to the bioeconomy.

The BAPA+40 outcome document also highlights that “developing countries tend to share common views on national development strategies and priorities when faced with similar development challenges. The proximity of experience is therefore a key catalyst in promoting capacity development in developing countries and, in this regard, it accentuates the principles of South-South cooperation. It is important to enhance South-South cooperation in order to fulfil its full development potential” (UN 2019, para. 13). This also applies to fostering the bioeconomy in the context of the 2030 Agenda that was the focus of the previous subsection, and also in the context of the Paris Agreement, which will be discussed here.

Many activities related to the bioeconomy have the potential to contribute to the implementation of the Paris Agreement, not only through reducing anthropogenic GHG emissions, but also by providing carbon sinks that can contribute to “...a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of this century ...” (UN 2015a, Art. 4).

Although the bioeconomy uses the biological resources of land and sea, it is usually associated to those deriving from land. Biomass from land can be used, inter alia, as forage, food, feed, essential oils, biofuel, timber and fuelwood.

Any changes to the land and to its biomass and how they are used can affect exchanges of water, GHGs, including CO<sub>2</sub>, CH<sub>4</sub>, N<sub>2</sub>O, between the land and the atmosphere. Land and land use change therefore alter the state and the dynamics of the atmosphere. It is well known that vegetation absorbs CO<sub>2</sub> to use for growth and maintenance, and if plant-based material (biomass) is used for energy, the carbon it absorbed from the atmosphere is released back. Forests contain more carbon in their biomass and soils than croplands and, therefore, a conversion of forest to cropland, for example, results in emissions of CO<sub>2</sub> to the atmosphere, thereby enhancing GHG-induced global warming. Viewed from a different perspective, there is an opportunity to mitigate climate change through the enhancement of terrestrial carbon stocks, as land is re-vegetated.

**Box 4: Selected messages from the IPCC Special Report on Climate Change and Land that have implications for bioeconomy activities**

- Land provides the principal basis for human livelihoods and well-being including the supply of food, fresh water and multiple other ecosystem services, as well as biodiversity.
- People currently use one quarter to one third of land's potential net primary production for food, feed, fibre, timber and energy.
- Land is both a source and a sink of GHGs and plays a key role in the exchange of energy, water and aerosols between the land surface and atmosphere.
- Sustainable land management can contribute to reducing the negative impacts of multiple stressors, including climate change, on ecosystems and societies (high confidence).
- Agriculture, Forestry and Other Land Use (AFOLU) activities accounted for around 13% of CO<sub>2</sub>, 44% of methane (CH<sub>4</sub>), and 82% of nitrous oxide (N<sub>2</sub>O) emissions from human activities globally during 2007-2016, representing 23% (12.0 +/- 3.0 GtCO<sub>2</sub>e yr<sup>-1</sup>) of total net anthropogenic emissions of GHGs (medium confidence).
- Many land-related responses that contribute to climate change adaptation and mitigation can also combat desertification and land degradation and enhance food security. The potential for land-related responses and the relative emphasis on adaptation and mitigation is context-specific, including the adaptive capacities of communities and regions.
- Although most response options can be applied without competing for available land, some can increase demand for land conversion (high confidence).
- Sustainable land management, including sustainable forest management, can prevent and reduce land degradation, maintain land productivity and sometimes reverse the adverse impacts of climate change on land degradation (very high confidence). It can also contribute to mitigation and adaptation (high confidence). Reducing and reversing land degradation, at scales from individual farms to entire watersheds, can provide cost effective, immediate and long-term benefits to communities and support several SDGs with co-benefits for adaptation (very high confidence) and mitigation (high confidence).
- Response options throughout the food system, from production to consumption, including food loss and waste, can be deployed and scaled-up to advance adaptation and mitigation (high confidence).
- Near-term action to address climate change adaptation and mitigation, desertification, land degradation and food security can bring social, ecological, economic and development co-benefits (high confidence). Co-benefits can contribute to poverty eradication and more resilient livelihoods for those who are vulnerable (high confidence).

*Source: IPCC 2019*

The bioeconomy initiatives offer fundamental synergies that can facilitate the joint implementation of strategies to achieve the SDGs and accelerate climate action, with particular reference to those climate response strategies related to agriculture, forestry and other land use (AFOLU). A recent report by the Intergovernmental Panel on Climate Change (IPCC), issued in August 2019, assesses the linkages among climate change, desertification, land degradation, sustainable land management, food security and GHG fluxes in terrestrial ecosystems, which are of special importance in the context of the bioeconomy.

Traditional biomass, such as fuelwood, charcoal and agricultural residues, remains a primary source of energy for more than one third of the global population leading to unsustainable use of biomass resources and forest degradation and contributing around 2 percent of GHG emissions. Reducing unsustainable use of traditional biomass stimulated by bioeconomy initiatives (e.g. a shift from traditional to modern bioenergy, especially in developing countries) has the potential to reduce land degradation and emissions of CO<sub>2</sub>, while providing social and economic co-benefits. In the context of the bioeconomy, both agricultural and woody biomass can be upgraded and used through modern conversion technologies and improved resource management, providing much greater energy output per unit of biomass. Thus, bioeconomy activities that help to avoid, reduce and reverse land degradation have a broad potential to mitigate climate change and help communities to adapt to climate change (e.g. reduce the impacts of floods and drought).

The use of biomass to produce heat, electricity and transport fuels (bioenergy) instead of coal, oil, and natural gas has the potential to contribute significantly to global climate mitigation efforts, although it is important to ensure integrated responses across different sectors in order to help reduce any eventual negative impacts and to promote sustainable development opportunities. For instance, the tripod sugarcane and cellulosic bioethanol, bio-power and biogas, high-biomass sugarcane, and renewable (green) chemistry is under implementation in Brazil throughout public-private partnerships. The initiatives advance agro-industrial technology performance and costs, land use gains and GHG emissions reduction of this endeavour. The benefits of such an initiative, whether it is nationally or globally framed, provide reliable foundations for the transition from a fossil based economy to a modern bioeconomy (CGEE 2017). Moreover, the combination of biomass conversion technologies with systems that capture CO<sub>2</sub> and inject it into geological formations (bioenergy with carbon dioxide capture and storage - BECCS) can deliver even net negative emissions (IPCC 2019).

About one quarter of the GHG emissions reduction by 2030, pledged by countries in their NDCs under the Paris Agreement, are expected to come from land-based mitigation options (medium confidence). Most of the NDCs submitted by countries include land-based mitigation, although many lack details. Several refer explicitly to reduced deforestation and forest sinks, while a few include soil carbon sequestration, agricultural management and bioenergy. Mitigation response options related to land use are a key element of most modelled scenarios that provide strong mitigation, alongside emissions reduction in other sectors (high confidence) (IPCC 2019).

Although there is an increasing acknowledgement on the sustainability implications of different bioeconomy pathways, there are still controversies on the social and environmental implications of such pathways. As for large-scale food and feed production, implementation of high intensity dedicated energy crops, as well as harvest of crop and forest residues for bioenergy, could contribute to increasing the area of degraded lands: intensive land management can result in nutrient depletion, over fertilisation and soil acidification, salinization (from irrigation without adequate drainage), wet ecosystems drying (from increased evapotranspiration), as well as novel erosion and compaction processes (from high impact biomass harvesting disturbances) and other land degradation processes (IPCC 2019). Moreover, when agricultural lands and/or food crops are used for bioenergy, competition between food and fuel can be exacerbated, with potential adverse impacts on food prices and food security. Nevertheless, these impacts are context specific and depend on the scale of deployment, initial land use, land type, bioenergy feedstock, initial carbon stocks, climatic region and management regime. Land competition and associated risk for food security can be reduced by policies promoting use of wastes and residues, the use of non-edible crops and/or reliance on degraded and marginal lands for bioenergy (IPCC 2019).

During the past two decades, standards and certification schemes with a focus on land use and climate have emerged as important sustainability and conservation instruments for agriculture, forestry, bioenergy, land-use management and bio-based products, which aim to support the long-term transition to a climate-resilient bioeconomy.

Bioenergy developed knowledgeably and implemented considering local and regional needs, can help to increase resilience in food supply, both locally and globally decrease pollution, preserve the biodiversity, improve human health, rehabilitate degraded land, mitigate climate change, and provide economic and business opportunities (SCOPE 2015)<sup>19</sup>.

The bioeconomy does not only have an important role to play in mitigating climate change but can also offer ways and means for developing countries to become more climate-resilient. The diversification of energy sources through the sustainable use of biomass for energy generation can contribute to energy security, including in those developing countries that largely depend on hydropower, which in many countries is becoming increasingly vulnerable to changes in frequency and in the quantity of rainfalls.

The bioeconomy can also significantly contribute to climate-resilient agriculture, for example through the use of biotechnology to increase the drought-resilience of traditional crops, or through the development of new value chains based on more climate-resilient crops, such as bamboo. Overall, the bioeconomy can contribute to the climate-resilience of rural communities by offering opportunities for diversifying their income generation, for example by putting bioenergy to productive use, or by selling other bio-based products.

The Paris Agreement, while recognizing that adaptation is a global challenge faced by everyone, establishes a global goal in this regard, that of enhancing adaptive capacity, strengthening resilience and reducing any vulnerability to climate change. In fact, climate change will affect land-related ecosystem services (e.g. soil conservation, carbon storage) and biodiversity, both directly and indirectly, which can have adverse effects on the bioeconomy. The global goal on adaptation stated in the Paris Agreement aims to significantly strengthen national adaptation efforts. The Paris Agreement recognizes the importance of support for and international cooperation on adaptation efforts and the importance of taking into account the needs of developing country Parties (UN 2015a, Art. 7).

Two other important components of the Paris Agreement are crucial to foster the bioeconomy, especially in developing countries. International cooperation on climate-safe technology development and transfer and building capacity in developing countries are strengthened in the context of the Paris Agreement: a technology framework is established under the Paris Agreement and capacity-building activities will be strengthened through, inter alia, enhanced support for capacity-building actions in developing country Parties and through appropriate institutional arrangements (UN 2015a, Art. 7 and 11). Therefore, bioeconomy activities can potentially benefit from such arrangements under the Paris Agreement.

Technology transfer in regard to bioeconomy activities offers new opportunities for advancing climate change adaptation and mitigation. For instance, international cooperation to modernize the traditional biomass sector has the potential to reduce GHG emissions, and also to free up both land and labour for more productive uses (IPCC 2019).

