C3-BIOECONOMY

Circular and Sustainable Bioeconomy

International Journal of Circular and Sustainable Bioeconomy

C3-BIOECONOMY
Circular and Sustainable Bioeconomy

Index

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa
Junta de Andalucía
Andalucía se mueve con Europa

C3-BIOECONOMY
Circular and Sustainable Bioeconomy

EDITORIAL

José Carlos Gómez Villamandos
President, ceiA3

Dear readers of C3-BIOECONOMY: Circular and Sustainable Bioeconomy:

As president of the ceiA3, I am pleased to welcome you to this first issue of the journal, an international publication centering on innovation related to the Circular and Sustainable Bioeconomy, published annually, and more specifically focused on the agri-food and forestry spheres. The journal aspires to a multisectoral scope, thus accepting works from all sectors in the innovative system, especially business and academia, exploring innovations in food, agriculture and forestry, in addition to bioproducts and bioprocesses related to the agri-food and forestry sectors.

The Bioeconomy encompasses every sector, along with systems based on biological resources, their functions and principles, including agriculture, forestry, fisheries, food and bio-industries, constituting a key force to generate growth in rural and coastal areas. The Bioeconomy Strategy for Europe addresses the production of renewable biological resources and their conversion into essential products and bioenergy.

Since its updating in 2018, the Bioeconomy Strategy has focused on accelerating the deployment of a sustainable European bioeconomy in order to maximize its contribution to the 2030 Agenda and its Sustainable Development Goals (SDGs), as well as to the Paris Agreement: "The Bioeconomy

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa
Junta de Andalucía
Andalucía se mueve con Europa

must be circular, in such a way that biological resources are kept for as long as possible in the production chain, in order to ensure that no resources go unused." A sustainable bioeconomy contributes to the modernization and strengthening of the industrial base through the creation of new value chains and greener and more cost-effective industrial processes. It constitutes the renewable segment of the Circular Economy, able to transform bio-waste, waste and disposables into valuable resources. At the same time it gives rise to innovations and incentives to help retailers and consumers reduce food waste, promoting healthy ecosystems and contributing to their restoration.

We share a joint vision of the future of agriculture, livestock, and our forests, based on a quest for sustainability and food security, quality and safety. In this regard we are faced with two realities: areas and people that require a secure food supply, but also a society characterised by greater demands in terms of food quality and safety, and one that is more sensitive to social, environmental, food waste and animal welfare factors. We must continue working together to tackle these realities, and in this effort the Bioeconomy constitutes a strategy capable of addressing a portion of current concerns.

The Bioeconomy must be a question of social conscience, entailing policies furthering innovative research and activity, but also integrating its content into lines of training and education so that its objectives and approaches affect producers, economic operators and consumers. This is something on which progress is definitely being made, as consumers are demanding a greater environmental commitment from the food production chain, which includes aspects of sustainability, the recycling of materials, reduced carbon footprints, and a commitment by the sector to the sustainable maintenance of our world, in accordance with the motto of the VII World Environmental Action Program "Living well within the limits of our planet".

It is essential that innovation ecosystems, in which governments, universities, the private sector and society converge, talk to each other, share knowledge and

articulate the needs they have so that, together, we are able to respond to these needs and overcome the great challenges that we have ahead to guarantee food supplies and improve food quality and sustainable production.

Favouring alliances between institutions, internationalization, and interconnections between agents are founding principles of the campus. Based on them, and after hard work on the devising, dynamization and pooling of ideas, this journal arose, in which the ceiA3 functions as a catalyst to reflect on policies in the field of the Bioeconomy, gauge the needs of the agri-food sector, and promote links with the scientific community, sharing innovative solutions and success stories with the knowledge network, the sector, and society, all in accord with its Bioeconomy strategy.

Special participation by the IICA and a prestigious group of experts in the field aims to serve as one more instrument to raise awareness and for transfer between the field and society.

After this first issue, which we release with the greatest enthusiasm, I look forward to and expect great participation in the journal and outstanding achievements associated with it.

Sincerely,

José Carlos Gómez Villamandos President, ceiA3

C3-BIOECONOMY
Circular and Sustainable Bioeconomy

EDITORIAL

José Carlos Gómez Villamandos
Presidente del ceiA3

Estimados lectores de la revista C3-BIOECONOMY: Circular and Sustainable Bioeconomy:

Como presidente del ceiA3 me complace daros la bienvenida a este primer número de la revista, una revista internacional de innovación en Bioeconomía Circular y Sostenible, de periodicidad anual y centrada específicamente en el ámbito agroalimentario y forestal. La revista, tiene una vocación multisectorial, aceptará trabajos de todos los sectores del sistema innovador, especialmente del sector empresarial y académico, y versarán sobre innovación en alimentación, agricultura y silvicultura, y bioproductos y bioprocesos relacionados con el sector agroalimentario y forestal.

