

Latin America's developing bio-economies: concept note for a regional panel discussion @ GBS2018¹ 2

I. Introduction

The Latin America and the Caribbean (LAC) region is particularly well placed to both contribute and benefit from bio-economies in construction. The region is well known for its immense wealth of natural resources, in terms of land, water and biodiversity, all factors of increasing strategic value for a bio-based world. The rapid agricultural transformation occurring in many countries, and the way that the region has rapidly evolved to become a world leader in the exploitation of the new agricultural technologies and in the bio-fuels markets is a clear sign of this potential. A rapid analysis of supply and demand factors clearly points in the direction that, in any possible future scenario, achieving the needed new global equilibriums, has the LAC region playing a critical role. At the same time, the region has a challenge of its own. Hunger and poverty, although not as dramatic as in other parts of the development world, are continuing preoccupations in the region, especially in the rural areas. These are turning agriculture and biomass production into essential components of any hunger and poverty alleviation strategy (INCO-Net ALCUE-NET, 2016).

The Bioeconomy in LAC is an alternative for the productive diversification and aggregation of value in rural areas, both in the bio-based economic sectors (agriculture, livestock, fishing and aquaculture and forestry) and their processing and manufacturing related activities (agroindustry, food industry, forestry industry). Taking the 2030 Agenda as a policy framework, the Bioeconomy is an alternative for the intelligent specialization of the territories, for innovation and structural change with a focus on sustainability, as well as to promote agricultural and rural development (Rodríguez et al., 2017).

In Latin America no consensual vision on the bio-economy exists for the region. However, there is increasing acceptance of the notion of the Bioeconomy as: a) an economy based on the consumption and production of goods and services from the direct use and sustainable transformation of biological resources, including biomass residues generated in the processes of transformation, production and consumption; b) taking advantage of knowledge of biological systems, principles and processes; and c) making good use of modern technologies relevant to the knowledge and transformation of biological resources and the emulation of biological processes and principles.

Building a regional Bioeconomy vision, followed by roadmaps and action plans to strategically take advantage of the region's strengths, were the goal of several bi-regional S&T strengthening EC financed projects since 2011 i.e. ALCUE-KBBE, ALCUE-NET, ERA-NET LAC. These aimed at constructing a bi-regional platform of cooperation to accompany the introduction, validation and implementation of the LAC Bioeconomy through the cooperation of key stakeholders, actors and experts from the LAC and EU regions. "Bioeconomy development

¹ Background document prepared to inform the participants (and other interested parties) in the Session *Bioeconomy of World Regions – Latin America and the Caribbean*, II Global Bioeconomy Summit (19-20 April 2018, Berlin, Federal Republic of Germany) of the principal characteristics of the bio-economies in the LAC region and to help the identification of future cooperation opportunities. The document is based mostly on the discussions at the "Regional Seminar Latin America and the Caribbean Bioeconomy 2018", UN-ECLAC, 24 - 25 January 2018, organized by ECLAC's Agricultural Development and Unit (DPPM) and Sustainable Development Policy Unit (DSDHS), as part of the France - ECLAC Work Program, with collaboration from the Germany - ECLAC Cooperation program and FAO/RLC. Relevant inputs have been obtained also from the EC ALCUE-KBBE (Hodson., 2015) and INCO-NET ALCUE-NET (2016) Projects and ongoing work at ECLAC (Aramendis et al., 2018; Rodríguez et al., 2017). The results and principal messages of the discussions will be incorporated in a final version of the concept note, that then serves as one of the GBS2018 formal products.

² The document was prepared by Adrián Rodríguez (UN-ECLAC), Guy Henry (CIRAD/CIAT) and Eduardo Trigo (Ministry of Agroindustry, Argentina). The opinions expressed in the document are responsibility of the authors and may not coincide with those of their institutions.



pathways" were identified, proposing specific roadmaps in line with the resource conditions of the region. These include (Trigo et al., 2015):

- i) *Leveraging biodiversity resources*. This covers all scenarios where the distinctive feature is valorization (domestication, transformation, links to markets, etc.) of biodiversity (discovery of functional traits related to specific sectors and uses, development of new products through innovative transformation, development of markets for local products, etc.);
- ii) *Eco-intensification in agriculture*. This relates to the agricultural practices aimed at improving environmental performance of agricultural activities without sacrificing current levels of production/productivity.
- iii) *Biotechnology applications* (products, tools, and processes). These include industrial tissue culture, marker assisted selection in crop and animal breeding, genetically modified plants and seeds, molecular diagnosis, improving animal reproduction through molecular techniques, modified enzymes, microorganisms and yeasts, etc. This carries over to the management of natural resources, food, fibers and chemical industries, as well as to the supply of energy.
- iv) *Ecosystem services*. They include the processes through which the environment produces the resources used by humans, such as air, water, food, and materials. Due to the special nature of the relationship between natural resources and social and economic activities under a Bioeconomy approach, an ecosystems perspective is a crucial component of any sustainable bioeconomic strategy.
- v) *Material efficiency, biorefinery, and bioproducts*. This refers to the bioenergy sector and the processes focusing on the substitution of fossil fuels for industrial consumption. For instance, ethanol, biodiesel, biogas plants and bioelectricity, as well as the different activities associated to green chemistry.
- vi) *Value chain efficiency/circular economy*. This includes activities that (i) reduce post-harvest losses and food waste at any level they may occur and (ii) aim at the development of the links to markets needed for innovative bio-based products.