According to the latest synthesis report of the technology needs assessment prepared by developing countries under the UNFCCC (UNFCCC 2013), the majority of developing countries prioritize agriculture for adaptation action, which is also a key component of the bioeconomy. Being centred on technology and innovation, the bioeconomy offers an important opportunity to accelerate the development, transfer and diffusion of agricultural technologies that increase the adaptive capacity of farmers and the agricultural sector as a whole in developing countries.

The emergence of the bioeconomy has shown its intrinsic relation to different aspects of climate action. The examples contained in the next section of this report – which attempt to reflect the principles of SSTC – showcase a few of the many bioeconomy initiatives in developing countries that are being designed to advance climate action in the context of the Paris Agreement and to deliver on the SDGs.

19. The Scientific Committee on Problems of the Environment (SCOPE) is an international nongovernmental organization founded in 1969. SCOPE is a cross-sectoral and trans-disciplinary network, connecting experts and institutions around the world. It is recognized for its authoritative, independent and influential scientific analyses and assessments of emerging environmental issues that are caused by or impact humans and the environment.



### III. SELECTED CASES STUDIES ON SOUTH-SOUTH AND TRIANGULAR COOPERATION ON THE BIOECONOMY FOR ADDRESSING CLIMATE CHANGE AND FOSTERING SUSTAINABLE DEVELOPMENT





photo: Embrapa

## A. Using microorganisms for enhanced crop production

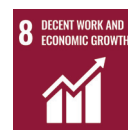
- **Case study by:** The Brazilian Agricultural Research Corporation (Embrapa)
- **Short summary:** Using biotechnology advancements from Brazil, the project fostered collaboration between the two countries to transfer knowledge and innovation for improving the fertility of acidic and poor tropical soils thereby increasing crop yields and food security, ensuring a more stable income and enhancing the climate resilience of vulnerable rural communities in Mali.
- **Context:** The low productivity of tropical soils endangers both the livelihood and food security of local populations in tropical regions. The rural population in Mali is largely dependent upon subsistence agriculture and, therefore, highly vulnerable to changing climatic conditions. Despite similarities in the soil and climate in Brazil and Mali, Brazil has become a major food producer due to its research and development of cheap and efficient biotechnological solutions for the correction of acidic and poor tropical soils. The resilience of smallholder agricultural production systems in Mali can likewise be increased through transfer of cost-effective and efficient biotechnology developed in Brazil. In addition, innovative technology can help mitigate the effects of climate change on soils found in tropical regions.
- **Solution:** To improve the fertility of tropical soils and increase agricultural productivity, the project promoted the "On-Farm" arbuscular mycorrhizal fungi (AMF) inoculum production technology. Developed by the Brazilian Agricultural Research Corporation (Embrapa), this method corrects any soil phosphorus deficiency using AMF inoculation together with phosphorus solubilization by microorganisms. AMF's ability to improve the acquisition of plant phosphorous has been documented in scientific literature and is extensively used in Brazil. However, the availability and cost of industrial mycorrhizal inoculum production is a constraint for smallholder farmers in rural Africa. The project facilitated the transfer of inoculum production technology to be utilized on-farm by smallholder farmers along with phosphate fertilization in the form of rock phosphate. This solution decreases the cost of the inputs to a fraction of the market prices, secures a supply and has the potential to increase the productivity of smallholder agricultural systems in Mali. The key project counterpart organizations were Embrapa and the University of Sciences, Techniques and Technology of Bamako (USTTB).
- **Impacts and results:** The project resulted in the installation of infrastructure for large-scale mycorrhizal fungi inoculum production at USTTB, Mali. Additionally, a practical manual on techniques for the production and use of mycorrhizal inoculant "On-Farm" was published and distributed. The national capacity to utilize and disseminate the technology in Mali was created



Countries:  
Brazil and  
Mali

### CASE STUDY

A



through the training of two scientists, 20 university staff members and one Master's student at Embrapa in Brazil.

Under the purview of the project, four "On Farm" mycorrhizal inoculant production units were established in Mali and 500 smallholder farmers were trained on inoculum production techniques.

The project contributed to the achievement of SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 13 (Climate action), SDG 15 (Life on land) and SDG 17 (Partnerships for the goals). The project has responded to 7 of the 17 Sustainable Development Goals and has enabled innovative opportunities that have improved the quality of life of the rural population in Mali.

- **Challenges and lessons learned:** One of the challenges faced during the project implementation was the cultural and religious differences between the partners that needed to be taken into account and respected. The project activities included training of USTTB researchers and students in Brazil, allowing them to replicate the training to manage the technology in Mali. In doing so, selected researchers and students were placed at the head of demonstration units while maintaining a relationship with local communities. This ensured the quality and sustainability of the project outcomes. Moreover, a key lesson learned through the implementation of the project was that cooperation should not seek to supersede local institutions. Another important lesson learned during the training process was the need to contextualize working processes of the "On-Farm" technology within the local context in Mali.
- **Long-term sustainability, replicability and potential for upscaling:** The long-term sustainability of the project is very likely as the project facilitates the transfer of an innovative biotechnological method to a local scientific institution, establishing adequate local infrastructure and providing training for its staff. The project focused on the development of local capacities, and led to the establishment of an institution along with trained and competent technical staff to enable the effective transfer of "On-Farm" AMF inoculum production technology. This allows for the replicability of the initiative and its scaling-up to reach a larger number of communities within the country.
- **Alignment with priorities outlined in the NDCs of beneficiary countries under the Paris Agreement:** The project contributed to the implementation of targets established in the NDCs of respective countries. In Brazil, the project supported South-South cooperation through technology transfer as a means to implement adaptation measures (NDC Brazil 2015). In Mali, the project was in line with national efforts to ensure the food security of the population and modernize the agricultural production systems through sustainable and innovative agriculture (NDC Mali 2015).





photo: INBAR

## B. Fostering the industrial use of bamboo

- **Case study by:** International Bamboo and Rattan Organisation (INBAR)
- **Short summary:** The Dutch-Sino-East Africa Bamboo Development Programme<sup>20</sup> fosters low-emission climate-resilient development in Ethiopia, Kenya and Uganda by developing and improving industrial bamboo value chains and enhancing local capacities to manage, plant and restore bamboo resources. Implemented by the International Bamboo and Rattan Organisation (INBAR)<sup>21</sup> with financial support from the Ministry of Foreign Affairs of the Netherlands, the programme is transferring experiences and lessons learned from the successful development of bamboo industries in Asia and Europe to East African countries.

- **Context:** Bamboo is a fast-growing, renewable and versatile resource, which is found in large parts of the tropics and subtropics in the Global South. Its growing and utilization can significantly contribute to climate action, as bamboo forests store a lot of carbon, and many bamboo products and their related manufacturing processes are carbon-neutral or even carbon-negative (INBAR 2015). Bamboo also increases climate resilience as it prevents soil erosion through its extensive rhizome systems and enables the soil to retain more water.<sup>22</sup>

East Africa's bamboo sector remains largely untapped, despite the region having sub-Saharan Africa's largest natural bamboo forests, accounting for around 3-4 percent of the world's total known bamboo coverage. Low-value products and a lack of capacity for industrial processing of bamboo and adhering to international standards have resulted in underdeveloped domestic markets in Ethiopia, Kenya and Uganda and their exclusion from the global markets.

The programme contributes to both climate change mitigation and adaptation. It does this by supporting the establishment and development of bamboo nurseries, plantations and planting in farms, along boundaries and as shelterbelts. These bamboo stocks and the products they create can act as an important future carbon sink and as an important means of additional income and employment for rural communities affected by the negative impacts of climate change.

- **Solution:** In response to this challenge, the Dutch-Sino-East Africa programme was established to transfer experiences and lessons learned from the successful development of advanced bamboo markets in Asia and Europe to East African countries, thus enabling Ethiopia, Kenya,

20. <https://www.inbar.int/project/dutch-sino-east-africa-bamboo-development-project>.

21. INBAR is an intergovernmental organization with 45 Member States, mainly from the Global South, that promotes the use of bamboo and rattan for sustainable development. It is headquartered in China with regional offices in Cameroon, Ecuador, Ethiopia, Ghana and India. For further information on INBAR's support for South-South cooperation see "South-South in Action – Inspiring Sustainable Development with Bamboo" (UNOSSC 2017).

22. A land restoration programme in India restored 85,000 ha of infertile land to productivity and within ten years of planting, bamboo was adding about 20cm of humus to the soil annually and raised the water table by over 15 metres (INBAR 2014).



Countries:  
China,  
Ethiopia,  
Kenya,  
Netherlands  
and Uganda

CASE STUDY

B



and Uganda to fully participate in, and benefit from, a modern bamboo economy. The programme builds on Chinese and Dutch expertise in bamboo value chain development, product design, marketing and standardisation to help those East African countries to unlock the vast potential of their indigenous bamboo resources. At the same time, it contributes to low-emission and climate-resilient development through carbon sequestration and the replacement of GHG-intensive products with low-emission bamboo solutions, as well as through the restoration of degraded lands. INBAR developed this programme in close cooperation with Chinese and Dutch partners based on national consultations with Ethiopia, Kenya and Uganda.

The programme provided a technology transfer in the form of bilateral training programmes for "small and medium-sized enterprises. Chinese and Dutch partners with expertise in the bamboo sector visited the beneficiary countries. Similarly, a number of participants from beneficiary countries were able to visit China, the Netherlands and each other's countries, to learn from their experiences. Overall, the project has trained more than 7,000 beneficiaries between 2016 and 2019.

The programme has partnerships with various technical and research agencies and with industries. In China, the project collaborated with Tsinghua University to create regional remote sensing-based bamboo inventories in East Africa to ascertain the distribution of bamboo across the three beneficiary countries, which is an important prerequisite for developing suitable bamboo industries. The project also collaborated with the China-based International Center for Bamboo and Rattan (ICBR) on the property-testing of bamboo and on technology transfer regarding value chains, resource development and the necessary machinery and tools for development. Other Chinese partners included the Chinese Academy of Forestry, which worked with ICBR to build capacity to implement relevant standards related to bamboo product testing and development, and Zhejiang Agriculture and Forestry University for the development of a methodology for assessing the carbon stored in bamboo forests.

In the Netherlands, the project worked with Wageningen University to share technology for the development of bamboo composite products. Durable, smart-looking and versatile, bamboo composites can replace a large variety of traditional materials in everything from flooring and decking to cladding and beams, and are increasingly popular goods in bamboo importing countries. Wageningen University organised discussion platforms and workshops to bring together Chinese, European and East African partners to learn more about these technologies and their applications. The project also received support from Moso International BV, a Dutch company for luxury bamboo goods, on standards and certification. Adherence to international standards is an important way for suppliers to sell their products internationally, but many lack the capacity or in-depth knowledge to adhere to these standards. Finally, the project also conducted a study tour to pair East African and Chinese industries, for possible investment and scaling-up of international cooperation.