La bioeconomía engloba todos los sectores y sistemas basados en los recursos biológicos, sus funciones y principios, incluyendo agricultura, silvicultura, pesca, alimentación y bioindustrias, y es un sector clave para incentivar el crecimiento en las zonas rurales y costeras. La Estrategia de Bioeconomía de Europa aborda la producción de recursos biológicos renovables y su conversión en productos fundamentales y bioenergía. Desde su actualización en 2018, la Estrategia de Bioeconomía se centra en acelerar el despliegue de una bioeconomía europea sostenible para maximizar su contribución a la Agenda 2030 y sus

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa
Junta de Andalucía
Andalucía se mueve con Europa

Objetivos de Desarrollo Sostenible (ODS), así como al Acuerdo de París: "La bioeconomía debe ser circular, de manera que los recursos biológicos se mantengan el mayor tiempo posible en la cadena productiva con el fin de lograr que no existan recursos sin aprovechamiento." Una bioeconomía sostenible contribuye a la modernización y el fortalecimiento de la base industrial, a través de la creación de nuevas cadenas de valor y unos procesos industriales más ecológicos y rentables; es el segmento renovable de la economía circular, que puede transformar los biorresiduos, residuos y descartes en recursos valiosos y generar innovaciones e incentivos para ayudar a los minoristas y a los consumidores a reducir el desperdicio de alimentos; y fomenta ecosistemas saludables, contribuyendo a la restauración de los mismos.

Compartimos una visión conjunta del futuro de la agricultura, de la ganadería, de nuestros bosques, hacia la búsqueda de la sostenibilidad y del aseguramiento alimentario, por un lado y, por otro lado, de la calidad y de la seguridad alimentaria. En este sentido, nos encontramos con dos realidades: zonas que necesitan de un abastecimiento alimentario, es decir, personas a las que les tenemos que asegurar esa alimentación, pero también una sociedad con mayores exigencias de calidad y seguridad alimentaria, y que es más sensible a los factores sociales, medioambientales, de desperdicio alimentario o de bienestar animal. Sobre estas realidades debemos seguir trabajando conjuntamente, para lo cual, la Bioeconomía se configura como una estrategia capaz de paliar parte de las preocupaciones presentes.

La Bioeconomía tiene que ser una cuestión de conciencia social, no solamente en aspectos de políticas y de actividad investigadora e innovadora, sino que debe incluir su contenido en líneas de formación y educación para que sus objetivos y planteamientos calen en productores, operadores económicos y consumidores. Es algo que sin duda está evolucionando y es que, los ciudadanos, como consumidores, están exigiendo un mayor compromiso medioambiental de la cadena de producción de alimentos, que incluyan aspectos de sostenibilidad, reciclado de materiales, reducción de la huella de

carbono y el compromiso del sector hacia el mantenimiento sostenible de nuestro mundo, siguiendo el lema del VII Programa Mundial de Acción Medio Ambiental "vivir bien dentro de los límites de nuestro planeta".

Es fundamental que los ecosistemas de innovación, donde administraciones, universidades, sector privado y sociedad se den la mano, se hablen, compartan conocimiento y planteen las necesidades que tienen y entre todos seamos capaces de darle respuesta a esas necesidades y resolver los grandes retos que tenemos por delante en ese aseguramiento de alimentación y en esa mejora de la calidad y de la producción sostenible.

Favorecer la agregación entre instituciones, la internacionalización y la interconexión entre agentes son principios fundacionales del campus y con base a esos principios y tras un intenso trabajo de diseño, dinamización y puesta en común de ideas surge esta revista, donde ceiA3, que actúa como un catalizador para reflexionar sobre las políticas en materia de Bioeconomía, recoger las necesidades del sector agroalimentario y promover su vínculo con la comunidad científica y divulgar las soluciones innovadoras, y los casos de éxito al tejido del conocimiento el sector y la sociedad. Todo ello alineado con su estrategia de Bioeconomía y contando con la especial participación del IICA y un prestigioso elenco de expertos en la materia y pretende ser una vía más de concienciación y transferencia de su ámbito a la sociedad.

Tras este primer número, que lanzamos con gran ilusión, auguro una enorme participación en la revista y grandes logros asociados a la misma.

Reciban un cordial saludo.

José Carlos Gómez Villamandos - Presidente del ceiA3

Bioeconomy, strategies and impact

Alfredo Aguilar[1]

Corresponding Author: alfredo.aguilar@efbiotechnology.org

Abstract:

Bioeconomy has been in existence for fifteen years and in those years, it has spread to more than fifty countries and regions around the world. It emerged as a means of seeking an alternative to an economy based exclusively on the exploitation of oil and other fossil resources. Each specific bioeconomy is adapted by its nature to the climate, agricultural, industrial and socioeconomic development of a country or region and to its political environment. At present, there is a great consensus at a global level that the bioeconomy must be circular, sustainable, use renewable raw materials and accept the ecological limits of the planet. The experience of these years allows us to reflect on how to increase the impact of the bioeconomy by learning from those successful experiences. In this article the following themes are proposed: need for coherence between the bioeconomy and other policies; generate a broad social and political consensus; strategies and action plans must be inclusive and combine strategies with concrete actions. It also advances some considerations between the concepts of bioeconomy, sustainability and biodiplomacy.

