

Introduction

The Global Bioeconomy Summit (GBS) is a high-level, biennial international conference gathering actors from all over the world to discuss progress in developing new visions, actions, and strategies for a sustainable bioeconomy. These actors represent various backgrounds ranging from governments to businesses, civil society, and science. Although a universally accepted definition of what constitutes a bioeconomy does not exist, the 2018 GBS defined bioeconomy as “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” (GBS, 2018). The GBS has emerged as a key platform for informing and connecting key actors from local to national to global levels and thus providing leadership in shaping the bioeconomy agenda.

The GBS 2020 acknowledged the increasing number of national, regional, and business sector climate neutrality pledges. Thus, bioeconomy strategies need to align the sustainable use of bioresources and bioindustries with the climate neutrality target. Joachim von Braun, Co-Chair of the Bioeconomy Council, noted this target has been met with “amazingly rapid progress in bioeconomy, adapted to local conditions, for example with sustainable high-tech solutions for agriculture, and innovative use of wood.” The German Federal Minister of Education and Research Anja Karliczek, who opened the Summit together with the Deputy Prime Minister of Thailand, emphasized the importance of global cooperation for sustainability and the innovations needed to drive this forward. The GBS 2020 identified three major bioeconomy contributions to people and planet (GBS, 2020):

1. for health and wellbeing as a key element in building back better during and after Covid-19;
2. Science and technology breakthroughs advancing the sustainable bioeconomy;
3. Climate action, ecosystems, and biodiversity protection;

The workshop summarized in this report emphasized the first of these contributions, while also recognizing the strategic importance of contributions (2) and (3). The workshop fell under Track 4 of the GBS workshop structure, which emphasised Regional Bioeconomies and Global Collaboration.

Purpose of the workshop on “Regional cooperation for innovative bioeconomy pathways to promote health and well-being”

The Covid-19 pandemic has revealed vulnerabilities in economies and societies while reminding us of the intertwined relationship between human, animal, and ecological health (Lebov et al, 2017). The workshop was designed to include both thematic and regional parallel breakout sessions, in order to cross-fertilise between thematic and/or sectoral issues and regional efforts at integration on the other hand, thereby emphasising the cross-cutting, cross-regional, and innovative nature of a sustainable bioeconomy. The workshop explored **positive narratives** of regional cooperation for innovative bioeconomy pathways to promote environmental and human health and well-being and to align short-term recovery with long-term resilience building, in order to reduce risks from future epidemics and other shocks and pressures. A bioeconomy aiming for long-term sustainability is expected to be consistent with the principles of resilience in terms of exhibiting diversity, redundancy, modularity, and accounting for inter-linkages (Feint et al, 2020).

Three thematic and four regional parallel sessions served to identify context-specific **innovative and transformative bio-economy pathways** that go beyond business-as-usual approaches. Rather than only emphasising substitution of fossil resources with biomass, the bioeconomy approach presents many opportunities, emerging in fields such as biobased green chemicals, probiotics, or carbon-storing construction materials. These collectively present new and more diversified biobased value-added products, processes, and models (e.g. circularity), for improved human well-being while maintaining and restoring the integrity of environment, ecosystems, and biodiversity. Developing countries have a unique opportunity, when leapfrogging rather than repeating the outdated fossil-based and resource-intensive models that the industrialized countries are currently trying to leave behind. These efforts can benefit from transnational partnerships and innovation systems to develop bioresources and bio-based industries while reducing trade-offs and promoting synergies between human, animal, environmental and planetary health.

As with the broader economy, the bioeconomy and the associated production, distribution and consumption of biobased resources have seen rapid **globalization**. For instance, international trade in biomass for use in the energy sector alone (like wood pellets, palm oil, ethanol or roundwood) has increased from around 785 PJ in 2004 to around 1250 PJ in 2015 (Proskurina et al. 2019). A fair distribution of benefits, and shared responsibility for environmental and socio-economic costs along **international supply and value chains** requires regional and global cooperation of all actors. Supply chain transparency and footprint traceability are key to inclusive and sustainable bioeconomies, enabling more value-generation upstream and eventually more sustainable sourcing. Cooperation also builds on the comparative advantages that each region has in biomass availability, production, or processing (technology). There is no clear answer yet as to whether shorter supply chains and more local production and consumption systems—or more diverse and longer supply chains—are best for building resilience and preventing the spread of pandemics and other shocks. Finding the right balance between globalization and localization (*glocalization*) remains a challenge.