- **Impacts and results:** By 2025, the 900 hectares of restored and new bamboo forests under this programme will have stored about 300,000 tonnes of carbon dioxide. Furthermore, significant GHG emission reductions will be achieved through the increased use of bamboo-based products, substituting wood and fossil-fuel-based materials. In just under 40 years, the bamboo plantation, and durable products made from it, could store almost 600,000 tonnes of carbon dioxide.

The introduction of bamboo-based income streams has increased the resilience of communities given that bamboo is more resilient to climatic changes than other agricultural plants. The climate resilience of bamboo and its positive effects on the ecosystem, such as reversing land degradation, will also increase the resilience of the ecosystem as a whole.

The main objectives of the programme are the generation of new income streams from bamboo growing and processing, supporting climate action and facilitating South-South and triangular cooperation. As such the programme contributes to the achievement of SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 13 (Climate action), SDG 15 (Life on land) and SDG 17 (Partnerships for the goals). In addition, the programme has a variety of socioeconomic and environmental co-benefits, including contributing to SDG 12 (Responsible consumption and production). This also accounts for SDG 15 (Life on land), for example in Uganda, where the new bamboo plantations have reduced the pressure on food sources of mountain gorillas and turned mountain gorilla poachers into bamboo farmers as bamboo provides a more sustainable source of income than poaching.<sup>23</sup>

- **Long-term sustainability, replicability and a potential for upscaling:** Long-term sustainability is ensured by creating business models for the growing and industrial processing of bamboo that will persist beyond the programme duration. These business models serve as a reference both for bamboo growers who are not involved in this programme and for other local farmers and companies not yet engaged in the bamboo sector in Ethiopia,

23. <https://www.inbar.int/programmes/sdg15-restoring-ecosystems/#2>.

Kenya and Uganda for potential replication. In addition, the programme has built the capacity of beneficiary governments on including bamboo in REDD+<sup>24</sup> projects through which additional support for the sustainable management of domestic bamboo resources can be obtained from international partners. A demonstration project will be established in Ethiopia as a reference for potential replication by other countries (INBAR 2018).

- **Alignment with priorities outlined in the NDCs of beneficiary countries under the Paris Agreement:** The Dutch-Sino-East Africa Bamboo Development Programme is supporting the achievement of NDC targets in beneficiary countries through, for example, enabling the sequestration of significant amounts of carbon dioxide and improving and diversifying economic opportunities from agroforestry and sustainable afforestation of degraded forest areas in Ethiopia (NDC Ethiopia 2015); supporting innovation and development of appropriate technologies that promote the climate resilience of private sector investment, while demonstrating an operational business case in Kenya (NDC Kenya); and reversing deforestation and fostering sustainable biomass production in Uganda (NDC Uganda 2015).

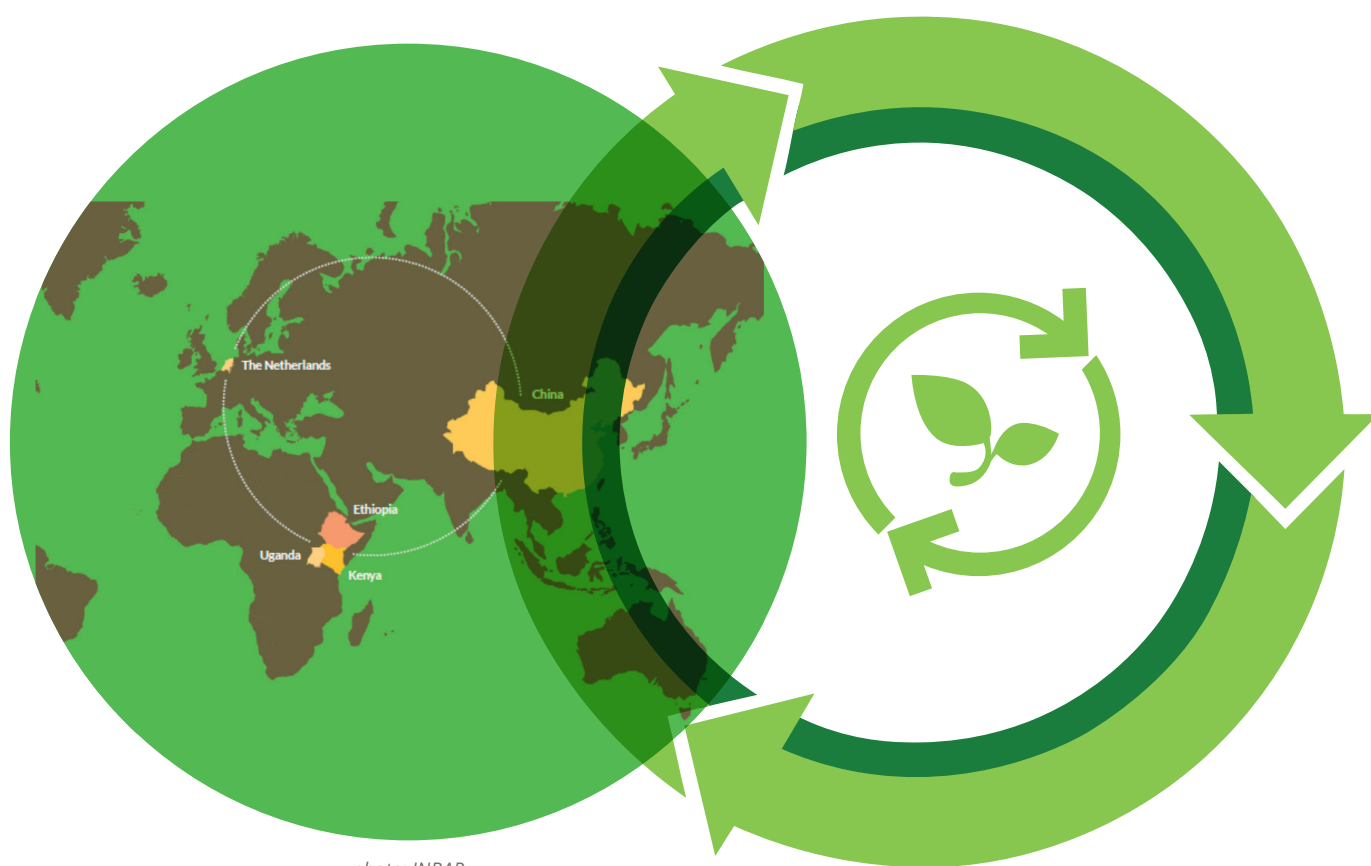


photo: INBAR

24. REDD+ stands for "Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries."





photo: UNIDO

## C. Overcoming policy, market and technological barriers to ethanol production from cassava

■ **Case study by:** United Nations Industrial Development Organization (UNIDO)

■ **Short summary:** Using the very high density – simultaneous saccharification and fermentation (VHD – SSF) technology developed by Thailand's King Mongkut's University of Technology Thonburi (KMUTT) to produce bioethanol from fresh cassava roots, the project fostered technical innovation and South-South technology transfer in Southeast Asia. In cooperation with UNIDO, local partners in participating countries effectively established a conducive environment to promote bioethanol technology and strengthened policies to promote ethanol to replace conventional fuels. In this way it reduced the high dependence on fossil fuels for transportation within the region.

■ **Context:** Being net importers of energy products, the economies of Viet Nam and the Lao People's Democratic Republic (Lao PDR) are affected by changes in global energy prices. The reduction of gasoline consumption is recognized as a national priority in the development strategies of participating countries. Additionally, these countries have introduced biofuel development strategies that set specific targets for bioethanol use. The region is characterized by very low energy efficiency, as its transport sector and manufacturing industry are highly energy-intensive. Cassava is generally grown in Lao PDR, Thailand and Viet Nam as an annual crop that is further processed into starch and chips. Unlike in Africa, the Philippines, Latin America and parts of Indonesia, cassava is not regarded as a food crop. Thus, the food versus energy problem of competing resources and priorities is not a cause for concern within the region.

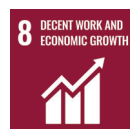
■ **Solution:** To establish bioenergy as an alternative to fossil fuels so as to improve energy security within the region, the project promotes the production of bioethanol from cassava using VHD-SSF technology. Developed by KMUTT, this method reduces energy consumption and production costs while increasing the production capacity of existing bioethanol producing facilities. It also helps in decreasing the amount of water and energy required in the process, reducing GHG emissions and increasing the bioethanol concentration compared to that of the conventional simultaneous saccharification and fermentation process. The project was executed in collaboration with the relevant Ministries of respective countries, national organizations and private sector stakeholders. The key project counterpart organizations in Thailand were KMUTT, the Thai Tapioca Development Institute and the Liquor Distillery Organization; in Viet Nam, the Ministry of Industry and Trade and the Food Industries Research Institute; and in Lao PDR, the Ministry of Energy and Mines and the Institute of Renewable Energy and Promotion under the afore-mentioned ministry.



**Countries:**  
Lao People's  
Democratic  
Republic,  
Thailand and  
Viet Nam

### CASE STUDY

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- **Impacts and results:** The project resulted in the consolidation of a consortium of Thai institutions, led by KMUTT, to transfer the VHG-SSF ethanol production technology, while engaging and training farmers, entrepreneurs and specialists in Viet Nam and Lao PDR. In addition, manuals, toolkits and structured training programmes were developed for technology transfer. The project led to the improvement of the regulatory frameworks thereby promoting bioethanol production from cassava in the participating countries.

Under the purview of the project, established training centres conducted several regional training workshops on bioethanol production from cassava. A technology study tour was conducted in Thailand for government officials, private sector companies and key investors from Viet Nam and Lao PDR, which contributed to creating regional awareness on the bioethanol technology. A key outcome of the project was the establishment of two demonstration plants, one in Thailand with an ethanol production capacity of 200 l/day and another in Viet Nam with an ethanol production capacity of 50 l/day. Under a public-private-partnership scheme, the project also led to the establishment of the first bioethanol demonstration plant in Lao PDR with a capacity of 10,000 l/day.

The main objective of the project was to enhance energy security in the region by promoting alternatives to fossil fuels through South-South cooperation. As such, the project contributed to the achievement of SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 12 (Responsible consumption and production), SDG 13 (Climate action), and SDG 17 (Partnerships for the goals), and enabled innovative opportunities to improve the quality of life and protect the environment.