Key Words: Bioeconomy, sustainability, biodiplomacy, natural resources, circular economy

Bioeconomía, estrategias e impacto

Alfredo Aguilar[1]

Resumen:

La bioeconomía tiene quince años de existencia y en esos años se ha extendido por más de cincuenta países y regiones de todo el mundo. Surgió como medio de buscar una alternativa a la economía basada exclusivamente en la explotación del petróleo y de otros recursos fósiles. La bioeconomía se adapta por su naturaleza al clima, desarrollo agrícola, industrial y socioeconómico de un país o región y a su entorno político. En la actualidad, hay un gran consenso a nivel global sobre el hecho de que la bioeconomía ha de ser circular, sostenible, usar materias primas renovables y aceptar los límites ecológicos del planeta. La experiencia de estos años permite reflexionar sobre la forma de incrementar el impacto de la bioeconomía aprendiendo de aquellas experiencias exitosas. En el presente artículo se postulan los siguientes temas: necesidad de una coherencia entre la bioeconomía y las otras políticas; generar un amplio consenso social y político; las estrategias y los planes de acción deben de ser inclusivos y combinar

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa

Junta de Andalucía

Andalucía se mueve con Europa

estrategias con acciones concretas. Se avanza asimismo unas consideraciones entre los conceptos de bioeconomía, sostenibilidad y biodiplomacia.

Palabras clave: bioeconomy, sostenibilidad, biodiplomacia, recursos naturales, economía circular

[1] Working Group Bioeconomy, ESAB, European Society for Applied Biocatalysis, Frankfurt Am Main, Alemania; Ex – Jefe de Unidad Biotecnologías, (Comisión Europea), Bruselas (Bélgica), alfredo.aguilar@efbiotechnology.org.

1. REASONS FOR A BIOECONOMY

The reasons prompting the two great regions on the planet, the European Union (EU) and the USA, in the first decade of the 21st century, to develop initiatives in favour of a Bioeconomy were different. Consequently, their objectives, strategies and initiatives also diverged. The EU furnished the concept of the Bioeconomy with a solid scientific and technical foundation in order to develop the scientific knowledge to make the planet "greener" and less dependent on oil. Thus, the concept of the Knowledge-Based Bioeconomy (KBBE), was advanced in 2005 by the European Commission and, two years later, by Germany, which at that time occupied the presidency of the EU. This was the first decisive step to defining a framework for action and ensuring that policies in other areas - like agriculture, industry and the environment, among others - would concur with the new concept of the Bioeconomy. A few years later, in 2012, the EU adopted the Bioeconomy Strategy (European Commission, 2012). It is important to note that none of these documents just fell out of the sky, or were the result of mere improvisation. 10 years had passed between the adoption of a European strategy on Biotechnology (European Commission, 2002) and the strategy on the Bioeconomy; and 30 years since the first European biotechnology programme, and the adoption of the Bioeconomy Strategy (Patermann & Aguilar, 2018) (Aguilar et al, 2013). It is important to highlight this aspect since initiatives of this magnitude not only require decision and clear political initiatives, but also a variety of management instruments, maturity in sectoral policies, and broad socio-economic and political consensus. Without these essential elements, it is very likely that an initiative, no

matter how laudable, will fail due to the difficulty of its implementation, or a lack of follow-up.

The USA, meanwhile, based its strategy on ensuring its energy supply as far as possible at a time when its political relationships with several oil-exporting countries were strained (National Bioeconomy Blueprint, 2012). Its main objectives were to stimulate economic development based on innovation and to bring these innovations to the market in a way that allowed the US to maintain its leadership in innovation-related areas.

In the years after 2012, more than 50 countries around the world developed initiatives or strategies in relation to the Bioeconomy. The constraints of this article do not allow us to carry out an analysis - even a superficial one - of each and every one of these initiatives and strategies. Interested readers may consult the references published by the Office of the German Bioeconomy Council, where the different initiatives that exist today are described (Bioeconomy Policies Part I, Part II & Part III). Many of these initiatives were inspired by the strategies of Germany, a pioneering country in Bioeconomy, the EU, and the United States. Perhaps as surprising as the number of national strategies, and many more regional ones, is their diversity. Contrary to what some have articulated in an excessively reductionist way, a single Bioeconomy does not exist, but rather a great diversity of bioeconomies, each adapted to specific climates, agricultures, socio-economic and scientific-technical development, etc. However, it is necessary to insist on the fundamental characteristic that all bioeconomies must feature: the development of a socioeconomic system based on the sustainable use of biological resources, while respecting the ecological limits of the planet.

While a knowledge base was the starting point for the EU Bioeconomy, this approach has been complemented over the years by a more holistic vision based on making the Bioeconomy compatible and synergistic with other Community policies, while at the same time seeking clear and

resounding support from society. To be successful the Bioeconomy needs to strike and maintain a delicate balance between the impetus of science and technology, mainly supported by the public sector, and of the market and society, stimulated, in turn by, the agricultural, industrial and financial sectors, all within a coherent policy framework. In each of these stages widespread social consultation, participation and support in preparation and decision-making is absolutely essential. In this regard, in 2018 the EU adapted its Bioeconomy Strategy of 2012, in which aspects such as sustainability and the Circular Economy, as well as the need to know the ecological limits of the Bioeconomy, became inseparable parts of the concept (European Commission, 2018).