Transnational **innovations** can complement national efforts and contribute to robust **solutions** for more resilient and sustainable bioeconomies, making use of specific knowledge, skills, and infrastructure to foster innovation across borders. Bioeconomy innovations can improve the allocation of scarce bioresources and valorisation of by-products, reduce losses and waste, promote circularity, and eventually generate more value and human well-being without overexploiting bioresources and environment. New bioeconomy pathways require besides technological innovations (e.g. in synthetic biology, novel biosciences, etc.) also **socio-economic and governance innovations**, as well as innovations on the consumption side, e.g. through reuse, recycling, reduction, sufficiency and changes in lifestyles, diets etc.

National and regional bio-economy strategies can support **integration** across different sectors (e.g. agriculture, forestry, industry) and across different policy domains (e.g. development, trade) so as to promote **policy coherence**, via concerted efforts to align with existing strategies and policies (Canales and Gonzales, 2020). In the case of the EU, bioeconomy strategies need to be coherent, for example, with the Green Deal, the Common Agricultural Policy, the Farm-to-Fork Strategy, and the Circular Economy Strategy as well as with trade agreements (e.g. EU-Mercosur) and partnerships (e.g. EU-Africa). Such entry points for aligning bioeconomy strategies with other existing policies can also be explored in other world regions to investigate potential synergies with regional trade agreements and resource regimes.

Ultimately, **regional cooperation** on the right strategies for producing, engineering, utilising, and recycling terrestrial and maritime bioresources and for expanding bioresource production and bio-industries and knowledge exchange and capacity development can improve human, animal, ecological and planetary health and lead to more resilient communities and societies. The workshop emphasised regional cooperation, strategic partnerships, and regional branding, exploring the range of measures, data, and new frameworks, (virtually distributed) networks, platforms, centres of excellence, tools and awareness raising for cooperative sustainable bioeconomies.

Thematic Sessions

The three thematic parallel breakout sessions explored different pathways for innovation and resilience through broad and inclusive approaches for:

- i. Bio-based resources and industries
- ii. Bioeconomy for health and well-being
- iii. Transnational innovation systems

Theme 1: Bio-based resources and industries

Recovery from the pandemic and building long-term resilient systems provides an opportunity for both developed and developing nations to comprehensively re-assess their renewable (bio-)resource base, innovate across key technologies and develop new modalities of value-addition and sustainable bio-based resource and industry transformation. The convergence in modern biological and digital technologies is also propelling new partnerships and collaborations on how to add value to bioresources and optimize biomass use. One such example is *SynBioBeta*, an emerging global network on synthetic biology.

Regional cooperation complements national efforts to promote bio-based products and processes, thus meeting more sustainably the burgeoning demand for food, feed, renewable fuels, and health and wellness bioresources and products (e.g. prebiotics, probiotics, and microbiomes) due in part to the increased awareness and pursuit of well-being and healthy lifestyles.

Although bioresources are renewable, they are not infinite, and thus conservation efforts and continuing improvements in best practices need to be mainstreamed. Bioeconomy strategies therefore need to ensure sustainable production of raw materials and their efficient conversion into diverse bio-based products without overexploiting natural resources, while minimizing waste and instead promoting circularity. Other important factors needed to create sustainable bioeconomies include international partnerships, access to capital, and policy support, such as in the US-based Bio-preferred program (www.Biopreferred.gov). Disparities in availability and distribution of bioresources and technical expertise for value addition, call for cooperation, capacity development and sharing of technologies as well as fair market access and sustainable supply chains.

This thematic session featured presentations on new tools (e.g. synthetic biology) for harnessing bioresources, bio-products, standards and bio-based industries followed by a dialogue and exchange on best practice to enable new collaborations and partnerships.

Guiding questions for Theme 1 “Biobased resources and industries” were:

- 1) How can nations and regions sustainably harness bioresources through value-addition to improve health and well-being?