- **Challenges and lessons learned:** One of the key challenges of the project was to assess the best way to implement innovative technology that can be customized to fit the needs of a country. Another challenge arose from competition among businesses, as producers preferred to source technology and technical expertise from outside the region to avoid having business rivals learn about their production methods and replicating them within the region. An important lesson learned through the project was the need for the technology transfer model to encompass the entire value chain, going beyond the stages related to planning and processing for the production of bioethanol from cassava. Another important lesson learned during the project was the need for special attention and caution when selecting project partners and defining their roles to ensure that ethical considerations were taken into account and conflicts of interest avoided.
- **Long-term sustainability, replicability and potential for upscaling:** The long-term sustainability of the project is very likely as the project adds value to knowledge and skills transfer. The training centres established in the participating countries act as knowledge hubs, disseminating the technology packages and showcasing the technology developed. Furthermore, by raising awareness and providing training to a wide diversity of actors ranging from academia to private and public sectors, the project has fostered a conducive environment for the uptake of bioethanol in the participating countries. Building public awareness is essential to increase the acceptance of change from gasoline to bioethanol. One of the key project outcomes was the development of the technology package, which includes information on bioethanol and cassava production, technology transfer, development of training tools and a database about ethanol production. This package serves as a reference for future beneficiaries, ensuring replicability and a high potential for upscaling.
- **Alignment with priorities outlined in the NDCs of beneficiary countries under the Paris Agreement:** The project supported the achievement of the NDC targets in the beneficiary countries. In Thailand, the project was in line with ongoing efforts to achieve energy security by increasing the share of renewable energy as stated in the Alternative Energy Development Plan of 2015 (NDC Thailand 2015 and AEDP 2015). In Viet Nam, the project supported the target for increasing the proportion of new and renewable energy sources in energy production and consumption (NDC Viet Nam 2015). In Lao PDR, the project contributes to the target of increasing the share of biofuels to meet 10 percent of the demand for transport fuels by 2020 along with enhancing the share of renewable energy (Lao PDR 2015).



photo: BioInnovate Africa

## D. Turning fruit waste into fuel for rural households

### ■ Case study by: BioInnovate Africa

■ **Short summary:** Partners from Kenya, Tanzania and Uganda are jointly developing and commercializing a bio-alkanol gel fuel from local organic fruit waste and other biological ingredients as an affordable and low-carbon emission alternative to firewood and charcoal for cooking in rural households.<sup>25</sup> The project is part of the BioInnovate Africa programme, which mobilizes multidisciplinary teams of scientists, researchers, innovators and entrepreneurs to develop and pilot innovative and economically viable bio-based technologies, products, and services in Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda with support from the Swedish International Development Cooperation Agency.<sup>26</sup>

■ **Context:** The Lake Victoria Basin, which is a significant water resource for the region, is characterised by high rates of deforestation. Only 6 percent of rural households around the lake basin rely on modern fuels with the majority predominantly using solid fuel, such as charcoal, paraffin and firewood for their primary cooking needs. Burning of these traditional fuels both result in GHG emissions and indoor air pollution, which may cause numerous respiratory ailments such as pneumonia, asthma and lung cancer, among others.

■ **Solution:** To provide an alternative to wood-based fuel and paraffin, the project is commercializing a renewable biofuel known as bio-alkanol gel. The gel is a thick liquid fuel made from fruit waste and biological additives and binders. The resulting biomass from the production of the bio-alkanol gel will be processed into bio-fertilizer as a secondary product. The gel burns with a clear flame without smoke or soot and is comparable in terms of cooking efficiency to gaseous cooking fuel such as liquid petroleum gas (LPG). The gel works with fabricated bioethanol gel cook stoves that are already in use in the region.

The bio-alkanol gel also has the potential to repel mosquitoes that cause malaria. The gel will be commercially produced and sold to rural and peri-urban household communities in the Lake Victoria basin. The project team is in the process of validating its business model, testing its final products with customers and obtaining product and quality certifications.

The project team is comprised of Maseno University and its Business Incubation Centre in Kenya, two national research institutions, namely the National Agricultural Research Organisation in Uganda and the Tropical Pesticides Research Institute in Tanzania, as well as the Lake Basin Development Authority in Kenya. The partners have an agreement in place on the sharing of technical information and patented products. Maseno University is the project

25.. <https://bioinnovate-africa.org/bio-alkanol-gel-fuel-for-rural-households-in-the-lake-victoria-basin>.

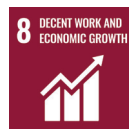
26. The BioInnovate Africa programme, now in its second phase (2016-2021), is hosted by the International Centre of Insect Physiology and Ecology (ICIPE) in Nairobi, Kenya. For further information see: <https://bioinnovate-africa.org/about-us>.



Countries:  
Kenya,  
Tanzania and  
Uganda

### CASE STUDY

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leader and inventor of the technology. The national research institutions are conducting market studies and are evaluating the product, including its mosquito repellent properties, which will provide inputs for product development and marketing activities. The business incubation centre is working closely with the university on the development of the business model.

- **Impacts and results:** The project will result in the establishment of a bio-alkanol gel production facility and a company that will produce and market the gel on a commercial basis. The production process entails the recycling of fruit waste, which will directly contribute to organic waste management within the region. Furthermore, the gel is an environmentally friendly alternative to traditional biomass fuels, and will therefore minimize reliance on wood-based fuel and eventually reduce deforestation, GHG and other harmful emissions into the atmosphere. The project will directly benefit the rural population living around the Lake Victoria basin in Kenya, Tanzania and Uganda as the gel will provide an affordable and healthy cooking fuel choice within the region.

The main objectives of the project are to develop and commercialize an affordable bio-based cooking fuel through South-South cooperation. As such, the project contributes mainly to the achievement of SDG 1 (No poverty), SDG 3 (Good health and well-being), SDG 7 (Affordable and clean energy), SDG 13 (Climate action) and SDG 17 (Partnerships for the goals). Given the project's commercial focus, it will also contribute to job creation and hence to SDG 8 (Decent work and economic growth).

- **Challenges and lessons learned:** Key challenges for this project were the relatively weak local innovation ecosystems and capacity-building at partner institutions to foster commercialization of the bio-alkanol gel. BioInnovate Africa therefore supported the team through targeted capacity strengthening initiatives leading to their own participation in the local innovation ecosystem-building at their institutions. In addition, the project has fostered close cooperation with private sector experts to strengthen capacities for the commercialization of the product. Furthermore, the culture of transparency and open communication is greatly encouraged at all levels of project implementation as one way of building trust among the partners in the project.
- **Long-term sustainability, replicability and a potential for upscaling:** Long-term sustainability is ensured through the commercialization of the product based on a sustainable business model that delivers value with respect to efficiency, safety and health benefits to rural customer segments. A business-to-consumer model is being tested involving distribution intermediaries with proximity to customer segments. It is envisaged that high sales volumes of products will ensure the long-term sustainability beyond the project duration. The product and business model can also serve as reference for others to replicate.
- **Alignment with priorities outlined in the NDCs of beneficiary countries under the Paris Agreement:** The project supports the achievement of NDC targets in the beneficiary countries. For example, in Kenya, it is in line with ongoing efforts to reduce overreliance on wood fuels (NDC Kenya 2015). In Tanzania, the project supports the target on enhancing the use of renewable energy (NDC Tanzania 2015). In Uganda, the project contributes to the target of encouraging efficient biomass energy production and utilization technologies (NDC Uganda 2015).





photo: THU

## E. Increasing efficiencies in the biodiesel production process

- **Case study by:** Tsinghua University (THU), Federal University of Rio de Janeiro (UFRJ) and China-Brazil Center for Climate Change and Energy Technology Innovation.
- **Short summary:** THU developed an innovative technology that allows turning low quality oils and fats into biodiesel while using less energy and water than conventional biodiesel production processes. The technology was successfully transferred to Brazil in cooperation with UFRJ. The transfer of this technology led to a broader cooperation between Brazil and China on biofuels, including South-South cooperation with other countries in Latin America.
- **Context:** Brazil has a national policy in place requiring that diesel is blended to 11 percent with biodiesel, and this requirement is envisaged to increase to 15 percent by 2022 and 18 percent by 2030. The main feedstock for producing biodiesel in Brazil is soybean oil. Brazilian biodiesel producers are currently using the conventional chemical-catalyzed method to produce biodiesel from high quality soybean oil, which is very energy-intensive due to the high chemical reaction temperature required and because it is very water-intensive as the produced biodiesel needs to be washed extensively for removing contained salt before use.

The process of turning vegetable oils and animal fats into biodiesel requires a catalyst that changes the chemical properties of these substances through so-called transesterification. In comparison to the traditional chemical-catalyzed transesterification, the lipase-catalyzed transesterification provides a number of advantages, particularly reduced energy and water consumption and the possibility to use low quality vegetable oils, like waste cooking oil and animal fats as inputs factors. However, so far, the low stability of the lipase has prevented lipase-catalyzed biodiesel production on an industrial scale. THU developed a process that increased the operational life of the lipase from a few cycles to more than 300 cycles and successfully demonstrated the process in a commercial plant with a production capacity of 50,000 tons of biodiesel per year.

- **Solution:** Cooperation between THU and UFRJ started in 2008 and led to the establishment of the China-Brazil Center for Climate Change and Energy Technology Innovation<sup>27</sup> in 2010. THU's lipase-catalyzed biodiesel production process was successfully transferred to Brazil, where a pilot production plant was established at UFRJ's Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering (COPPE), with the purpose of broadening Brazil's biodiesel production technologies. The pilot plant was established through the readjustment of an existing plant that produced biodiesel with the conventional chemical-catalyst method. THU analysed the existing equipment and with COPPE developed a solution for readjusting

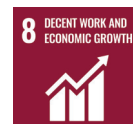
27. <http://www.centrochinabrasil.coppe.ufrj.br>.



Countries:  
Brazil and  
China

### CASE STUDY

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the production to the lipase-catalyst method. First, technicians from Brazil were trained in China on the operation and maintenance of the technology, before experts from China were sent to Brazil to commission the readjusted production plant.

- **Impacts and results:** Through the project China learned about Brazil's biofuel policies and technologies and Brazil adopted the lipase-catalyst-based biodiesel production process from China. Following this successful cooperation between THU and UFRJ, the China-Brazil Center for Climate Change and Energy Technology Innovation, was upgraded with support from China's Ministry of Science and Technology to the China-Latin American Joint Lab for Climate Change and Renewable Energy (Joint Lab). The Joint Lab subsequently expanded cooperation with other Latin American countries, including Chile, Cuba, Ecuador, Mexico, Panama and Peru, together with the private sector and research institutes.