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Different countries have developed different bioeconomy development pathways. Examples from some of these countries are provided in Anex 1.

II. Advances in policymaking for the Bioeconomy

In many countries there are currently in place policies which are relevant for the development of the bioeconomy, in areas such as: science, technology and innovation; climate change; sustainable agriculture, livestock and aquaculture; forestry and biodiversity; biotechnology; bioenergy; and the use of residual biomass (Rodríguez et al., 2017). Many of those policies have evolved over time, in response to different national and international political and policy contexts. Within this context, over the last three years several countries have started processes intended to develop bio-economy related or dedicated bioeconomy strategies (Aramendiz et al., 2018).

Argentina is at the forefront of the process that goes back to 2013/14 when the first national Bioeconomy symposia were held aimed at establishing the bioeconomy as a vision of development. and the role of the agricultural and food sectors in its development. The process was regionalized in 2015/16 to allow the provinces to participate in the discussions; and the new administration led the development of an Inter-Ministerial Agreement (MINAGRO / MINCYT / Production / Environment / Interior) for the Development of the Argentine Bioeconomy, which establishes the responsibility for the promotion and policy coordination in the area, through a Board of Directors (National Council of Bioeconomy). The Agreement seeks to establish common criteria, goals and objectives at the national level and coordinate federal Bioeconomy-related interventions and is now working on the design of a roadmap for the development of the Argentine Bioeconomy. To continue the promotion of bioeconomy based production initiatives and support the Agreement activities, MINCYT and MINAGRO, with the support of the Buenos Aires Grain Exchange, have put together an on-line introductory course on the bioeconomy that in its first edition has more than 1000 participants (see <http://www.bioeconomia.mincyt.gob.ar/curso-virtual-introduccion-a-la-bioeconomia-argentina>).



Brazil has carried-out over the years many Bioeconomy-related initiatives, including in the fields of biofuels, biotechnology and low carbon agriculture. However, it is not until recently that the Bioeconomy has been formally recognized as a strategic area, in the National Strategy of Science, Technology and Innovation 2016-2019, identifying strategic lines for its development in the use of biomass, processing and biorefineries and bioproducts. The Strategy foresees the elaboration of an *Action Plan of Science, Technology and Innovation in Bioeconomy*, to promote "the increase of the competitiveness of the national Bioeconomy, through the revision and adaptation of the regulations, the strengthening and the exchange of infrastructures and support for lines of research that focus on innovative solutions for technological problems in the agricultural, industrial, environmental and human health sectors, prioritizing the sustainable use of Brazilian biodiversity and considering aspects related to water, food and energy security and to climate change." Complementarily, the strategy proposes the elaboration of an *Action Plan for Science, Technology and Innovation in Biomass*, as well as the creation of a *Brazilian Bioeconomy Observatory*, for the monitoring of national and international trends related to bioindustry and the scientific and technological development in the areas of interface with biotechnology.

In **Colombia**, in September 2016, President Juan Manuel Santos, in a forum on biodiversity stated that "... the end of the conflict implies the possibility of consolidating a new economy which gets higher returns of our resources and environment (...). We want to get to the year 2025 transformed into a Bioeconomy based on science, technology and innovation, and which makes the most of its immense natural wealth."³. The Bioeconomy is regarded as an alternative to generate economic growth, while conserving natural capital through sustainable use of biodiversity — as an opportunity for the creation of jobs with added value, a tool to improve the productivity and competitiveness of traditional economic sectors and a development alternative for the rural sector. Colombia's National Planning Department - DNP leads a "Mision de Crecimiento Verde" program, that aims to formulate a National Bioeconomy strategy before end of 2018. In 2017, CIRAD and CIAT, together with the Colombian COLCIENCIAS S&T agency, organized a National Forum on the Bioeconomy (Henry et al., 2017).

Costa Rica is considered a leader in policymaking for sustainable development in many Bioeconomy-related areas, such as biodiversity, sustainable tourism and clean energy. The country is currently in the process of accession to the Organization for Economic Cooperation and Development (OECD), which in its revision of the innovation policy (OECD, 2017), has recommended the need to promote innovation to increase productivity, strengthen long-term commitment to science, technology and innovation, strengthen policy coherence and its implementation, and strengthen the contribution of public research to the innovation. The Bioeconomy is being considered an alternative to address those recommendations, as it offers a framework for the design of policies considering the strengths and opportunities that this organization highlights for the country in terms of innovation. For example, strengths in terms of the diversification of the export base, the branding of the country, expertise in some relevant industries (e.g. agro-industry, specialized manufacturing, medical devices, digital economy and ecotourism), the strong commitment to invest in education and exceptional resources of biodiversity as well a great attention to the protection of the environment. To start the development of a national bioeconomy policy / strategy, on November 27, 2017, the Ministry of Science, Tecnology and Telecommunications (MICITT) organized the "First Workshop on Bioeconomy, summary on OECD recommendations", with the participation of public, academic and private sector entities.