- 2) Are there global best practices and standards for bio-industries and bio-products? And how might cooperation between differently endowed regions promote synergy for food security, health, livelihoods, construction, textiles, packaging, energy, and climate management?
- 3) What policies should governments establish to prevent supply chain shocks (such as during Covid-19), and enable optimal transformation and diversification of bio-based resources. At what level – local, national, transnational, regional or global should these policies (related to markets, standards, finance, technology sharing, capacity building, ecosystem protection, etc.) be instituted?

Discussion converged on two key points:

- i. value addition to bioresources should intentionally lead to diversification of bio-products and services, using emerging but also well-established biobased technologies; and
- ii. regional cooperation is critical to building resilience of supply chains and supporting food security, health, and overall wellbeing.

The workshop participants also agreed that countries and regions should start with a strategic bioeconomy blueprint, whose implementation will be critically dependent on:

- A. Enabling policies and action by governments to build the infrastructure and attract funding / investments;
- B. Creation of national / regional hubs, clearing houses or bio-incubators for sharing expensive assets and knowledge;
- C. Use of modern biology, such as synthetic biology, for expanding the horizon of renewable bioresources and authentic bioproducts;
- D. Sustainable trade between countries and regions, which can be based on bio-product certification such as the systems used in the EU, USA, and elsewhere; and
- E. Knowledge and technology sharing are indispensable, including local or indigenous knowledge.

A general observation from the discussion is that regional collaboration is valuable in all its forms (e.g. subregional, regional, and inter-regional). However, for regional collaboration to be effective, different types of convening platforms are needed at different levels, to catalyse knowledge sharing, policy development, capacity building and to support sustainable bioeconomy development.

Theme 2: Bioeconomy for health and well-being

Health and well-being are recognised as integral to a modern bioeconomy through approaches such as OneHealth and EcoHealth, including human, animal, ecological and planetary health (Lerner and Berg, 2017; Harrison et al, 2019). Sustainable use of bioresources and biodiversity is an important pillar of the future bioeconomy. Increasing demand for bio-based products in response to bioeconomy strategies and economic growth requires a careful combination of environmental conservation, sustainable production, and suitable market applications. The Covid-19 pandemic demonstrated the links between the outbreak of zoonotic diseases and intensification of land use, agriculture, and biotic resources, bringing wild animals, livestock and humans into closer contact and providing breeding grounds for pests and diseases (Everard et al, 2020).

Medicine and health treatments span major global markets while also providing opportunities for locally-produced products. The benefits of local production and use and benefits for local livelihoods must then be weighed against cost reductions through the economies of scale of global supply chains. Besides the focus on food systems and food security, other high value products and industries should also receive more attention.

Guiding questions for theme 2 “Bioeconomy for human health and well-being” were:

- 1) How can nations and regions sustainably harness their bioresources through value-addition for improving health and well-being while preserving biodiversity and maintaining ecosystems?
- 2) How can implementation of national and regional bioeconomy strategies enhance synergies between animal, human and ecological health?
- 3) What resource transformations or improvements in policy coherence are needed?

The presentations and discussions in this session focused especially on:

1. the need to curb unhealthy trajectories, e.g. in food systems with their large share in GHG emissions, fertilizer, and land use change (also in other regions through international supply chains)
2. Food consumption patterns, overconsumption and associated diseases need to be addressed, so that bioeconomies can contribute to health and wellbeing and more generally to sustainability.

A presentation on India’s National Mission Biodiversity and Human Wellbeing explained the ambitious goal to transform biodiversity science (India being a megadiverse country) to meet the SDGs and sustainably utilize biodiversity and ecosystems for development without species loss. A second presentation used social-ecological systems to show how bioeconomy can emphasise overall well-being and connect to societal goals at local and sub-national levels. A third presentation focused on a bioeconomy case study on local plant extracts to prevent malaria in East Africa.

Bioeconomy can generate jobs and diversify livelihoods through new ways of using ecosystems. Biodiversity based livelihoods include for example science and educational tourism and restoration. Partnerships of institutions (academia, NGOs, local communities, and public-private partnerships) are key. These can lead to new science-practice interactions, e.g. engaging citizen science, supporting policies, entrepreneurship and digital tools (e.g. DNA barcoding).