The project contributed to the achievement of SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 13 (Climate action) and SDG 17 (Partnerships for the goals).

- **Challenges and lessons learned:** It is important to consider the critical role that the creation of an enabling policy environment plays for attracting investments into a new technology and as such for ensuring its uptake. In this regard, government policies need to be analysed from the outset to identify opportunities to incentivize the conversion of biodiesel production sites. Raising awareness among policy-makers about the GHG emission reduction potential of biofuels produced from wastes and residues was an important activity for obtaining high-level political support for the project.
- **Long-term sustainability, replicability and a potential for upscaling:** The pilot plant at COPPE has been operating successfully under local management for the past seven years. Following the project, a number of Brazilian companies showed interest in replicating or scaling-up the production process introduced by THU. In addition, Chinese companies and investors have shown an interest in replicating the project in cooperation with other Brazilian production plants and further commercializing the technology developed by THU.
- **Alignment with the priorities outlined in the NDC of the beneficiary country under the Paris Agreement:** The project supports the achievement of Brazil's NDC targets, including to "enhance cooperation initiatives with other developing countries, particularly in the areas of ... biofuels capacity-building and technology transfer" and to increase the "share of biodiesel in the diesel mix" (NDC Brazil 2015).



photo: SANBio

## F. Developing affordable and nutritious food from indigenous climate-resilient crops

■ **Case study by:** Department of Science and Technology of South Africa and Southern Africa Network for Bioscience

■ **Short summary:** The Healthy Smart Snacks from Climate-Smart Crops project<sup>28</sup> resulted in the successful development and commercialization of affordable and nutritious snacks in Botswana, Lesotho and South Africa by using insights from bioscience and an extrusion technology for the processing of indigenous climate-resilient crops. The project was funded by BioFISA II<sup>29</sup>, which is the second phase of the Finnish-Southern African Partnership Programme to strengthen the New Partnership for Africa's Development (NEPAD)'s Southern Africa Network for Bioscience (SANBio)<sup>30</sup>.

■ **Context:** Climate change is exacerbating the challenge of food security in Southern African countries through its adverse effects on agricultural production. However, malnutrition does not only occur in these countries due to a lack of food, but also due to the inadequate intake of macronutrients and micronutrients, for example through overreliance on maize as a staple food. So far, healthier alternatives such as sorghum, a drought-resistant and protein dense crop have been largely neglected. Sorghum is an important cereal crop widely grown for food, feed, fodder, forage and fuel in Africa, Asia and other semi-arid tropical areas in the world.

The challenges of food insecurity, climate change and rapid urbanization in Africa require the development of convenient, affordable, nutritious foods from climate-smart and sustainable plant crops that are acceptable to communities. To contribute to tackling these challenges, the Healthy Smart Snacks from Climate-Smart Crops project aimed to create an innovative platform for optimizing and commercializing innovative nutrient-dense snack foods using indigenous crops to address health and nutrition needs of vulnerable consumer groups in the region.

■ **Solution:** Researchers from the Botswana University of Agriculture and Natural Resources, the National University of Lesotho and the University of Pretoria teamed up to create a platform for optimizing and commercializing innovative, nutrient-dense snack foods using indigenous crops to address the nutrition and health issues of vulnerable consumer groups in the region. BioFISA II supported the initiative by awarding it a seed grant. The project deliverables

28. <https://nepadsanbio.org/node/725>.

29. BioFISA started in 2015 and is funded by the Ministry of Foreign Affairs of Finland and the Department of Science and Technology of South Africa. For further information see: <https://nepadsanbio.org/biofisa-two>.

30. SANBio is a shared bioscience research, development and innovation platform for working collaboratively to address some of Southern Africa's key bioscience challenges in nutrition and health. The network is one of five regional networks under the African Biosciences Initiative. It includes Angola, Botswana, Eswatini, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Lesotho, Seychelles, South Africa, Zambia and Zimbabwe. SANBio supports the implementation of the Science, Technology and Innovation Strategy for Africa, which is part of the African Union's 2063 Agenda: The Africa We Want. For further information see: <https://nepadsanbio.org>.



**Countries:**  
Botswana,  
Lesotho and  
South Africa

### CASE STUDY

F





included technology transfer, prototype development and product co-development with a commercial partner. For example, the expertise and extrusion technology of the University of Pretoria contributed greatly to the development of an instant sorghum-lerotse melon product in Botswana based on the popular local dish *bogobe jwa lerotse*.<sup>31</sup>

- **Impacts and results:** The projected enabled technology transfer from the University of Pretoria to the National University of Lesotho, prototype development at the Botswana University of Agriculture and Natural Resources, and co-development of a product with a commercial partner, Denmar Estates Pty Ltd. The commercialisation strategy for products developed at the universities included graduates as owners or team members of start-up companies. At the end of the project, three companies have been registered, one in South Africa (Sorghum Revolution Pty Ltd), another in Lesotho (Healthily Baked Pty Ltd), and a third in Botswana (Foods on the go Pty Ltd.).

After the National University of Lesotho saw the potential of Bohlale biscuits in Lesotho, the university supported the project with a contribution of 400,000 South African Rand to renovate a space that was previously used as a bookshop. The establishment is now a micro-bakery and forms part of the National University of Lesotho Innovation Hub that is incubating Healthily Baked Pty Ltd. under a contract agreement.

In South Africa, the University of Pretoria granted a license to Sorghum Revolution (Pty) Ltd. to commercialize intellectual property leading to SO YHUM sorghum snacks. The company is incubated with the Bakery and Food Technology Incubation Centre of South Africa (BICSA) for business support. Through the partnership between the University of Pretoria and the commercial food manufacturing company, Denmar Estate Pty Ltd., two sorghum-based motoho products were commercialized and are sold in several stores.

The University of Pretoria's expertise and facilities for extrusion technology were used by the team from the Botswana University of Agriculture and Natural Resources to develop an instant sorghum-lerotse melon product based on the popular Botswana dish bogobe jwa lerotse from conception to product level.

This project with its multifaceted research contributed to the training of a vast number of post-graduate students and involved the skills development of research assistants at the three universities.

The main objectives of the project are to enhance food security through the promotion of climate-resilient crops, improve health through the increased availability of healthy food choices and increase the number of green jobs through the creation of value chains. As such, the project contributes to the achievement of SDG 2 (Zero hunger), SDG 9 (Industry, innovation and infrastructure), SDG 13 (Climate action) and SDG 17 (Partnerships for the goals).

- **Long-term sustainability, replicability and a potential for upscaling:** Long-term sustainability is ensured through the creation of products and business models that continue beyond the project duration. These products and business models can also serve as references for other research institutions, entrepreneurs and companies for potential replication and upscaling.
- **Alignment with priorities outlined in the NDCs of beneficiary countries under the Paris Agreement:** The project supports the achievement of NDC targets in the beneficiary countries. For example, in Botswana, it is in line with ongoing efforts to switch to crops that are drought-resistant and tolerant to high temperature (Botswana NDC 2015). In Lesotho, the project supports the NDC target on building capacity to prevent malnutrition (Lesotho NDC 2015). In South Africa, the project contributes to targeted investments in increasing food security (NDC South Africa 2015).

31. It is a national dish of Botswana, characterized by a delicate flavour imparted by the lerotse melon, a type of fruit that is visually reminiscent of a typical watermelon and distinguished by its orange-colored flesh. Lerotse has a neutral flavour when raw, but it imparts a unique flavour to the dish when cooked. The dish is typically stirred with a traditional wooden whisk, called lehetho, and has a porridge-like consistency when fully cooked. See also <https://www.tasteatlas.com/bogobe-jwa-lerotse>.



photo: IFAD

## G. Expanding the use of an innovative and affordable biogas system as an off-grid energy solution for rural households

■ **Case study by:** International Fund for Agricultural Development (IFAD)

■ **Short summary:** The project<sup>32</sup> helped bring a locally developed innovative and inexpensive biogas system, which is also portable and expandable, to scale in Kenya and introduce it to smallholder farmers in Rwanda through South-South cooperation among partners from India, Kenya and Rwanda. The project was implemented by the International Fund for Agricultural Development (IFAD)<sup>33</sup> with financial support from the Department for International Development of the United Kingdom, in close cooperation with the Indian Institute of Technology, Biogas International in Kenya and the Ministry of Agriculture and Animal Resources in Rwanda.

■ **Context:** The most common type of biogas systems is a fixed dome system. Its construction requires skilled technical expertise and logistics, making the installation expensive and time-consuming. Fixed dome systems are permanent installations, so secure land tenure is a prerequisite. These challenges make it difficult to adopt fixed dome systems in Africa. As a result, many systems have failed and adoption rates have been low.

■ **Solution:** A new type of a biogas system, manufactured in Kenya, is *Flexi Biogas*, a flexible aboveground system that is simpler and less costly to build and operate than traditional fixed dome systems. This system does not require agitation and the digester is not a sealed tank but simply a large plastic bag. The Flexi Biogas system is portable and expandable. The plastic digester bag is housed in a greenhouse tunnel, which acts like an insulated jacket. It traps heat keeping the temperature between 25 and 36 degrees Celsius. The combination of the tunnel and the plastic bag increases the volume of gas production and reduces the retention time, ensuring a high rate of fermentation and gas production. The gas is then piped through a plastic tube connected to an appliance or piece of equipment such as a gas stove for cooking.

In addition, the output bio-slurry is a mineral rich organic fertiliser that is ready for use and also works as an extremely effective pest repellent. The project facilitated South-South cooperation between Kenyan engineers and the Indian Institute of Technology (IIT) on how to adapt the technology to different local environments and bring it to scale in combination with other equipment and appliances. IIT installed the technology in their campus to assess the technical performance and worked side-by-side with their Kenyan counterparts to solve

32. <https://www.ifad.org/en/web/knowledge/publication/asset/39396094>.

33. IFAD is an international financial institution and a specialized agency of the United Nations dedicated to eradicating poverty and hunger in the rural areas of developing countries. See also: <https://www.ifad.org/en>.



Countries:  
India, Kenya  
and Rwanda

### CASE STUDY

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design, testing and validation challenges. The biogas technology was also installed in rural Odisha under an IFAD-supported project, where IIT played a key role as facilitator and trainer and for project monitoring. Kenyan engineers moved the results from this cooperation forward, including when they worked with their Rwandan counterparts to set-up biogas systems in Rwanda.