In recent years a broad social movement has emerged around the world, mainly comprised of young people, demanding from those in power a more rational use of biological resources, and changes to an outdated productive system that functions at the expense of young people's futures. There are incipient initiatives in this direction, undertaken by both institutions and individuals, to ensure that the fight against global warming and population growth, for food security, and for the preservation of the environment, including that of the oceans, is approached from a global perspective. In this way the interests of humanity as a whole may prevail over legitimate, but more limited, national or regional priorities (Marvik & Philp, 2020) (Aguilar & Patermann, 2020). In this regard "biodiplomacy" has been proposed as a new instrument, in addition to the existing ones, for the global, efficient management of biological resources and to deal with the major challenges that the planet faces, such as climate change, food security, and the increase in the population, among others (Aguilar & Patermann, 2020).

At the Global Bioeconomy Summit 2020, (GBS2020) the IACGB (International Advisory Council on Global Bioeconomy) published its fourth report, featuring a very interesting, critical analysis of the evolution of policies

and initiatives in different countries around the world in relation to the Bioeconomy, as well as its evolution in recent years. Of particular interest in this context was the communiqué, or final statement, of the GBS2020, which provides guidance on the different sensibilities and global challenges facing the world in relation to the Bioeconomy (IACGB, 2020).

It is clear that the Bioeconomy is destined to play a key role on the political and social agendas of tomorrow in the short and medium term. However, degrees of involvement and political and social commitment will largely depend on the way in which the Bioeconomy, or bioeconomies, respond to the social demands to address and solve, or at least mitigate and adapt to, the global challenges that humanity has been facing. It is important to remember, once again, that the Bioeconomy is not a scientific discipline, nor is it a technology, or even an industrial sector. The concept of the Bioeconomy is generated by the amalgamation of all these disciplines, technologies and agricultural and industrial sectors, integrated into a socioeconomic context and with the political objective of managing the use of natural resources in a sustainable and economically viable way (Aguilar et al., 2019).

2. THE BIOECONOMY AND OTHER POLICIES

One of the most important aspects in the development of a Bioeconomy strategy is ensuring coherence with other policies and initiatives, both national and regional, as well as the support of the different socio-economic sectors. The need to engage society as a whole in each and every one of the stages, both of preparation and implementation, cannot be stressed enough. As the Bioeconomy is an activity that aspires to have a positive socioeconomic impact, its implementation must be harmonious, coherent and synergistic with other existing policies.

It is particularly important to guarantee maximum connection and interaction with what might be called "traditional" agricultural, industrial, and environmental policies. Quite a few of the benefits of the Bioeconomy, such as new jobs and technologies, and a positive impact on the environment, among others, will be generated where these policies interface with the Bioeconomy. It is critical, therefore, to nurture these interactions and promote dialogue, assistance and attention, with a view to allowing both traditional policies and the Bioeconomy to emerge strengthened from them. Some of the initiatives of the European Union in which there have been positive mutual interactions between the Bioeconomy and other policies are described very briefly below. Given the complexity of these multiple interactions, only those EU initiatives closely related to research and innovation will be mentioned:

- Food 2030. In this 2015 initiative the EU prioritizes food security in Food and Nutrition through the production of sustainable and healthy food that is accessible to the entire population (European Commission, 2015).
- Blue Growth. This initiative seeks to serve as an EU response to the United Nations Sustainable Development Agenda, in particular to its Objective 14: "Conserve and sustainably use the oceans, seas and marine resources" (European Commission, 2019).
- Bio-Based Products and Processing. This joint initiative of the European Union and European bioindustries aims to promote and develop new technologies favouring the sustainable transformation of renewable biological resources (EU Regulation No. 560/2014) (Mengal et al, 2018) (Ruíz Sierra et al, 2020).
- International Bioeconomy Forum. The aim of this initiative is to ensure that the Bioeconomy is assigned the importance it deserves at the international level, in concert with ongoing global initiatives, such as COP21, the SDGs (Sustainable Development Goals), the Circular Economy, and food security, while promoting research and innovation

internationally to help achieve the political objectives of the Bioeconomy (European Commission, 2020).

EU authorities recently adopted the European Green Deal initiative. This ambitious undertaking, of great political significance, aims for Europe to become the first climate-neutral continent by 2050. The Green Deal features a roadmap to provide the EU with a sustainable and prosperous economy. The attainment of this objective will require the transformation of climate and environmental challenges into opportunities in all areas so that a just and inclusive transition is achieved for all (The European Green Deal, 2019). The European Green Deal establishes an action plan to promote the efficient use of resources by moving towards a clean and circular economy, as well as restoring biodiversity and reducing environmental pollution. The Green Deal also describes the necessary investments and the financing tools available, and explains how to ensure a just and inclusive transition. To achieve this ambitious goal, it will be necessary to act in every sector of our economy, across each and every country and region in the EU. In particular, this will be done by investing in environmentally friendly technologies, supporting innovative industry, and developing and deploying cleaner, cheaper and healthier public and private transport systems for users, living beings and the environment; and by helping to decarbonize energy and ensure that buildings are more energy efficient. Finally, the EU aims to take the lead at the international level, collaborating with other regional and international partners to improve global environmental standards.