Theme 3: Transnational innovation systems

This session addressed transnational cooperation on innovations for the bioeconomy. It considered whether and where transnational innovation cooperation is already happening and discussed the important networks, actors, and institutions as well as the challenges and opportunities of more transnational innovation cooperation. From an innovation perspective, regional or sub-national innovation is happening also because regional constituencies often share common norms, know-how and practices, all factors important for innovation to happen. But in a globalised world, there is a significant cross-border element in innovation networks and knowledge flows, particularly in well-integrated spaces such as the EU (Bößner et al, 2021). However, the session went beyond bilateral innovation networks and took a broader, transnational view which included non-state actors such as NGOs, labour unions, transnational corporations, and research institutes as driving forces who often collaborate across many borders and constituencies .

Guiding questions for theme 3 “Transnational innovation systems” were:

- 1) How can transnational cooperation facilitate exchange of knowledge, skills, and talent to foster transnational innovation systems?
- 2) Are there any best practice examples and/or actor networks who cooperate across borders on bioeconomy innovation pathways?
- 3) What are the barriers (but also the opportunities) to transnational innovation systems in bioeconomy pathways? And what can be done to overcome those barriers?

Participants agreed that cooperation on innovation happens increasingly across borders and that different regions, given their specific preconditions and localized knowledge, know-how and skills, could benefit when learning from each other. Successful innovation benefits from cooperation between regional actors, who hold essential and often tacit local knowledge, with international partners that can tap into global networks; this cooperation is not only across borders but also across sectors. When diverse stakeholders are brought together across sectors, common visions and narratives can emerge, which often form the basis of regional and, further along the road, transnational innovation systems. Similarly, only if knowledge and know-how crosses borders as well as sectoral silos, transnational innovation systems can flourish. Indeed, many participants emphasized this need to work across disciplines, particularly when it comes to bioeconomy pathways, given the cross-sectoral nature of the concept which aims at replacing unsustainable production, distribution, and consumption modes with more sustainable, preferably bio-based ones. Participants, particularly during the second session, pointed out how digitalization and virtually distributed networks would play a key role in stimulating innovation and how a new geography of innovation would emerge, thus reflecting an increasing transnational character of innovation networks. Indeed, one participant pointed out that innovation regions should not be defined by national borders but by ecological, economic, or social structures like innovation infrastructure or skill sets that may help to foster transnational innovation systems. However, in order for those systems to emerge, it is essential to establish a stable and predictable policy and regulatory environment, which can facilitate those flows of skills, knowledge, and information across borders.

Exploring regional options

Regional cooperation could bridge the gap between local and global approaches, identifying the complementarities and synergies that arise in modern bio-economies. Regional efforts can augment national strategies in terms of comprehensively evaluating the bio-resource base, comparing best practices for processing and utilization, building capacity, promoting the sharing of technologies, and innovating. The ultimate aim is to link local entrepreneurship and/or traditional knowledge to modern biosciences to promote health, well-being, and resilience. The regional sessions aimed to pick up the results from the three thematic sessions and identify different modes for facilitating change through regional cooperation:

Bioresources and bio-industries, with a focus on the cross-cutting importance of new bioresources and bio-industries and the role of governments and policy makers in promoting bio-based products and processes, and particularly to identify how regional cooperation could support the sustainable development of bio-based enterprises;

Bioeconomy for health and wellbeing, with a focus on a modern bioeconomy as a platform for locally-produced drugs and health treatments, so that biodiversity is used sustainably, providing local benefits. Regional efforts could aim to link local entrepreneurship and/or traditional knowledge to modern biosciences for health and well-being. At the same time, international trade and investment may be required as technological applications and their upscaling/provision of bioresources that may not be feasible through local channels.

Transnational innovation systems, with a focus on cooperation of different actors across national borders, complementing national and local cooperation and stimulating innovations through sharing best practices, technology transfer mechanisms and/or taking advantage of comparative advantages

in different countries. Transnational cooperation networks can improve knowledge sharing, methodological comparisons, and identification of new options for value chains.

General guiding questions for all regional sessions (Africa, Asia, EU/OECD, Latin America) were:

- 1) In building bio-based industries, sustainably sourcing and adding value to bioresources, what can regions learn from each other? How can learning between regions be enhanced?
- 2) When is regional cooperation most useful and in what areas (e.g. when creating regional markets, setting international standard, catalysing national bioeconomy strategies, developing policies, financing, protecting fragile ecosystems etc.)? What are the limits to regional cooperation as compared to local, national, and transnational or global cooperation?
- 3) Which comparative (dis-)advantages do countries and regions have for bioresources and bio-based products (e.g. land availability, ecosystem diversity and resilience, processing technologies and know how, capacity for value-adding) and how can regional cooperation enhance capacity without increasing dependency on potentially fragile supply chains?