- **Impacts and results:** The project has led to the installation of hundreds of biogas systems in Kenya and Rwanda that are now turning kitchen, animal and human waste into cooking fuel and electricity for lighting and for Internet use.<sup>34</sup> The use of the biogas systems reduces GHG emissions by lowering firewood consumption by approximately 2 kg per person per day, which also decreases deforestation and land degradation; improves livestock manure management thereby reducing methane emissions; and produces bioslurry as a good alternative to chemical fertilisers thereby reducing nitrous oxide emissions and improving soil health.

The more modern biogas systems have improved women's socioeconomic status by reducing the time and effort involved in household chores (e.g. women usually travel longer distances and spend a lot of time fetching fuelwood) and alleviating the health risks associated with current traditional energy practices (e.g. air pollution from burning biomass in traditional stoves).

The introduction of the biogas system has also led to economic gains of US\$44 to US\$50 per household per month as a result of reducing costs associated with firewood, charcoal and labour. The return on investment to a new biogas system can be relatively quick, with a cost-recovery period of less than one year. After the successful installation of a number of systems in Kenya, the technology was transferred to Rwanda in partnership with the Kenyan technology provider, building on the insights gained in Kenya, including from technical cooperation with partners from IIT.

The main objective of the project was to provide an affordable and sustainable off-grid energy solution for rural households. As such the project contributed to the achievement of SDG 7 (Affordable and clean energy), SDG 13 (Climate action) and SDG 17 (Partnerships for the goals). In addition, the project offered a variety of socioeconomic and environmental co-benefits, including contributing to SDG 1 (No poverty), SDG 5 (Gender equality) and SDG 12 (Responsible consumption and production).

- **Long-term sustainability, replicability and a potential for upscaling:** The successful continuation of the biogas systems beyond the project duration and the technology's economic viability have already been proven in different local contexts. The project has shown that its approach is replicable through its achievements in Kenya and Rwanda, which will be further demonstrated in the context of a new project in Mali<sup>35</sup> in 2020. In Rwanda, the dissemination of the biogas system is being further scaled-up through a government programme that helps cover the installation costs.
- **Alignment with priorities outlined in the NDCs of the beneficiary countries under the Paris Agreement:** The project supports priorities outlined in Kenya's NDC with regard to expanding "renewable energy technologies to reduce overreliance on wood fuels" and introducing "sustainable waste management systems" (NDC Kenya 2015). The project is also in line with targets of Rwanda's NDC, in particular with regard to "promoting the environmentally sustainable use of biomass fuels" (NDC Rwanda 2015).

34. <https://www.youtube.com/watch?v=D0Zn7VhZpXU>.

35. [https://www.ifad.org/documents/38714170/40195712/biogas\\_hdt.pdf/51f35bfa-54f5-435a-857c-3da0f175e07d](https://www.ifad.org/documents/38714170/40195712/biogas_hdt.pdf/51f35bfa-54f5-435a-857c-3da0f175e07d).





photo: LNBR

## H. Generating electricity from sugarcane straw

■ **Case study by:** Brazilian Biorenewables National Laboratory (LNBR)

■ **Short summary:** The Sugarcane Renewable Electricity (SUCRE)<sup>36</sup> project is increasing low-emission electricity production in Brazil through an innovative technology that allows sugarcane mills to generate power from sugarcane straw. The technology for sugarcane straw collection and its use for electricity generation developed under this project is now being transferred to Argentina, Colombia, Cuba and Guatemala, which, together with Brazil, are among the largest sugarcane producers in Latin America. The project was funded by the Global Environment Facility (GEF) and implemented by LNBR, which is part of the Brazilian Center for Research in Energy and Materials (CNPem), in close cooperation with UNDP and partners from the sugarcane industry.

■ **Context:** Brazil is highly dependent on hydropower, which meets around 70 percent of its electricity demand. However, the prolonged dry seasons of recent years have led to an increase in fossil fuel-based electricity generation. At the same time, Brazil is the world's largest producer of sugarcane, which has a tremendous potential for electricity generation. While most of the country's sugarcane mills have been using bagasse, the dry pulpy fibrous residue that remains after sugarcane stalks are crushed to extract their juice, as a biofuel for the production of heat, energy and electricity, about a third of the sugarcane energy potential, namely its tops and leaves (sugarcane straw), have so far been left on the ground after the harvest gone to waste. Until recent changes in national legislation, sugarcane straw was mostly burned in the fields.

With the end of sugarcane straw burning, besides becoming a necessity, straw collection has become an opportunity for energy generation. The lack of information on economically viable collection, transport and processing methods has so far prevented most sugarcane mills to turn sugarcane straw into energy. Argentina, Colombia, Cuba and Guatemala are facing similar challenges as they want to diversify their energy mix through an increased use of renewable energy sources, including biomass, but so far lack economically viable technologies for using sugarcane straw for electricity production.

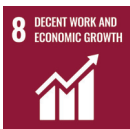
■ **Solution:** The SUCRE project has five major components for addressing this challenge in Brazil and then fostering the transfer of the developed technology to other countries in Latin America through South-South cooperation.



**Countries:**  
Argentina,  
Brazil,  
Colombia,  
Cuba and  
Guatemala

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# H



36. <https://lnbr.cnpem.br/en/research/technological-challenges/sucre-project>.

Firstly, the project developed a methodology to map, both at the mill and country scales, the quantity of available sugarcane straw in a given area.

Secondly, guidelines for sustainable straw harvesting were developed under the project (LNBR 2019). The project also undertook a comprehensive analysis of environmental impacts of sugarcane straw, including GHG emissions and hydrological impacts from the straw, if left on the fields.

Thirdly, different approaches were tested for straw collection, transport and use based on local circumstances and existing technologies in sugarcane mills with a view to identify economically viable solutions.

Fourthly, the legal and regulatory framework of the power sector and barriers for sugarcane mills to increase their electricity sales to the national grid were analysed and potential solutions were suggested.

Fifthly, the project ensured the broad dissemination of its findings, which resulted in an ongoing cooperation with partners in Argentina, Colombia, Cuba and Guatemala. The Brazilian project team is regularly engaging with their counterparts in those countries to exchange information and experiences on the sustainable recovery, processing and use of sugarcane straw for power generation and to share the methodologies and technologies used in the SUCRE project. Furthermore, cooperation with Mauritius, South Africa and Thailand is also being explored in this regard.

- **Impacts and results:** Four years after the project began, the partner mills of the first batch are, on average, jointly exporting to the grid 1 TWh of electricity, using bagasse and straw mixture in different proportions. As a target, the project envisaged the adhesion of 3 mills, with a total average processing capacity of 6 million tons of sugarcane per season, which would lead to a production and export to the grid of 180,000 MWh. After four years, not three but four mills joined the project in the first batch and these partners have processed together more than 21 million tons of sugarcane per season.

Thus, to maintain the expectation of electricity export based on the capacity of sugarcane milling, the partners of the first batch would have to export an average of 650,000 MWh per season. Since they are exporting on average more than 1 TWh per season, this indicator has been exceeded by 60 percent, showing the great potential and reach of the project results. Moreover, considering the average amount of electricity exported to the grid by the first batch and applying a life cycle assessment in GHG balances, considering the replacement of natural gas as an electricity source, together they avoid the emission of more than 500,000 metric tons of CO<sub>2</sub> equivalent every year.

Thus, over the last four years, they helped avoid the emission of more than 2 million metric tons of CO<sub>2</sub> equivalent. By extrapolating the electricity generation to the potential of the sector in Brazil, regarding the use of all the produced bagasse plus 50 percent of the produced straw, it is possible to generate more than 100 TWh of electricity in Brazil without expanding sugarcane areas. In this case, only biomass-based electricity can supply almost 80 percent of the household electricity demand in the country and mitigate more than 50 million metric tons of CO<sub>2</sub> equivalent per year, which corresponds to more than 10 percent of the total GHG emissions from the Brazilian energy sector.

The project's main objective is to enhance electricity generation by promoting alternatives to fossil fuels in Brazil, and to broadly disseminate the project results within the region. Therefore, the project contributes to the achievement of SDG 7 (Affordable and clean energy), SDG 8 (Decent work and economic growth), SDG 9 (Industry, innovation and infrastructure), SDG 13 (Climate action) and SDG 17 (Partnerships for the goals).

- **Challenges and lessons learned:** The main challenges remaining today is to supply the straw to the boiling fuel-feeding system in a quality similar to bagasse in terms of ash and to deal with the contents of problematic chemical elements (potassium chlorine, sulfur and silicon), as well as to improve the regulatory framework of the electricity sector. The SUCRE project has proposed some solutions for both cases, but for the former it is up to the mills to implement them and for the latter it depends on a government decision. Although it was not possible to test the proposed solution for straw processing at the mill under the project, bench scale tests at LNBR and preliminary measurements at two partner mills have shown promising results.

Lessons learned include the following ones: the straw mulch has many benefits when it remains on the ground after cane harvesting such as soil protection against erosion, an increase in soil carbon, nutrient recycling, water retention and an increase soil microbial activity; at the same time it presents significant challenges such as being a fire hazard, there are increases in the pest population and a reduction in the soil temperature. The magnitude

of the impacts depends greatly on local conditions in the soil and climate and, therefore, no universal formula exists to determine the optimal amount that should remain on the ground. However, some basic rules should be followed to assure a sustainable straw collection.

The two main straw collection routes (baling and integral harvesting) have pros and cons and the best choice depends on the local conditions, specifically on the amount of straw to be collected in each area (tons of straw per hectare) and the distance to the mill.

The present regulatory framework of the Brazilian electricity sector presents several barriers to the expansion of power generation for sale in the mills, the price volatility being one such impediment. The use of sugarcane straw to increase power generation in the mills is still very modest, but it has an enormous potential to reduce the carbon footprint of the electricity sector even further.

- **Long-term sustainability, replicability and a potential for upscaling:** The long-term sustainability of the project is ensured through the successful commercial uptake of the methodologies and technology that were developed under the project. Replicability and upscaling is being explored with partners from Argentina, Colombia, Cuba and Guatemala.
- **Alignment with priorities outlined in the NDCs of beneficiary countries under the Paris Agreement:** The project supports the achievement of Brazil's NDC targets on "expanding the use of non-fossil fuel energy sources domestically, increasing the share of renewables (other than hydropower) in the power supply ..., including by raising the share of ... biomass" and the target to "enhance cooperation initiatives with other developing countries, particularly in the areas of ... biofuels capacity-building and technology transfer" (NDC Brazil 2015). This also accounts for Cuba's NDC target to increase electricity production from sugarcane biomass (NDC Cuba 2015).



photo:LNBR





photo: Fujian Agriculture and Forestry University

## I. Cultivating climate-resilient *juncao* grass for energy and food production

■ **Case study by:** Fujian Agriculture and Forestry University

■ **Short summary:** The project established the China-Fiji Juncao Technology Demonstration Center and introduced Chinese technology for growing and using wild grasses to produce edible and medicinal mushrooms, animal feed and fertilizer in Fiji. Initiated by China and Fiji under the United Nations Peace and Development Trust Fund<sup>37</sup>, the project facilitated South-South cooperation on scientific research, technical training and the commercial use of the Juncao technology.