In **Ecuador**, the Moreno Administration (2017-2021) has proposed Bioeconomy as an alternative to reduce the heavy dependence on fossil resources, while at the same time taking advantage of the richness and diversity of biological resources. The process started on June 6, 2017, with the seminar "Perspectives to move towards an economy based on biodiversity and eco-systemic services" and since then the Ministry of Environment has assumed the leadership, with a strong biodiversity-based approach to the Bioeconomy. Between June and December 2017, a Working Group on Bioeconomy was set up within the Ministry and a process of conceptualization was carried-out, which has laid the foundations for developing a Public Policy on Bioeconomy. For 2018, the priorities are focused on the consolidation of processes initiated in 2017, including: the preparation of a *National Research Agenda for Innovation on Biodiversity*; the consolidation of a Unit for the Promotion of Bioeconomy and Entrepreneurship in the Ministry of the Environment; the creation of a National Working Group

³ Juan Manuel Santos, President of Colombia, in the "Gran Foro de la Biodiversidad", 14 September 2016. Source: El Compromiso del Gobierno con la Bioeconomía (<http://www.eje21.com.co/2016/09/el-compromiso-del-gobierno-con-la-bioeconomia>)



on Bioeconomy; the creation of a Center for the Promotion of biobusiness; and the preparation of a portfolio of investments and financing of bio-enterprises and bio-industries. In addition, for 2018-2019 it is expected to complete the formalization of a public policy on Bioeconomy, the creation a National Fund for the Promotion of Bio-Entrepreneurship, reaching a National Agreement for Bio-Entrepreneurship, and d) the officialization of the Intersectorial Committee for the Promotion of the Bioeconomy.

III. Examples of companies / experiences / Bioeconomy constructions

The LAC region is already well underway in exploiting the opportunities offered by the Bioeconomy. The region has been for more than a decade among global leaders in exploiting the benefits of the new biotechnologies. Three of the countries in the region are among the top five users of GM crops, and several more are included in the 15 top countries in terms of these technologies. Also, the region shows emerging eco-efficient agricultural practices, such as no-till, precision agriculture, integrated pest and nutrient managements, and organic agricultural approaches. Additionally, the region is also a leader in bio-energy production and is home to several of the early and best-known efforts to institutionalize biodiversity valorization activities. The last couple of years also has seen a profusion of small biotech start-ups, mostly targeting high value niche markets, in many cases developed by young bio-entrepreneurs (see Annex 2). In several countries, circular economy companies have heavily invested in value adding waste streams (e.g. ECLAC, 2018).

The here and there significant advances at technical, economical, scientific, political and institutional level are almost entirely at individual country levels i.e. Brazil, Argentina, Chile, Costa Rica, Colombia, Mexico, Peru etc. Five notable examples, because of the ability to adapt to new needs and contexts, the level diversification and sophistication of bio-based products and market penetration, include:

- *Bioceres (Argentina), an international company leader in biotechnology.* Bioceres is a firm created by a group of soybean farmers which operates through a multi-discipline and multi-product platform capable of providing solutions throughout the entire crop cycle, from pre-planting to transportation. Since its creation it has developed into a fully-integrated provider of crop productivity solutions, including seeds, seed traits, seed treatments, biologicals, high-value adjuvants and fertilizers. Its business model is driven by three key pillars: technology sourcing, product development partnering, and production and market access. It has become an effective flagship agricultural solutions provider, as well as the natural partner for global conglomerates, in Argentina and South America. Among its most important developments are drought tolerant soybean and wheat varieties — which are now in the regulatory cycle — and many joint ventures with national and international partners to work on metabolic engineering solutions and molecular farming. In the last case is soon coming into the market with a chymosin "SPC" (quinoline produced through genetic modification of safflower), produced in cooperation with another Argentinean firm, Porta Hermanos, which — focalizes on alcohol production and has developed the MiniDest concept, a mini distillery for in-site value added to agricultural production under a circular economy approach — has provided the separation technology to extract the enzyme from the safflower. Lately Bioceres is expanding its activities into bioenergy production focalizing in developments based on non-traditional bioenergy crops.
- *Natura (Brazil), a leading global biocosmetic company.* Natura was founded in 1969, focused on the development and commercialization of biocosmetics based on natural products, including native products from the Amazonian biodiversity. With the launching of the Ekos line in 2000, Natura was the first Brazilian company that committed to share the benefits generated by innovations which were possible because of access to genetic resources and traditional knowledge of the communities. The company invests annually 3% of its revenues in innovation; it has registered 11 model and design patents, and its products have copyright and brand protection. Natura is part of the Dow Jones Sustainability Index 2014 (DJSI) of the New York Stock Exchange, it is a B corp certified company and has a carbon neutral program. It has agreements for the supply of natural assets with farms, companies and communities in Brazil and Latin America, including agreements with traditional communities and local providers of genetic resources or traditional knowledge related to native species. These agreements have benefited 1,600 families.
- *Aguas Andinas (Chile), urban circular Bioeconomy.* Aguas Andinas is a utility company responsible for the supply of drinking water and sewage collection for most of the city of Santiago de Chile. It is currently