The EU will also provide financial support and technical assistance to help those individuals, businesses and regions most affected by the transition to the green economy. This is called the Just Transition Mechanism. It will help marshal at least €100 billion over the period from 2021 to 2027 in the most affected regions.

The European Green Deal features many elements that converge with the

European Bioeconomy Strategy, although these synergies have not been outlined in the former's initial documents. The subsequent execution of the Green Deal's actions and programmes, as well as the European Bioeconomy Strategy, should illustrate in a more visible way these actions' greater synergy and convergence.

Beyond the EU, representatives of the Organization for Economic Cooperation and Development (OECD) and Norway, have pointed to the vital need to integrate the concept of the Bioeconomy into a broader perspective related to a renewable carbon cycle strategy integrating biomass production into the industrial carbon cycle (11). This line of thought coincides with that previously advanced by Aguilar and Patermann (2020), who indicated the pressing need to address in a global way the great challenges that humanity faces at this time, as, if nothing is done, they will worsen, irreversibly. These authors argue that it is not possible to address the great challenges of the planet in a sectoral or piecemeal way, which, as mentioned above, are well known: climate change, food security, and the increase in the population, among others. Each of these challenges has innumerable consequences in different areas and sectors of our lives.

Furthermore, the challenges we face are inextricably linked. It is naïve to think that the only effect of climate change is global warming, and that by fighting global warming from a reductionist perspective, the problem will be solved. Climate change will have (in fact, it is already having) devastating effects on agriculture in certain countries, and the transmission of zoonoses, and other diseases, with this triggering migrations and the displacement of human populations of unthinkable dimensions and consequences, including in terms of security and armed conflicts. Therefore, a holistic approach is required, guided by the United Nations and supported by the regions and countries committed to these sustainable policies, serving as a stimulus and catalyst encouraging other countries to join this collective effort. For this

process to be successful, it is necessary to replace - at least as regards the management of the planet's biological resources - the classic diplomacy of countries, in which national interests prevail over collective ones, with biodiplomacy, in which the global interests of humanity come first. Our survival as a species, at least in the way we know it today, will depend on the way in which political leaders become aware of the dimension of the problems that humanity as a species faces, and broaden their horizons and fields of political vision. Interested readers can consult reference No. 12, featuring a more extensive discussion of the interactions between the Bioeconomy, biodiplomacy and the planet's global challenges related to the biosphere.

The Club of Rome recently published a study, complementing the previous one, indicating the catastrophic consequences entailed by the continuation of current economic models, which are unsustainable, as they prey on the environment and surpass the planet's ecological limitations (ULRICH VON WEIZSÄKER & WIJKMAN, 2018). This work also analyses some of the new economic theories that have been developed in recent decades calling for sustainable economic development and biological resource exploitation, thereby guaranteeing resources for future generations.

The concept of the Bioeconomy has evolved greatly since its advent 15 years ago. In 2009 the OECD defined the Bioeconomy in a rather restrictive way: "The Bioeconomy involves economic activities related to the invention, development, production and use of biological products and processes" (The Bioeconomy to 2030, 2009). In other words, the Bioeconomy was considered one like others, but one based on products of biological origin. The EU, in its 2012 European Bioeconomy Strategy, stated that, "The Bioeconomy deals with those parts of the economy that use renewable biological resources from land and sea, - such as crops, forests, fish, animals and microorganisms - to produce food, materials and energy." European Commission (2012). In this case, the concept of renewable resources was introduced. Later, the 2015

Global Bioeconomy Summit (GBS) integrated the concept of sustainability into the definition of Bioeconomy: "The Bioeconomy consists of the production and use of biological resources based on innovation and biological knowledge, processes and principles to provide goods and services in a sustainable way in every economic sector" (Bioeconomy Summit Global Communiqué, 2015). It was not until 2018, however, that the EU's review of the Bioeconomy Strategy included the concepts of sustainability, the Circular Economy, and, above all, the need to know and understand the ecological limits of the Bioeconomy, which then became integral parts of the concept (European Commission, 2018).

3. THE IMPACT OF THE BIOECONOMY: LESSONS FOR THE FUTURE

Until very recently, the Bioeconomy, or rather, the different strategies of bioeconomies, have been developed in a "top down" manner. Generally, they had come from political circles, and been based on technical and scientific sectors and scientific and technological knowledge of living beings. For more than a decade these approaches have served to build the scaffolding needed to take the requisite actions to implement the Bioeconomy. Given the high level of specialization of some contents of the Bioeconomy, these approaches may have been, despite some criticisms, the only ones possible under the circumstances in which they were adopted. It is necessary to recognize that a good number of these strategies were very successful, and continue to yield concrete actions and projects having a visible impact on society and the socioeconomic fabric. However, the strategies of a good number of countries and regions developed without this consensus often had a limited impact on their respective societies.