■ **Context:** Invented in 1986 by Lin Zhanxi, a researcher at the Fujian Agriculture and Forestry University, the Juncao technology originates from the efforts to alleviate desertification and soil erosion and restore and maintain soil fertility in the fragile ecosystems of the Yellow River basin. By cultivating mushrooms on dried and chopped wild grasses instead of on wood logs and sawdust, farmers benefit from shorter production cycles and lower production costs. The technology also generates biomass for the production of animal feed and fertilizer. Over the past decades, China successfully transferred the Juncao technology through South-South cooperation to dozens of other developing countries.

Fiji is a small island developing State with a land area of about 18,400 km<sup>2</sup>, of which 16 percent is arable land and 43 percent is suitable for tree cropping and grazing. Fiji is vulnerable to droughts and extreme weather events, such as cyclones and floods, which are exacerbated by climatic changes. The agricultural sector remains the greatest source of employment within the country, but its contribution to the gross domestic product is decreasing.

■ **Solution:** Initiated by the Ministry of Agriculture of Fiji together with the Ministry of Commerce of China, the project was carried out by the Fujian Agriculture and Forestry University with smallholder farmers in Fiji to commercialize the Juncao technology. The technology allows for the efficient production of mushrooms around the year and has laid the foundation for a mushroom industry that will not only cover the domestic demand, but also produce for export. In addition, Juncao grass is used as animal feed and for the production of organic fertilizer, in particular during the dry season, given that it can withstand long periods of dry weather.

■ **Impacts and results:** The project contributed to the reduction of GHG emissions by decreasing the volume of mushrooms imported to Fiji and increasing the use of organic fertilizer. In addition, each hectare of land growing Juncao grass absorbs about 90 tons of carbon dioxide. The project increased climate resilience among local communities as the Juncao grass is

37. <https://www.un.org/en/unpdf/index.shtml>.



Countries:  
China and Fiji

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resistant to drought and extreme weather events and provides an important alternative source for animal feed during the dry season. More than 600 smallholder farmers are already cultivating Juncao grass, most of them for animal feed. Project results are being shared through regional workshops with the Cook Islands, Samoa and Tonga.

The main objectives of the project are to transfer and commercialize the Juncao technology through South-South cooperation. As such, the project contributes mainly to the achievement of SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 13 (Climate action), SDG 15 (Life on land) and SDG 17 (Partnerships for the goals).

- **Long-term sustainability, replicability and a potential for upscaling:** The long-term sustainability of the project is ensured by adding value to the knowledge and skills of smallholder farmers that allows them to continue using the Juncao technology beyond the end of the project. In addition, the China-Fiji Juncao Technology Demonstration Center established in Fiji acts as a knowledge hub and a place for showcasing the technology to smallholder farmers who have not been engaged in the project. Furthermore, by raising awareness and showcasing the socioeconomic benefits of the technology, the project has created a conducive environment for upscaling the use of the technology in the country.
- **Alignment with priorities outlined in the NDC of the beneficiary country under the Paris Agreement:** The project supports the achievements of Fiji's NDC with regard to increasing the resilience of local communities to droughts, floods and extreme weather events like cyclones (NDC Fiji 2015).





## VI. CONCLUSIONS AND THE WAY FORWARD



## Conclusions

More and more developed and developing countries around the world are pursuing national bioeconomy strategies and fostering innovations in bio-based energy, products, materials and chemistry. The bioeconomy has a tremendous potential to help shift economic development towards low-emission and climate-resilient pathways in line with the Paris Agreement and to contribute to the achievement of the SDGs. However, if not planned in a sustainable and responsible manner, the increased use of biomass may lead to adverse impacts on ecosystems and communities. Policy coordination and integrated strategies, covering socioeconomic and environmental aspects and engaging a broad range of stakeholders, are therefore required to unlock the positive potential of the bioeconomy.

There are promising efforts underway to ensure that the bioeconomy is guided by sustainable development and climate action. These include the establishment of dedicated global and regional forums in recent years, and the potential development of international guidelines on a sustainable bioeconomy and related sustainability standards in this area. Countries of the Global South are playing a key role in driving these efforts.

Given the abundance of biomass in the Global South, developing countries are well positioned to lead a global transition to a sustainable bioeconomy, including through South-South and triangular cooperation. The report has shown that some developing countries have emerged as leaders in bioeconomy and are effectively cooperating with other developing countries at the policy and implementation levels to generously share their technologies, knowledge and innovations. With a growing interest in, and demand for, bioeconomy partnerships from developing countries, developed countries, the United Nations System and other intergovernmental organizations are increasingly supporting South-South cooperation in this area.

While publicly available information on South-South and triangular cooperation on the bioeconomy remains very limited, the case studies presented in this report provide valuable insights, lessons learned and proven good practices for all stakeholders aspiring to engage in this blossoming field of development work.

## The way forward

More efforts are needed to raise awareness of, and utilize, the tremendous potential that sustainable bioeconomy has for the achievement of the SDGs and the implementation of the Paris Agreement in developed and developing countries. These efforts should focus on integrated and sustainable approaches towards the bioeconomy to be implemented through the development of regulatory frameworks and standards that are guided by economic, environmental and social sustainability and in line with national development objectives.

The sharing of knowledge, good practices and lessons learned through South-South and triangular cooperation is a key component of fostering sustainable bioeconomy in developing countries. Developing countries involved in global initiatives, such as the FAO-led development of Sustainable Bioeconomy Guidelines or the Biofuture Platform under Brazil's leadership, should share their insights gained at the international level more proactively within their own region and across regions. This also applies to an increasing number of countries spearheading a plethora of bioeconomy projects on the ground, including through South-South and triangular cooperation. Information on these projects should be made publicly available to serve as inspiring and concrete examples for other developing countries and as a contribution to the creation of a global knowledge base on the bioeconomy.

UNOSSC's newly launched South-South Galaxy<sup>34</sup> provides a state-of-the-art online platform that is open for any stakeholders involved in South-South and triangular cooperation, including on the bioeconomy, to share information with the global audience through a simple upload process. Stakeholders are encouraged to make full use of this new platform announced by the United Nations Secretary-General on the eve of his Climate Action Summit in September 2019.

Given that some developing countries are already successfully spearheading advances in the bioeconomy, South-South and triangular cooperation can serve as a key driver for bringing a sustainable bioeconomy to scale. The BAPA+40 outcome document provides a new global framework for leveraging South-South and triangular cooperation for the achievement of the 2030 Agenda, including in key areas of the bioeconomy, such as "sustainable agriculture and food systems" (UN 2019, Paragraph 24). In this context, "multilateral, regional and bilateral financial and development institutions" are called upon "to consider increasing financial resources and technical cooperation to promote South-South and triangular cooperation" (UN 2019, Paragraph 24), including with the engagement of the private sector (UN 2019, Paragraph 31). As some of the case studies in this report

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34. <http://www.southsouth-galaxy.org>.

have shown, the engagement of the private sector can be a key component for the long-term sustainability and scaling-up of Southern bioeconomy solutions and should continue to be pursued in future projects.

Fostering sustainable bioeconomy requires support at the highest political level, as integrated approaches across various sectors are indispensable for its success. Therefore, linkages between the bioeconomy and climate change mitigation and adaptation, renewable energy and agriculture and, more broadly, innovation, science and technology, research and education as well as job creation and poverty reduction, need to be advocated for and demonstrated, based on evidence, in a more comprehensive manner. The United Nations development system is well placed to facilitate advancements in this area through South-South and triangular cooperation given its cross-cutting work in these sectors with the political leadership in most developing countries. The case studies of this publication have shown that the United Nations family is already actively engaged in South-South and triangular cooperation on the bioeconomy from the global and national policy to the grassroots levels.

Realizing the Global South's drive to lead the world towards a sustainable bioeconomy will require more concerted efforts and also the scaling-up of South-South cooperation with technical and financial support from developed countries. Triangular cooperation would also allow the North to learn about Southern solutions that are of relevance in Northern development contexts.

Future South-South and triangular cooperation on the bioeconomy should focus on advancing sustainable and inclusive development by creating enabling environments, fostering ecosystems for innovation, sharing of knowledge and expertise, designing effective business models and policies, thereby contributing to job creation and poverty reduction.



## Bibliography

**Alternative Energy Development Plan (AEDP) (2015).** Department of Renewable Energy Development and Energy Efficiency, Ministry of Energy, Thailand. Thailand's Alternative Energy Development Plan: AEDP2015. Available at: <http://www.eppo.go.th/images/POLICY/ENG/AEDP2015ENG.pdf>.

**Bioökonomierat (2018).** Update Report of National Strategies around the World. Available at: [https://bioekonomierat.de/fileadmin/Publikationen/berichte/GBS\\_2018\\_Bioeconomy-Strategies-around-the-World\\_Part-III.pdf](https://bioekonomierat.de/fileadmin/Publikationen/berichte/GBS_2018_Bioeconomy-Strategies-around-the-World_Part-III.pdf).

**Bowyer, Catherine and Allen, Ben (2018).** Bioeconomy Value Chains and Rural Development-the policy context. European Network for Rural Development.

**Center for Strategic Studies and Management (CGEE) (2017).** Second-generation sugarcane bioenergy & biochemicals - Advanced low-carbon fuels for transport and industry. Available at: <https://www.cgee.org.br>.

**Georgescu-Roegen, Nicholas (1975).** Energy and Economic Myths. Southern Economic Journal, Vol. 41, No.3, pp. 347–81. Available at: [https://www.jstor.org/stable/1056148?origin=JSTOR-pdf&seq=1#page\\_scan\\_tab\\_contents](https://www.jstor.org/stable/1056148?origin=JSTOR-pdf&seq=1#page_scan_tab_contents).