carrying out a large-scale operation to convert the sewage treatment plants into Biofactories, under a model of circular economy that seeks to transform waste waters into usable natural resources. Activities include: a) Zero sludge going into sanitary landfill (codigestion plant sludges, thermal drying of sludges, gasification of dry sludge); b) Energy Efficiency Plan - ISO 50.001 (new more efficient biological processes, optimization of regulation systems and asset replacement); c) energy self-sufficiency through the development and use of unconventional renewable energy (cogeneration of biogas from digestion, cogeneration of the syngas from the gasification of the biosolids, hydraulic energy from the discharge of the treated water, thermal energy from the cooling of the cogeneration and cooling engines of its exhaust gases); d) methanolization of biogas for domestic and / or vehicular use; e) valorization of the sands obtained in the pretreatment; and f) valorization of elements and compounds of undigested sludge (e.g. phosphorus, humic substances) for use in agriculture.

- *Inbio (Costa Rica), conservation, knowledge and sustainable use of biodiversity.* The National Biodiversity Institute of Costa Rica was established in 1989 as a private center of public interest for research and management of biodiversity, with the purpose of supporting efforts to strengthen the protection and knowledge of biodiversity and promoting its sustainable use. The management model developed by INBIO has been very successful in the development and administration of biological collections to generate knowledge, but without sufficient emphasis on the promotion of its use for potential commercial developments. However, to move in such direction, integrating commercial and market aspects more explicitly into its activities, INBIO is joining the CR-Biomed, a non-profit association created by a group of entrepreneurs, scientists, professionals, members of the academy and representatives of the public and private sectors, to promote and optimize the sectors of the biotechnology, medical devices and sectors related to the life sciences.
- *CIGB (Cuba), developing a world class biotechnology sector.* The Center for Genetic Engineering and Biotechnology, founded in 1986, is the Cuban scientific research center that works in the fields of medicine and biology, to improve human health, agriculture and the environment. It is a leading third world biotechnology center, with significant advances in the development of pharmaceutical and biotechnological products. During the period 2001-2013 developed 41 products, including the Haemophilus B vaccine, MAbs for cancer therapy, DPT vaccine, Meningococcus ACYW135 vaccine, equipment for neurophysiology and neuroinformatics, leptospirae vaccine, salmonella vaccine, and new advanced generics drugs. As of 2015 the CIGB had 171 records of 14 products in 57 countries and exports to 40 countries (including all Latin American countries). It also had 1237 applications and patents (68.5% of patents approved) around the world, including more than 40 or more patents in Canada and the United States (48), Argentina (49), Brazil (45), India (40), People's Republic of China (49), South Africa (42), Europe (51) and Australia (40). In the agricultural sector current initiatives includes development of: recombinant enzymes for diversification of the sugar industry (Kestozyme, invertases, dextranase); veterinary vaccines against PPC, rabbit hemorrhagic fever, and immunogen against ticks; identification of genes for tolerance to salt stress and drought; methods of genetic transformation of crops and genomic characterization studies; and bionematicides and bioproducts.

Besides these well-established initiatives there are many smaller ones that are emerging into the market in different countries of the region. A number of these developments are reported as Annex 2.

IV. Barriers and constraints

A. Regulatory barriers

There are various types of barriers that limit the development of the bioeconomy in the region. Several of them relate to the lack of regulatory frameworks, especially in fields of rapid advancement in knowledge and application of new technologies (e.g. biotechnological applications, such as NBT and industrial enzymes). In other cases, the difficulties lie in the complexity of national regulatory processes (e.g. access to biological resources for research and commerce), weakness in capacities to comply with regulations in destination markets and / or lacking of knowledge of such requirements (e.g. novel food products, biopharmaceuticals and biocosmetics), incompatibility of regulations between conventional products and similar bio-based products (e.g.



bioenergy, biopharmaceuticals, bioremediation, biomaterials), and absence of harmonization in the classification criteria for bio-related products (e.g. functional and novel foods, biopharmaceutics, bio-agricultural inputs).