An exhaustive analysis of the reasons why a certain number of Bioeconomy strategies and initiatives have not had an impact on the social and economic

fabric would require a much more in-depth discussion than this article can provide. However, some of the factors that may have impeded the implementation of otherwise sound Bioeconomy strategies are briefly outlined below.

The need for a broad social and political consensus. The first has been some leaders and institutions thinking that the development of a strategy was an end in itself, rather than the beginning of a long process to culminate in the incorporation of sound Bioeconomy practices into society. Some of these strategies have been limited to political declarations of intent, lacking real work and follow-up plans. Also, the Bioeconomy has often been seen by many leaders as party initiatives. Thus, changes in the parties in power have led to the abandonment of the Bioeconomy initiatives undertaken by previous ones. Those strategies that have been successful in terms of their implementation and social acceptance have featured widespread dialogue with scientific, technical, and industrial actors in each and every one of the stages of strategy preparation, and in the execution of action plans. Moreover, efforts to establish a broad consensus with other political forces were made. This process undoubtedly retards the development of the strategy, but it allows for the gauging of sensibilities and specific aspects that are important to certain sectors. It also allows the majority of society and its representatives to take on joint responsibility for planning and managing strategies, and their action mechanisms.

Strategies and their action plans must be inclusive. A factor critical to broad social acceptance is paying particular attention to not excluding any social sectors from the positive, beneficial aspects of the Bioeconomy. A strategy that supports and benefits a certain sector at the expense of another, or whose possible benefits do not encompass all social actors, will probably be short-lived. A quintessential example of this is the initial development of GMOs (Genetically Modified Organisms) back in the 1980s, whose benefits were

approached almost exclusively with reference to seed producers and farmers, while the public was all but ignored. The result is well known, and should serve as a lesson that is learned once and for all: in areas in which scientific-technical aspects converge, having a broad social impact on very sensitive sectors, such as food, environment, health, etc., it is absolutely essential to reach a broad social consensus. This social consensus is based on several factors: reliable and accurate information, dialogue in which everything is on the table, and in which all actors and sectors with legitimate interests in the issue are welcome; and, finally, a process of co-decision and co-governance that favours joint responsibility in decision-making. Scientific evidence and technological reliability are absolutely essential elements, but it is critical for a successful implementation of a Bioeconomy strategy to generate a climate of trust between the different actors sharing a common objective.

Combining strategies with concrete actions**.** The Bioeconomy is not developed through the devising of ambitious strategies alone, nor through the execution of projects that are dissociated from one another, lacking a shared strategy. Unfortunately, there are many examples illustrating that strategies conceived and developed without sufficient dialogue and social consensus, and without a corresponding action plan, have little impact. Meanwhile, projects and actions without any strategic planning or follow-up on results and impact generally have only fleeting mobilisation effects, lasting only as long as the actions and projects last. It is necessary, therefore, to inextricably combine strategies with concrete actions that yield visible results. In this regard, it is critical to integrate high-level concepts such as:

- the preservation of our planet's natural capital, both biological and non-biological;
- connecting economy and ecology;
- maintaining the biosphere's conditions of sustainability and habitability.

Concrete and verifiable actions should include:

- very specific actions, with a concrete and measurable impact on the area in question;
- programmes and action plans leading to the creation of jobs, programmes and plans favouring the development of sustainable economic growth. All these specific actions should be evaluated by independent committees. This area has recently been covered in depth by Wohlgemuth et al (2021).

4. BIOECONOMY, SUSTAINABILITY AND BIODIPLOMACY

Perhaps the most important shift in the development of the Bioeconomy in recent years has been the incorporation of the concept of sustainability into local ecosystems and the framing of the Bioeconomy taking into account the ecological limits of the planet at a more global level. In the face of the predatory attitude adopted in the last two centuries with respect to the extraction and consumption of fossil fuels, the Bioeconomy embraces these two key concepts as keystones of its action. It is not possible, though some have tried, to simply transfer, in a mechanical way, the economic model of an economy based on fossil resources over to the Bioeconomy. In a recent monograph on which numerous Spanish-speaking authors collaborated, the concepts of the Bioeconomy are discussed against the backdrop of sustainability, the development of a circular Bioeconomy, and its relationship to society as a whole (Aguilar et al, 2018).

The Bioeconomy is an activity that, by its very nature, encompasses numerous industrial, agricultural, scientific-technical and, of course, social sectors, of which it is not possible to have a reductionist vision. In this regard the Bioeconomy aims to contribute, with all its potential, but also aware of its limitations, to the discussions that are currently taking place on a global scale about the great challenges facing the planet. The development of

biodiplomacy has recently been proposed, which, adopting a sustainable circular Bioeconomy as a conceptual basis, articulates and manages the planet's biological resources. This management should be radically different from what has been done with fossil resources so that biological resources can be guaranteed for future generations, while ensuring the sustainability of our planet (Aguilar & Patermann, 2020). Thus, the authors also propose that the planet's great challenges, such as food security, population increase, climate change, and environmental preservation, among others, be tackled in an integrated way and managed by the United Nations on the basis of biodiplomacy, accepted by a significant number of countries.