**Georgescu-Roegen (1977).** Inequality, Limits and Growth from a Bioeconomic Viewpoint. Review of Social Economy Vol. 35, No.3, pp.361–375. DOI: 10.1080/00346767700000041

**German Development Institute (GDI) (2019).** NDC-SDG connections. Available at: <https://klimalog.die-gdi.de>.

**Group of 77 (G77) (2000).** Havana Programme of Action, G77 South Summit, Havana, Cuba, 10-14 April 2000. Available at: [http://www.g77.org/summit/ProgrammeofAction\\_G77Summit.htm](http://www.g77.org/summit/ProgrammeofAction_G77Summit.htm).

**G77 (2003).** Marrakech Framework of Implementation of South-South Cooperation, during the High-level Conference on South-South Cooperation, Marrakech, Morocco. Available at: <http://www.g77.org/marrakech/Marrakech-Framework.htm>

**G77 (2005).** Doha Plan of Action, Second South Summit, Doha, Qatar, 12-16 June 2005. G-77/SS/2005/2. Available at: [http://www.cooperacionsursur.org/images/docs/Doha\\_Plan\\_of\\_Action\\_2005\\_English.pdf](http://www.cooperacionsursur.org/images/docs/Doha_Plan_of_Action_2005_English.pdf).

**Intergovernmental Panel on Climate Change (IPCC) (2007).** Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. M.L. Parry et al., eds. Available at: [https://www.ipcc.ch/site/assets/uploads/2018/03/ar4\\_wg2\\_full\\_report.pdf](https://www.ipcc.ch/site/assets/uploads/2018/03/ar4_wg2_full_report.pdf).

**IPCC 2019.** IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security and greenhouse gas fluxes in terrestrial ecosystems. Available at: <https://www.ipcc.ch/report/srccl/>.

**International Energy Agency (IEA) (2017).** Energy Access Outlook 2017. Available at: <https://www.iea.org/energyaccess/database>.

**International Bamboo and Rattan Organisation (INBAR) (2014).** Working Paper No. 76. Greening Red Earth. Restoring Landscapes, Rebuilding Lives. Available at: <https://resource.inbar.int/download/showdownload.php?lang=cn&id=167692>.

**INBAR (2015).** Technical Report No. 35, The Environmental Impact of Industrial Bamboo Products: Life-Cycle Assessment and Carbon Sequestration. Available at: [https://www.inbar.int/wp-content/uploads/2017/02/Bamboo-products-LCA-TR-35\\_0-1.pdf](https://www.inbar.int/wp-content/uploads/2017/02/Bamboo-products-LCA-TR-35_0-1.pdf).

**INBAR (2018).** African Bamboo Industry's Growing Potential for Carbon Sequestration. Available at: <https://www.inbar.int/africa-carbon-sequestration>.

**Laboratório Nacional de Biorrenováveis of Brazil (LNBR) (2019).** United Nations Development Programme, Global Environment Facility, Laboratório Nacional de Biorrenováveis of Brazil and Centro Nacional de Pesquisa em Energia e Materiais (2019). Guid de Boas Práticas para Remoção da Palha da Cana-de-Açúcar. Available at: <https://lnbr.cnpem.br/wp-content/uploads/2019/10/Cartilha-Remoc%C3%A7%C3%A3o-Guia-de-Boas-Pr%C3%A1ticas.pdf>.

**Ministério da Ciência, Tecnologia, Inovações e Comunicações (MCTIC) (2018).** Plano de Ação em Ciência, Tecnologia e Inovação em Bioeconomia. Brasília, DF: Centro de Gestão e Estudos Estratégicos, 2018. Available at: <https://www.mctic.gov.br/mctic/opencms/ciencia/SEPED/Publicacoes/ENCTI/PlanosDeAcao.html>



**Nationally determined contribution of Botswana (NDC Botswana 2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Botswana%20First/BOTSWANA.pdf>.

**NDC Brazil (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Brazil%20First/BRAZIL%20iNDC%20english%20FINAL.pdf>.

**NDC Cuba (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Cuba%20First/Republic%20of%20Cuba-NDCs-Nov2015.pdf>.

**NDC Ethiopia (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Ethiopia%20First/INDC-Ethiopia-100615.pdf>.

**NDC Fiji (2015).** Available at: [https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Fiji%20First/FIJI\\_iNDC\\_Final\\_051115.pdf](https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Fiji%20First/FIJI_iNDC_Final_051115.pdf).

**NDC Kenya (2015).** Available at: [https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya\\_NDC\\_20150723.pdf](https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Kenya%20First/Kenya_NDC_20150723.pdf).

**NDC Lao PDR (2015).** Available at: <https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Laos/1/Lao%20PDR%20INDC.pdf>.

**NDC Lesotho (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Lesotho%20First/Lesotho%20First%20NDC.pdf>.

**NDC Mali (2015).** Available at: [https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Mali%20First/Mali\\_revised%20NDC.pdf](https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Mali%20First/Mali_revised%20NDC.pdf).

**NDC Rwanda (2015).** Available at: [https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Rwanda%20First/INDC\\_Rwanda\\_Nov.2015.pdf](https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Rwanda%20First/INDC_Rwanda_Nov.2015.pdf).

**NDC South Africa (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/South%20Africa%20First/South%20Africa.pdf>.

**NDC Tanzania (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/The%20United%20Republic%20of%20Tanzania%20First%20NDC/The%20United%20Republic%20of%20Tanzania%20First%20NDC.pdf>.

**NDC Thailand (2015).** Available at: [https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Thailand/1/Thailand\\_INDC.pdf](https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Thailand/1/Thailand_INDC.pdf).

**NDC Uganda (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Uganda%20First/INDC%20Uganda%20final%20%2014%20October%20%202015.pdf>.

**NDC Viet Nam (2015).** Available at: <https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Viet%20Nam%20First/VIETNAM%27S%20INDC.pdf>.

**NewClimate Institute (2018).** NDC update report special edition: Linking NDCs and SDGs. May 2018. Available at: <https://newclimate.org/2018/05/07/ndc-update-report-special-edition-linking-ndcs-and-sdgs>.

**Scientific Committee of Problems of the Environment (SCOPE) (2015).** Souza, Glaucia Mendes et al. Bioenergy & Sustainability: bridging the gaps. Available at: [http://bioenfapesp.org/scopebioenergy/images/chapters/bioenergy\\_sustainability\\_scope.pdf](http://bioenfapesp.org/scopebioenergy/images/chapters/bioenergy_sustainability_scope.pdf).

**Stockholm Environment Institute (SEI) (2017).** Dzebo, Adis et al. Policy Brief: Exploring connections between the Paris Agreement and the 2030 Agenda for Sustainable Development. Stockholm Environment Institute and German Development Institute. Available at: <https://mediamanager.sei.org/documents/Publications/SEI-PB-2017-NDC-SDG-Connections.pdf>.

**Trigo, Eduardo et al. (2014).** "Towards Bioeconomy Development in Latin America and the Caribbean". In *Towards a Latin America and Caribbean knowledge-based bioeconomy in partnership with Europe*. E. Hodson de Jaramillo, Editor. Bogota, Colombia: Pontificia Universidad Javeriana, 2014, pp. 14-41.

**United Nations (1978).** Plan of Action for Promoting and Implementing Technical Cooperation among Developing Countries. Available at: <https://www.unsouthsouth.org/bapa40/documents/buenos-aires-plan-of-action>.

**UN (2009).** Resolution 64/222. Nairobi outcome document of the High-level United Nations Conference on South-South Cooperation. Adopted on 21 December 2009 (A/Res/64/222). Available at: <https://digitallibrary.un.org/record/673444?ln=en>.

**UN (2015a).** Paris Agreement. Available at: [https://unfccc.int/sites/default/files/english\\_paris\\_agreement.pdf](https://unfccc.int/sites/default/files/english_paris_agreement.pdf).

**UN (2015b).** Transforming our world: the 2030 Agenda for Sustainable Development (A/RES/70/1). Available at: <https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf>.

**UN (2016).** Framework of operational guidelines on United Nations support to South-South and triangular cooperation. SSC/19/3. Available at: [http://www.un.org/ga/search/view\\_doc.asp?symbol=SSC/19/3](http://www.un.org/ga/search/view_doc.asp?symbol=SSC/19/3).

**UN (2017).** Second High-level United Nations Conference on South-South Cooperation (A/RES/71/318). Available at: <https://undocs.org/en/A/RES/71/318>.

**UN (2019).** Buenos Aires outcome document of the second High-level United Nations Conference on South-South Cooperation (A/RES/73/291). Available at: [https://digitallibrary.un.org/record/3801900/files/A\\_RES\\_73\\_291-EN.pdf](https://digitallibrary.un.org/record/3801900/files/A_RES_73_291-EN.pdf).

**United Nations Department of Economic and Social Affairs (UNDESA) (2016).** World Economic and Social Survey 2016: Climate Change Resilience: an opportunity for reducing inequalities. Available at: [http://www.un.org/en/development/desa/policy/wess/wess\\_archive/wess2016/WESS\\_2016\\_Report.pdf](http://www.un.org/en/development/desa/policy/wess/wess_archive/wess2016/WESS_2016_Report.pdf).

**United Nations Executive Office of the Secretary-General (UNEOG) (2017).** Catalyzing the implementation of Nationally Determined Contributions in the Context of the 2030 Agenda through South-South Cooperation. Available at: [https://unfccc.int/sites/default/files/ssc\\_ndc\\_report.pdf](https://unfccc.int/sites/default/files/ssc_ndc_report.pdf).

**United Nations Framework Convention on Climate Change (UNFCCC) (2013).** Third synthesis report on technology needs identified by Parties not included in Annex I to the Convention. Available at: <http://unfccc.int/resource/docs/2013/sbsta/eng/inf07.pdf>.

**United Nations Office for South-South Cooperation (UNOSSC) (2017).** United Nations Office for South-South Cooperation and the International Bamboo and Rattan Organisation. South-South in Action: Inspiring Sustainable Development with Bamboo. Available at: <https://resource.inbar.int/upload/file/1510881082.pdf>.

**UNOSSC (2019).** 'Cooperation Beyond Convention: South-South and Triangular Cooperation in a Changing Landscape.' Available at [https://www.unsouthsouth.org/wp-content/uploads/2019/09/Independent-Report\\_webversion.pdf](https://www.unsouthsouth.org/wp-content/uploads/2019/09/Independent-Report_webversion.pdf).

**World Resources Institute (WRI) (2016).** Northrop, Eliza et al. Examining the alignment between the intended nationally determined contributions and Sustainable Development Goals. World Resources Institute. Available at: [http://www.cac.int/sites/default/files/WRI\\_INDCs\\_v5.pdf](http://www.cac.int/sites/default/files/WRI_INDCs_v5.pdf).





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