In Bioenergy regulatory barriers have different facets, depending on the type of energy. In biofuels there are regulations which are difficult to comply with and enforce (e.g. mixing regulations of biofuels-fossil fuels), as well as lack of economic and environmental evaluation, not only in terms of direct and indirect effects on land use, but also on fossil-fuels subsidies or taxes on fossil fuels. Also, lack of legislation to allow the purchase by electric utilities of electricity produced in agricultural operations discourages investments in facilities to produce bioelectricity out of agricultural residues.

B. Market access

There are also barriers to the development of new markets and accessing existing ones, particularly regarding sanitary and phytosanitary measures, technical barriers to trade, pre-shipment inspections and other formalities, as well as intellectual property issues. The lack of the latter being of significant importance in the region. Some are technical barriers specific for the valorization of biodiversity pathway, such as the absence of traceability schemes for biodiversity-related products, and lack of homologated norms among exporter and importer countries. On the path of biotechnological products and processes, market barriers can be grouped into four categories: a) analytical barriers or lack of technical and scientific studies to comply with regulations in destination countries; b) logistic barriers, related to obtaining export certifications, labels and seals (e.g. infrastructure, GMP); c) economic barriers due to the high cost involved to comply with requirements of seals or certification schemes; and d) perception barriers, due to the producer's need to show to the target consumer that their product is harmless and safe.

C. Financing

Lack of financing is recognized as a restriction to innovation in Latin America, especially in new fields such as the Bioeconomy. The public funds available are scarce and usually restricted to initial R & D; the venture capital market hardly exists in most countries; and there is not a culture of investment in innovation by the private sector. There are, however, some mechanisms which have been developed for other purposes, with their own specificities, foci and access rules, which have the potential to support bioeconomy related entrepreneurship in the region. These are of four types: a) public funds in development agencies (e.g. CORFO in Chile; Colciencias in Colombia, Mincyt in Argentina, Concytec in Peru, Conacyt in Mexico, etc.); b) mixed funds (e.g. Bancoldex in Colombia, Fundecooperación en Costa Rica); national and regional private funds (e.g. LP HUB in Argentina, Venture Institute in Mexico, Bioincuba in Peru, Ingenio in Uruguay, Carao Ventures in Costa Rica, Nazca Ventures in various countries, WAYRA, Telefonica Foundation); and regional and global funds (e.g. FONTAGRO, Newton Fund, Multilateral Development Banks).

D. Science, innovation and human resources

For the new bioeconomy science, new knowledge, is needed to solve the values of the equation of producing “more with less”, implied in the concept of the bioeconomy. But new knowledge alone will not do the trick if it is not effectively put to work in transforming existing production patterns; there is also the need to assure appropriate levels of innovative behavior by the relevant economic actors.

A successful transition to the bioeconomy will require both an intensive effort at human resources development and improved mechanisms for social participation. Bio-based processes require not only a new technological base, which in turns reflects in a rearrangement of the scientific skills base for research and development. They do also need changes at the production and management levels as bio-based strategies, usually, are much more knowledge intensive than conventional approaches.

V. Needs and opportunities for regional research and Bioeconomy networks

Many countries in the region have already developed public policies and institutions relevant for the development of the Bioeconomy and there are incentive mechanisms that can be used for such purpose. The elaboration of Bioeconomy strategies in countries of the region, therefore, should start from the identification and articulation of the initiatives that already exist, together with dialogue processes with the private sector and other relevant actors, especially in the academic and research community.



Policy development for the Bioeconomy also calls for the alignment of relevant incentives that already exist in many countries, especially those intended to promote innovation and entrepreneurship; for example, in national science, technology and innovation funds, sectoral funds, payment of environmental services schemes, and existing public, private, mixed public-private, regional and global funds.

A policy framework for the Bioeconomy requires a clear vision and objectives, feasible goals and a well-defined road map. In a region of diversity, the territory should be a fundamental element, recognizing its particularities and potentials. In addition, science, technology and innovation instruments should be developed, as well as economic and fiscal incentives to overcome barriers and induce a broad societal distribution of the economic benefits from the Bioeconomy. In a region where policymaking frameworks change frequently—even within a governmental period—, reaching consensus and stakeholder support for a long-term process is a critical element in policymaking for the Bioeconomy, so that it can stand the test of government changes.

Analyses of regulatory frameworks, incentives to promote (bio) entrepreneurship, and barriers to market access, pose significant challenges for Bioeconomy policymaking. Achieving coherence among objectives and goals of public policies, coordination of interventions within the framework of these policies, adequate timing and rationality of regulations *via-a-vis* the development of knowledge and technologies, the alignment of incentives, and investment in public goods, especially to promote innovation, among others, are recognized as key factors in policymaking for the Bioeconomy in LAC.

Taking advantage of the potential offered by the Bioeconomy requires an adequate knowledge of the base of available biological resources, related scientific and technological capacities and market potential and consumers' acceptance of the new products of the Bioeconomy. It is also widely recognized [6, 7] that developing an inclusive, sustainable and competitive Bioeconomy can be hampered by factors such as the lack of adequate regulatory frameworks, inadequate and incoherent regulatory frameworks, insufficient coordination of existing technical and technological capabilities, market entry restriction to small Bioeconomy-related enterprises, and lack of funding for the creation of innovative Bioeconomy business ventures.