Regional Session: European Union + OECD

This regional focus was based on the common background of participants working in EU and/or OECD countries and included North America and Oceania as well as Europe. Workshop participants discussed the previously identified global challenges and opportunities while targeting the areas prioritized by the high-income countries and considering regional characteristics. Although the OECD countries tend to emphasise advances in biotechnology, the implementation of sustainable bioeconomies in high-income countries also requires far-reaching changes in value chains, business models, bioresource systems, policy domains and governance approaches. The large number of actors involved, and the wide range of ideas, attitudes and goals influence the regional decision-making processes. It is therefore necessary to pay particular attention to the transparency of these decision-making processes and the opportunities for active participation. Accordingly, the focus was on improving policy coherence, identifying strategic priorities, understanding regional heterogeneity (e.g., in climate conditions, socio-economic systems, etc.) and better aligning currently isolated sectoral considerations. An important aspect was also the potential scope for regional cooperation within the EU as well as between EU member countries and other OECD member countries.

Guiding questions for the EU/OECD regional session were:

- 1) Which regional visions of future bioeconomy transformation pathways exist?
- 2) How can regional cooperation promote a successful transformation towards a sustainable bioeconomy?
- 3) What are the key drivers, contextual mediators, and barriers affecting the sustainable regionalization of bioeconomies?

The presentations and discussions in this session focused on the availability of advanced technologies which enable the efficient use of bioresources. Also, this session addressed differences in terms of existing industries, infrastructures, resource availabilities and social backgrounds and cultures within Europe and across the OECD, many of which face significant structural changes as they move away from polluting and/or fossil-based industries. Accordingly, sub-regions or countries differ significantly in their readiness for sustainability transitions. Especially in light of these differences it becomes important that regions complement production, processing and use of bio-based resources with intensified research efforts (e.g. biopolymers as fossil substitutes, recovering phosphate from

biobased waste streams, advanced biofuels). Especially in well-developed regions, the successful establishment of businesses requires market analysis beyond the region, including a focus on the global market dependence. The session also emphasized that various constraints currently distort the market and that there is little or no price premium for environmentally and socially friendly products – these must be overcome.

A strong European example for a bioeconomy transformation ecosystem is the Rheinische Revier region in Germany. Following the decision by the German government to phase-out lignite mining, this region – Europe's largest contiguous lignite mining area – will undergo significant structural change. The region is characterized by a traditionally productive agriculture, strong industries demanding biogenic resources (e.g., food, chemical, pharmaceutical as well as textile industry), as well as an excellent innovation landscape (dedicated bioeconomy research and innovation instruments) and has further begun to establish formal mechanisms for stakeholder and citizen engagement as well as a comprehensive system analysis of bioeconomy transformation pathways. The cross-cutting bioeconomy approach thus enables:

- screening regions for SME innovation demand
- platforms for informal and confidential exchange
- systematically matching of innovation demands and existing solutions
- generation of business cases/start-ups for the required innovation

The discussions in the session have shown that regions can learn from each other in terms of successful bioeconomy transitions, while still going for context-specific approaches and solutions. There are positive experiences with transregional as well as cross-sectoral cooperation, but also major challenges in managing all partners. Successful implementation requires strong local political commitment across many policy fields and value-chains. The willingness to address trade-off can be increased by utilizing the high political relevance and local policy-makers' interest in making change happen. A key question then becomes: whom to engage with and why? Additionally, cultural aspects can be important, as leverage for achieving transformation and as foundation for communities, willing and able to follow their bioeconomy vision.

Regional Session - Latin America

The Covid-19 crisis has significantly affected Latin American countries, especially Brazil, Mexico, Argentina, Colombia, and Peru. Bioeconomy has been proposed by some governments as a key part of the recovery process, for building back better.