In short, the Bioeconomy is destined to play a very important role in our societies. For this, a change in our productive and resource consumption paradigm is necessary to ensure the sustainability of biological resources, today and tomorrow. This attitude concerns all of society: scientists, technologists, farmers, businessmen, financial institutions, etc. The fate of future generations depends on our responsible and determined attitude.

REFERENCES

AGUILAR, A., MAGNIEN, M. & THOMAS, D. (2013). Thirty years of European biotechnology programmes: from biomolecular engineering to bioeconomy. New Biotechnology, 5, 410-425. https://doi.org/10.1016/j.nbt.2012.11.014.

AGUILAR, A. & PATERMANN, C. (2020). Biodiplomacy, the new frontier for bioeconomy. New Biotechnology, 59, 20-25. https://doi.org/10.1016/j.nbt.2020.07.001.

AGUILAR, A., RAMÓN, D. & EGEA, F.J. (Eds.) (2018). Bioeconomía y desarrollo sostenible. Cajamar Caja Rural. Recuperado de: https://www.publicacionescajamar.es/publicaciones-

periodicas/mediterraneo-economico/mediterraneo-economico-31-bioeconomia-y-desarrollo-sostenible.

AGUILAR, A., TWARDOWSKI, T. & WOLHGEMUTH, R. (2019). Bioeconomy for sustainable development. Biotechnology Journal, 14(8), 1800638, 1-11. https://doi.org/10.1002/biot.201800638.

Bioeconomy Policy-Synopsis and Analysis of Strategies in the G7. (2015). Berlin, Office of the German policy Council. Recuperado de: https://gbs2020.net/wp-content/uploads/2020/04/BOER_Laenderstudie_1_.pdf.

Bioeconomy Policy (Part II). Synopsis of National Strategies around the World. (2015). Berlin, Office of the German policy Council. Recuperado de: https://biooekonomierat.de/fileadmin/international/Bioeconomy-Policy_Part-II.pdf.

Bioeconomy Policy (Part III) Update Report of National Strategies around the World. (2018). Berlin, Office of the German policy Council. Recuperado de: https://biooekonomierat.de/fileadmin/Publikationen/berichte/GBS_2018_Bioeconomy-Strategies-around-the_World_Part-III.pdf.

Communiqué Global Bioeconomy Summit 2015. Making Bioeconomy work for Sustainable Development. (2015). Global Bioeconomy Summit. Recuperado de: https://gbs2015.com/fileadmin/gbs2015/Downloads/Communique_final_neu.pdf.

El Pacto Verde Europeo. Comunicación de la Comisión al Parlamento Europeo, al Consejo, al Comité Económico y Social y al Comité de las Regiones. COM/2019/640 final. (2019). Recuperado de: https://eur-lex.europa.eu/legal-content/ES/TXT/?uri=CELEX:52019DC0640.

En route to the Knowledge-Based Bio-Economy in Europe (2007). German Presidency of the European Union. Cologne. Recuperado de:

https://dechema.de/dechema_media/Downloads/Positionspapiere/Cologne_Paper.pdf.

European Commission (2002). Life sciences and biotechnology, a strategy for Europe. Communication from the Commission to the European parliament, the Council, the Council, the Social and Economic Committee and the Committee of the Regions. Recuperado de: https://eur-lex.europa.eu/%20LexUriServ/LexUriServ.do?uri=COM:2002:0027:FIN:EN:PDF.

European Commission (2012). Innovating for sustainable growth. A bioeconomy for Europe. Recuperado de: https://ec.europa.eu/research/bioeconomy/pdf/official-strategy_en.pdf.

European Commission. (2018). A sustainable bioeconomy for Europe: strengthening the connection between economy, society and the environment. Updated bioeconomy strategy. Recuperado de: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_strategy_2018.pdf.

European Commission. (2020). World Bioeconomy Forum 2020. Recuperado de: https://ec.europa.eu/jrc/en/event/conference/world-bioeconomy-forum-2020.

European Commission. International ocean governance: an agenda for the future of our oceans. (2019). Recuperado de: https://ec.europa.eu/maritimeaffairs/policy/ocean-governance_en.

European Commission, Food 2030. (2015). Recuperado de: https://ec.europa.eu/info/research-and-innovation/research-area/bioeconomy/food-2030_es.

International Advisory Council on Global Bioeconomy, IACGB. (2020). Expanding the Sustainable Bioeconomy – Vision and Way Forward. Communiqué of the Global Bioeconomy Summit 2020. Recuperado de:

https://gbs2020.net/wp-content/uploads/2020/11/GBS2020_IACGB-Communique.pdf.

International Advisory Council on Global Bioeconomy, IACGB. (2020). Global Bioeconomy Policy Report (IV): A decade of bioeconomy policy development around the world. Recuperado de: https://gbs2020.net/wp-content/uploads/2020/11/GBS-2020_Global-Bioeconomy-Policy-Report_IV_web.pdf.