Moreover, as mentioned earlier, most bioeconomy related advances in the region have been at the country level. Besides industrial investments, this also applies to scientific activities and policy development. The few regional science related activities have been mostly part of EC and / or bi-regional research programs. Since 2012, these projects provided the EC with high priority bioeconomy research topics (e.g. new feedstocks, biorefineries, waste streams, bioproducts) to be included in the FP7 and H2020 research calls. In addition, between 2015-17 ALCUE-Net and ERA-NET LAC launched three joint-financed bi-regional research calls on common agenda bioeconomy topics⁴. The result has been that an increased number of LAC country research teams have partnered with European laboratories targeting bioeconomy research. Again, most impacts of these efforts will accrue at individual (LAC) country levels.

However, as discussed earlier, many countries of the region evidence significant adverse (relative to bioeconomy development) policy regimes, adverse (national market) conditions, lack of bioeconomy awareness and capacities/education. There is need for a combined regional integrated Bioeconomy research & policy effort through concerted intra-regional collaboration. There lies a great opportunity for the LAC regional agencies and institutes to play leading and/or facilitating roles, creating the necessary conditions to foster collaboration and as such generate increased economies of scale and efficiencies, besides creating an improved regional identity.

From the ALCUE-KBBE (Hodson, 2015) AND ALCUE-NET initiatives, Aramendis et al. (2018), and the Regional Seminar LAC Bioeconomy (ECLAC, 2018) several agenda themes have been identified, which could be addressed through those regional collaboration mechanisms.

A. *Policy and regulation*

- To accommodate the territorial and landscape specificities in national Bioeconomy policy frameworks to increase the distribution of benefits.

⁴ FP7 ERA NET LAC project: <https://www.eucelac-platform.eu/joint-actions>



- To articulate the national, regional and local levels, through well-designed and participatory processes, that allow to identify relevant regional needs, strategic vocations of territories and the design of supported policy instruments.
- Overcoming trade and regulatory barriers requiring adjustments in relevant formal education programs, technical training, use ICTs and digital technologies, as well as the compatibilization of current regulations and / or the emission of new ones.
- Innovative successful startups and productive Bioeconomy-related ventures should be more widely disseminated in the media, to bring societal attention towards the Bioeconomy and its potential to diversify the economy and articulate new value chains.
- Policy instruments should support and involve all relevant actors, including venture capitalists, investors and regulators.
- Information on innovation-related funding mechanisms needs to be systematized and made available to interested and potential bio-innovators.
- Generate education and dissemination processes so that the public begins to interact with this type of knowledge and with the implications and impacts that it generates (“Bioeconomy pedagogy”)

B. Research

- *Biotechnology themes:* Design and screening of multipurpose crops.
- *Eco-intensification themes:* Biological processing of agricultural and agro-industrial waste.
- *Biodiversity themes:* a) screening for new bioactive metabolites and enzymes from terrestrial and marine microorganisms for industrial use, based on market demand; b) Integrated open-access data bases on native organisms and their functionalities, c) A review of the bio-prospection programs carried out in LAC countries together with a review of the environmental and biodiversity laws/policies, with the objective to identify bottlenecks and challenges, and by doing so being able to propose viable and novel strategies for the region;
- *Bio-refinery and bio-products themes:* a) valorization of agro-industrial and urban residues at current biomass processing and consumption sites; b) Fractionation and valorization of residual biomass to intermediate and/or final high-value bio-based products; c) Ligno-cellulosic bio refinery platform to produce high value bio-based products.
- Across: Support to the development of the Bioeconomy (and circular economy) model in the LAC region including appropriate market and policy measures for new bio-products, bio-services and bio-employment.

C. Innovation and entrepreneurship

- Development of novel instruments to facilitate the interaction between the new Bio-companies and the universities or research centers; specially to promote bio-entrepreneurship among youth.
- Design financial and non-financial instruments to help new bio-companies to reach the world market of the Bioeconomy and enhance their capacities to respond and adapt to the speed of technological change.
- Public-private and regional-multilateral collaboration to strengthen national infrastructures available to comply with requirements in the importing countries of bioproducts, either in the form of infrastructure (e.g. laboratories) of quality certifications (e.g. good manufacturing practices; USDA, USFDA, EU certifications).
- Encourage a culture of entrepreneurship that values freedom of creation and innovation and which does not punish failure.

D. Valorization, market access and development



- Quantification and economic, social and environmental valorization of the potential of bio-products and Bioeconomy-pathways *vis-à-vis* their fossil counterparts.
- Design and disseminate tools to help the academia and private sector deal with regulatory and commercial barriers, both to import sophisticated bio-components and export bio-products.
- Public-private and private-private collaboration to educate consumers on the safety and sustainability of bio-products and create demand and markets for them.
- Taking advantage of the instances already created, such as industry and trade chambers and association and technology transfer offices, to promote collaborative networking, share best business practices and in general to educate and communicate to their communities the opportunities in the Bioeconomy.