Sustainable bioeconomies in the region are subject to specific structural opportunities and challenges, including (a) high endowment of bioresources, with Brazil, Colombia, Ecuador, México, Peru and Venezuela hosting large forests and other natural ecosystems and being among the 17 mega-biodiverse countries of the world; (b) high levels of inequality, with Latin America hosting 8 of the 20 most economically unequal countries in the world; (c) high levels of informal employment, with around 60% of employment being in the [informal sector](#), many without access to employment benefits or guarantees; and (d) low levels of science and technological development.

Ecosystem health is important to prevent future epidemics or pandemics, but also for ensuring a liveable planet, considering the global importance of the region's ecosystems and biodiversity, as well as its importance for national, local, and traditional culture and knowledge.

Key discussion points during the session included the role of bioresources and bio-industries in a post-Covid-19 recovery. In Colombia, the forthcoming bioeconomy strategy is part of the recovery package. The expectation is that by including the bioeconomy, the recovery process will be based more strongly on green sectors, for better recovery. This “green” recovery process through a bioeconomy, is expected to address the high levels of informal employment through the provision of new formal jobs within green sectors as well as through fostering new biotech-related businesses. This is expected to be achieved while paying attention to generate benefits also to local communities, to address the high levels of inequality. However, it is important to remember that bioeconomy it is not a panacea for every problem, and therefore ambitions on what the bioeconomy can achieve should be realistic.

In Latin America, the diversity within each country determines the focus of their bioeconomy strategies. Therefore, unlike in the European Union, levels of collaboration among countries vary according to whether they have similar or competing priorities and perspectives. For example, Costa Rica’s strategy focuses on green growth, while in Brazil the focus is on bioenergy, and in Argentina is on biotechnology.

Beyond transnational cooperation, also coordination and cooperation at different government levels within countries in the region is crucial for implementation. There are sub-national inequalities that need to be considered to ensure that bioeconomy does not perpetuate or even increase them, and that in fact helps to balance them. Examples of such inequalities include different levels of research capacities, including science and technological development; but also affordability levels, in particular between large urban and rural areas. Such cooperation also needs to happen beyond governments, and in particular trying to bridge academia and private sector.

Increasing bioresource demands within new bioeconomy strategies can pose new risks to the region’s ecosystems and biodiversity. Therefore, regulations to stop forest loss and promote biodiversity conservation should remain as a high priority. Given the current barriers for the use of biodiversity, both for scientific and commercial purposes, regulations to protect biodiversity need to be accompanied by regulations to guarantee its sustainable use.

A concrete example on good coordination for bioeconomy is the experience of the Oswaldo Cruz Foundation (Fiocruz) linked to the Brazilian Ministry of Health. One of the branches of this organization, Farmanguinhos, based in Rio de Janeiro, Brazil, works along six Brazilian biomes in a network called RedesFito, with different actors, including government, private sector, and research. Coordination among these actors allows Farmanguinhos’s innovation centre to produce pharmaceuticals from local Brazilian biodiversity. In addition, Fiocruz accompanies this coordination and innovation process with a Graduate Program in Biodiversity and Health since 2010, that aims to train masters and doctoral students in research, teaching and technical activities related to biodiversity and human health.

Regional Session – Africa

Endowed with vast biodiversity and arable land relative to its population, Africa's biophysical capacity coupled with a young population suggests that the bioeconomy could be a major engine for growth and sustainable development. However, African countries have only to a limited degree been able to apply technologies and skills that could modernise biomass utilisation such as agricultural production, bioprocessing and biobased value addition. The low degree of bioprocessing and value addition to primary produce makes it difficult for the region to use its bioresources as an engine for economic growth. Moreover, climate change and subsequent natural disasters increasingly affect

agriculture and biomass production negatively. Participants of this session considered the key drivers and mechanisms for a multifaceted integrated development agenda that combines international, regional, and local (including indigenous) knowledge. For example, the West Africa sub-region is a leading producer of the world's tubers and biomass but often employs fragile unsustainable agro-ecological systems, generating unutilized wastes with potential high value, e.g. for animal feed. In East Africa bioeconomy blueprints strongly encourage transnational collaborations and joint capacity building in the process of adapting suitable technologies for value addition to primary produce.

Guiding questions for the Africa regional session were:

- 1) Harmonizing strategies/sharing strategy development experiences: what are the best opportunities for regional cooperation, capacity building and entrepreneurial skills development in Africa?
- 2) Regional funding/financing strategies - how to attract foreign investments and expand exports of bio-based products (a regional clearing house).
- 3) Which measures, policy frameworks and economies of scale are necessary to stimulate trade within the continent and between its economic blocks? What is the best model to facilitate cooperation within the African market and collaborations for African-made bio-products?

The presentations and discussions in this session focussed on a vision of Africa becoming the next frontier in bioeconomy, unlocking biobased economic growth, employment potentials and generating wealth for its people (besides mitigating hunger). To realise these prospects for the bioeconomy, countries in the region need to develop effective policy frameworks for appropriate investments in infrastructure (including networks, platforms, and incubators), capacity building for biomass valorisation, and biobased business development (e.g. supporting SME growth, ease of doing business, and incentivising emerging bio-businesses). A regional network of agri-industrial parks, bio-hubs, and other innovation ecosystems constitute effective mechanisms for stimulating entrepreneurship, linking innovation actors, and promoting business collaboration, including a collaboration between African based SMEs with international companies. For example, Ethiopia builds a series of agri-development centres, which link innovation actors and promote agro and bioprocessing of primary agricultural produce in various parts of the country.

In order to promote coordination between sectors, governments should bring relevant stakeholders together and set financial incentives, help to overcome inherent inertia, and promote policy coherence. Nigeria was mentioned as an example where the development of a national bioeconomy strategy brings together different government actors and promotes policy coherence.

To broaden market access, African countries, like other regional groups, need quality assurance and certification schemes and labels for their bio-based products, in order to support market uptake. International companies such as the Miami-based Beta Analytics shared their best practices regarding bio-product certification and labelling. However, inequality and poverty means that high quality bioeconomy products (which internalize social and environmental costs) may be unaffordable for many Africans.

Regional cooperation, new partnerships (including private-public partnerships), investment in knowledge, local value adding and improved governance are essential. Bioeconomy strategies are developed in Eastern Africa and countries such as Burundi, Kenya, Rwanda, South Sudan, Tanzania, Uganda, and Nigeria. In that process, countries can learn from each other, as was demonstrated for

example for South Sudan, which is benefitting from being part of this regional effort, learning from the other countries and fast-tracking its national bioeconomy development.

There are now also emerging examples of biobased regional innovation hubs in the health sector in Africa. Regional innovation consortia, under the BioInnovateAfrica Programme, with actors from Burundi, Uganda, and Tanzania, are developing new bio-based products from plant extracts, serving as affordable mosquito repellents for malaria control. These plant extracts, based on locally available resources, the catnip flower, can be a cost-effective solution which promotes local value addition employment, regional development, and the achievement of SDGs. The project spans over a large part of the innovation process, including product formulation, efficacy tests, a branded product, trademarks, and business models.

In a concluding discussion, participants agreed on the importance of African bioeconomy policy agendas and improved governance to create enabling environments for biobased sustainable economic growth. It was also highlighted that the sustainable production and processing of biomass into goods of higher value and thus the valorisation of primary produce in the region is dependent on improved scientific and technological skills. These skills are today inadequate in Africa, but shared regional knowledge platforms and joint programs can enhance capacity building in the region. The BioInnovate Africa Programme in Eastern Africa is a good example of such a platform, but more of these regional platforms need to be developed, also in West Africa and Southern Africa.

Regional Session – Asia

China and India are major centres of biotechnology development with public and private investment in biomedical innovation and agricultural bioprocesses for food, feed, fibre, and fuel. In India, a major initiative on biodiversity for well-being has been launched with potentially global implications because of its innovative and integrative approach.

In Southeast Asia with Thailand and Indonesia as major players, bioeconomy is becoming a strategic focus, with social aspects increasingly viewed alongside technology. Civil society organisations promote community-driven bio-economies that emphasize well-being over growth, and thus there are also key tensions and trade-offs.

Guiding questions for the Asia regional session were:

- 1) Considering the tremendous diversity across the continent, what is the feasible scope in the respective sub-regions for greater regional cooperation to promote bioeconomy development while also respecting ecosystems and biodiversity?
- 2) What is the role of major multinational and national corporate actors for developing the bioeconomy in the region?