VI. Proposals for regional cooperation: networks and platforms

One of the collaborative instruments that seem opportune are regional networks. Regional bodies such as FAO/RLC, UN-ECLAC, CIAT and IICA have become increasingly aware of the significant needs and opportunities offered by the new bioeconomy model. Each of these institutions has a real and concrete offer that together can cover, policy, research, innovation, knowledge diffusion, capacity building, etc. and are already working in a number of initiatives to support bioeconomy development in the region. Some of them include

- IICA's Bioeconomy and value chain development program. Within its new Medium-Term Plan, IICA has given priority to supporting Bioeconomy development in the LAC region. The initial emphasis of the Program will be on the identification of opportunities and policy needs and technical assistance for policy development at country level.
- CIATs **Regional LAC BioSciences Platform** is identifying resources for the establishment of a mechanism to facilitate for the countries of Central America and the Andean Region access to the biosciences platform, as a mean to improve these countries' capacities to use advanced biosciences in the development and transfer of effective technological options for the further development and consolidation of their bioeconomies. It is based on 2 components: (i) training activities (short-term) and (ii) Research services and support, aimed at offering access to scientists in national (public and private) research institutions to advanced infrastructure and advice in support of their research efforts.
- ECLAC is a highly recognized UN regional organization, with extensive experience in the organization of policy dialogues, through conferences, technical workshops and expert group meetings and in sponsoring training workshops, symposia and seminars. ECLAC's mandate includes assisting in bringing a regional perspective to global problems and forums and introducing global concerns at the regional and sub-regional levels. ECLAC is also a reference organization in the region regarding the organization and systematization of statistical information and has expertise in the organization of regional observatories (e.g. Gender, Broad Band, among other).

Besides the above, from the discussions in the working groups organized during the Regional Seminar Bioeconomy Latin America and the Caribbean 2018 76], the following instrument for regional cooperation was identified, that seems most opportune to fit CEPAL's future agenda: Creation and coordination of a **Regional Latin American Bioeconomy Observatory and a Regional Bioeconomy Policy Network**, which among other, contribute to:

- Provide up-to-date relevant information on policies, markets, infrastructures, regulations, and inventories of available biomass;
- Develop methodologies and protocols for the provision of information and the execution of studies in Bioeconomy (comparable and standardized);
- Mapping of national technical resources and capacities for the development of the Bioeconomy.
- Mapping tariff and technical barriers for Bioeconomy related products (e.g. at the 10-digit level of the Harmonized System).



- Exchange of knowledge and capacity development.
- Supporting regional policy dialogue to articulate a vision for the Bioeconomy in the region and support the collaboration among countries currently involved and / or interested in the development of Bioeconomy strategies.

VIII Concluding remarks

The construction of the LAC bioeconomy has been so far, mostly, a trial and error process. Evidence shows a great diversity of cases — many of them with large potential impacts — which have developed in response to market opportunities, evolving from natural resources or scientific capacities strengths, but in a policy environment dominated by political-institutional frameworks that correspond to those of the industrial revolution and the fossil economy. Therefore, a key to the future is the need to rethink new forms of relationship between agriculture and food and between these and the industry. In those relationships new technological concepts and new value networks are generated that allow optimizing the contribution of natural resources with new products, new standards and new norms with different investment requirements.

The process will leave losers (e.g. in the fossil fuel economy) and winners (e.g. in new bio-based value chains) and it will be up to each country what decisions to take to manage the balance among. Also, countries (individually or multilaterally) will need to decide how to include the environmental dimension and internalize costs and externalities in any national or international decision taken in this regard. “De-carbonization” is an objective that increasingly appears in the regional and national discussions, but still it has not gone beyond the recognition of its importance and is hardly reflected in policy and investment strategies. LAC — as one of the major biomass producers at the global level — has a significant role to play in regards to this objective, so its an issue that claims for further work at all levels.

In addressing this challenge, the availability of biological resources (e.g. types, volumes and distribution) to support the development of the Bioeconomy must be assessed against scientific and technological (S & T) capacities. The region is the place for several megadiverse countries, but not all of them have the S & T infrastructures (e.g. biotechnologies) required to take advantage of the full potential that such diversity offers. Likewise, there are countries with higher S & T capacities where the most immediate opportunities are in relatively low-tech domains; for example, the use of agricultural and agroindustry waste biomass. This opens great cooperation opportunities that should be taken advantage of.

Another relevant consideration is the balancing of objectives, especially within the context of the Agenda 2030. For example, the bioenergy pathway can give rise to concerns about trade-offs in the use of land to produce biomass for food or fuels. Given productivity gaps vis-à-vis land and water availability and S & T capacities, the region could develop its Bioeconomy while at the same time it strengthens its contributions to global food security. Economic circularity could be a key element to achieve such convergence, not only because of environmental concerns, but also because of economic reasons.