The presentations and discussions in this session focussed on bioeconomy strategies pursued by Thailand and Indonesia. Thailand's strategies for the bioeconomy focus on promoting research and development, foreign investment, and private-public partnerships to develop bioeconomy projects from sugarcane and cassava. The presentation from the Indonesian perspective discussed the impacts of the EU's Green Deal and other policies on trade with Indonesia. As a strategy, Indonesia is placing emphasis on streamlining its supply chain to link small holding farmers with consumers. Key discussion points during the session included:

Types of cooperation between Asian Countries

Regional cooperation within Asia is currently challenging as countries are at extremely different

stages of development in developing their bioeconomies. Countries with developed bioeconomies such as Thailand are seeking trade as well as technological investment from major Asian powers (e.g. China and Japan) to develop downstream bioeconomy products.

On the other hand, countries like Indonesia that are seeking new markets for export of raw bioresources are seeking technical cooperation from larger Asian actors in the bioeconomy for capacity building, knowledge transfer, trade, and technological development.

Future of Asian bioeconomy

EU's green policies such as the EU farm to fork strategy and other green policies prioritize transparent and deforestation free sourcing. These new strategies have already affected trade with Asia. To cope with these demands, Asian countries are turning to direct sourcing as a business model. Better standards, certification and labelling are also identified as strategies for Asian countries to continue bioeconomy trade.

Key Insights and Challenges lying ahead

In order for the bioeconomy to be central in re-building more resilient economies, societies and ecosystems, there is a strong need for cooperation at all levels and scales. Besides diversity and redundancy, accounting for cross-sectoral, cross-level, and cross-scale interlinkages supports resilience. Cooperation across countries and regions has to acknowledge the different situations, contexts, and development stages. At the same time, it can build on the respective comparative advantages, e.g. in terms of land availability, productivity of natural resources and technological capacity for processing bioresources.

Cooperation in knowledge-based bioeconomies has to start from a synthesis of relevant data and information on these situations, contexts, comparative advantages, production, and processing systems and flows of bio-based resources and products within and across countries and regions, as well as relevant data and information on the consumption-side.

From that synthesis of information, recommendations can be derived, e.g. on mechanisms for local to national, regional, and international cooperation, the need for research and development, capacity development and knowledge sharing in transnational innovation systems. Also, national policy frameworks and bi-lateral and multi-lateral trade rules and agreements and national and foreign investments need to be adapted to the challenges and opportunities of the rapidly developing bioeconomies around the world.

Capacity development efforts have to be strengthened through the establishment of competence networks and innovation clusters which bring together both local stakeholders, who often hold tacit and local knowledge and are often drivers of vision development for regions, as well as international and global players, who are important for knowledge and technology transfer, for access to global markets or the achievement of economies of scale.

Integrating bioeconomy strategies into national policy frameworks and regulations requires new efforts towards improved policy coherence, e.g. across environment, development, industry, agriculture, finance and other economic sectors and/or government departments.

Building on all these steps, bioeconomy strategies can be implemented so that benefits are shared more equally along the value chains, for enhancing human wellbeing and protecting and regenerating ecosystems so as to support the resilience of people and their environment.

Acknowledgements

The workshop was led by the four partners: SEI, Applied Biotech, Jülich Science Centre, and Univ. Bonn ZEF. There were also many guest speakers and discussants to whom the partners are grateful. The names and affiliations of all workshop organisers, session moderators, presenters and discussants are listed in the Agenda for the Plenary session and the agenda for the Parallel Working Groups on the GBS website (https://gbs2020.net/track4_regions_health/). Thanks also to SEI Communications staff (Katja Bessonova and Venni Arra) as well as the GBS secretariat staff in Berlin. This workshop report was prepared by Holger Hoff and Francis X. Johnson of SEI, with inputs and support from many colleagues, especially the following:

- Applied Biotech: Nwadiuto Esiobu, Bamidele Solomon, Ken Ife, Charles Adetunji, Dominic Okolo
- Jülich Science Centre: Sandra Venghaus, Sophia Dieken, Florian Siekmann, Mirko Dallendörfer
- Stockholm Environment Institute (SEI): Nella Canales, Stefan Bößner, Ivar Virgin, Lina Gutierrez Cala, Martina Walaan, Matthew Fielding, May Thazin Aung, Pimolporn Jintarith, Alphayo Lutta
- ZEF, University of Bonn: Sascha Stark

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