A final, more political, consideration is related to the history and ways of insertion of the region in the global economy. The Bioeconomy offers an alternative to address the internal territorial and sectoral inequalities that affect most countries (e.g. ag.-industrial, rural-urban; commercial vs. family agriculture), and this is increasingly been recognized and becoming one of the most important drivers for future developments. The challenge is how to “redesign” visions and policies to ensure that it happen differently from how it was in the past: not as choice between agriculture vs. industry as pathways to economic and social progress — an idea that undoubtedly has slowed progress in the past —, but as a complex system of agricultural and industrial input–output relations as the basis of a more sustainable development pathway. In this, the key is how to articulate the gradient of paths that go from biomass to knowledge intensity — taking advantage of the progress in the biological sciences and technologies (e.g. biotechnology, synthetic biology, omics) and the convergence with other related and rapidly evolving fields (e.g. nanotechnology, digital technologies, robotics) —, which is the basis of an inclusive and sustainable Bioeconomy.



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Annex 1
Latin America (10 countries): Bioeconomy activities

Argentina	Precision farming; biotechnology in agriculture and health; bioenergy; agroindustry; biomaterials; biopharmaceutical products
Brasil	Precision farming; biotechnology in agriculture, forestry and health; biocosmetics; bioenergy; food and feed of native plants; organic agriculture; REDD +. biopharmaceutical products
Chile	Agroindustry; aquaculture and fisheries; bioenergy; forestry and wood; agricultural biotechnology and biotechnology applied to mining; functional foods.
Colombia	Biocosmetics; biotechnology in agriculture and health; food and feed of native plants; biopharmaceutical products; Functional Foods; bioinputs for agriculture.
Costa Rica	Organic agriculture; bio-inputs for agriculture; REDD +; ecotourism; biotechnology in agriculture and health; biopharmaceutical products; biocosmetics.
Cuba	Biotechnology in agriculture and health; biopharmaceutical products; bio-inputs for agriculture; GMOs.
Ecuador	Aquaculture and fisheries; biocosmetics; food and feed of native plants; bioenergy; forest and wood.
Mexico	Biotechnology in agriculture and health; bioenergy; agroindustry; food and feed of native plants; bioenergy; biomaterials; bioremediation; biopharmaceutical products; biocosmetics
Peru	Biocosmetics; bio-inputs; bioremediation; food and feed of native plants; functional foods; bioenergy; agriculture and fishing; aquaculture and fishing.
Uruguay	Agroindustry; biotechnology applied to agriculture; biopharmaceutical products



Annex 2
Examples of Bioeconomy related start-ups developed by young LAC bio entrepreneurs

Activity	Innovation and innovation	Name of startup	Web site
Bio-diagnostic	Manuel Rozas, Chile. Extracting β -glucuronidases from <i>Haliotis Rufescens</i> (Red Abalone) for the hydrolysis of clinical and forensic drugs.	KuraBiotech	http://www.kurabiotec.com/
Smart farming	Mariana Vasconsellos, Brazil; ICT platform to connect farmers to their crops	AgroSmart	https://www.agrosmart.com.br/
Biotechnology platform	Said Alejandro Muñoz, Mexico. GEMAS, an intuitive and powerful platform for differential expression analysis of microarray data for a wide range of genomic applications.	Abraxas Biosystems,	https://www.abraxasbiosystems.com
Bio-remediation	Carla Laucevicius, Panamá. Reduction of fats and oils accumulated in wastewater through a cocktail of bacteria.	Toth Research & Lab	http://www.laboratoriototh.com
Bio-plastics and other bioproducts	Scott Munguía, México. Elaboration of bioplastics and other bioproducts from wasted avocado seeds.	BioFase	https://www.biofase.com.mx
	Ana Laborde, México. Generation of bioplastics from waste agave fibers.	BioSolutions	http://www.biosolutions.mx
Bio-energy	Esteban Bermúdez, Costa Rica Delivering techno-economic advice and developing innovative clean energy and biotechnology projects (e.g. generation of energy from pineapple waste).	Escoia	http://escoia.com
New products	Enrique González, México. Extraction of fibers, proteins and antioxidants from fruit and vegetable waste for reuse in food processing.	GeniusFoods	http://geniusfoods.co
	Daniel Méndez, Costa Rica. Production of the enzyme bromelain and microcrystalline cellulose from pineapple waste.	Reuti-piña	http://reuti-pinacr.com
	Myrka Rojas, Diana Mendoza, Luis Mendoza, Costa Rica. Technological platform using microalgae to produce high value compounds, "reinventing natural solutions".	HemoAlgae	http://hemoalgae.com

Source: Own elaboration based on Rodríguez et al. (2008) and presentation at ECLAC (2018).