MARVIK, O.J., PHILP, J. (2020). The systemic challenge of the bioeconomy. A policy framework for transitioning towards a sustainable carbon cycle. EMBO Reports, 21(10), 1-6. https://doi.org/10.15252/embr.202051478.

MENGAL, Ph., WUBBOLTS, M., ZICA, E., RUIZ, A, BRIGITT, D., PIENIA, A. & BLACK, S. (2018). Bio-based Industries Joint Undertaking: The catalyst for sustainable bio-based economic growth in Europe. New Biotechnology, 40 Part A, 31-39. https://doi.org/10.1016/j.nbt.2017.06.002.

National Bioeconomy Blueprint (2012). The White House. Washington. Recuperado de: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf.

PATERMANN, C. & AGUILAR, A. (2018). The origins of the bioeconomy in the European Union. New Biotechnology, 40 Part A, 20-24. https://doi.org/10.1016/j.nbt.2017.04.002.

Reglamento (UE) n ° 560/2014 del Consejo, de 6 de mayo de 2014, por el que se establece la Empresa Común para las Bioindustrias. Diario Oficial de la Unión Europea. L 169/130, 7.6.2014, p. 130–151. Recuperado de: https://eur-lex.europa.eu/legal-content/ES/TXT/PDF/?uri=CELEX:32014R0560&from=ES.

RUIZ SIERRA, A., ZICA, E., LANGE, L., LLORENTE RUIZ DE ARZÚA., P., CANALISA, A., MALLORQUÍN ESTEBAN, P., PAIANO., P. & MENGAL, Ph. (2020). The bio-based industries joint undertaking: A high impact initiative that is

transforming the bio-based industries in Europe. New Biotechnology, 60, 105-112. https://doi.org/10.1016/j.nbt.2020.09.003.

The Bioeconomy to 2030: designing a policy agenda. (2009). OECD. Recuperado de: https://www.oecd.org/futures/long-termtechnologicalsocietalchallenges/thebioeconomyto2030designingapolicyagenda.htm.

ULRICH VON WEIZSÄKER, E. & WIJKMAN, A. (2018). Come on! Capitalism, short-termism, population, and the destruction of the planet. Club of Rome. New York, Springer.

WOHLGEMUTH, R., TWARDOWSKI, T. & AGUILAR, A. (2021). Bioeconomy Moving Forward Step by Step – A Global Journey. New Biotechnology, 61, 22-28. https://doi.org/10.1016/j.nbt.2020.11.006.

The bioeconomy as a tool for sustainable economic growth

Manuel Lainez[1]

Corresponding Author: manuel@lainezbtc.com

Abstract:

Technological development has made it possible to diversify the products obtained in the framework of the bioeconomy, from food, to forest products, textiles, energy, extracts, active compounds and a wide range of bioproducts. The new socio-economic context, in which it is essential to decarbonize and promote the circular economy, has furthered the development of the circular bioeconomy, especially within the new framework of the European Union Green Deal. The use of biomass generated in Spain, especially residual biomass from the agri-food, forestry and urban spheres, both from MSW and sewage sludge, constitute an opportunity for economic development. The technologies that are being developed make it possible to obtain basic chemical compounds, fuels, biopolymers, and compounds apt for different types of activities and functions, potential raw materials for new economic activity. The challenges and opportunities involved in the development of the bioeconomy in Spain are analyzed, as well as the need to carry out an analysis of the life cycle of the products that are going to be placed on the market, both those for end consumers and those supplied to industrial sectors. Traditional industrial sectors, such as energy, waste management, textiles, construction, packaging, motor vehicles, machinery and equipment, can represent opportunities for business for activities linked to the bioeconomy through the generation of bioproducts.

Key Words: Circular bioeconomy, bioproducts, industrial sectors, Green Deal

La bioeconomía como herramienta para el crecimiento económico sostenible

Manuel Lainez[1]

Resumen:

El desarrollo tecnológico ha permitido diversificar los productos obtenidos en el marco de la bioeconomía, desde los alimentos, los productos forestales, los textiles y la energía, hasta los extractos y compuestos activos y una amplia gama de bioproductos. El nuevo contexto socioeconómico, en el que es imprescindible descarbonizar la economía o promover la economía circular, ha impulsado el desarrollo de la bioeconomía circular, especialmente en el marco del nuevo marco del Green Deal de la Unión Europea. La utilización de las biomasas generadas en España, especialmente las residuales procedentes del ámbito agroalimentario, del forestal, del urbano, tanto de los RSU como de los lodos de depuradora, son una oportunidad para el desarrollo económico. Las tecnologías que se están desarrollando permiten obtener compuestos químicos básicos, combustibles, biopolímeros, o compuestos con distintos tipos de actividad y funcionalidad, que pueden ser las materias primas para una nueva actividad económica. Se analizan los retos y las oportunidades para el desarrollo de la bioeconomía en España, así como

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa
Junta de Andalucía
Andalucía se mueve con Europa

la necesidad de realizar un análisis del ciclo de vida de cualquiera de los productos que se vayan a poner en el mercado, tanto los que vayan al consumidor final como los que se suministren a los sectores industriales. Los sectores industriales tradicionales como el de la energía, el de la gestión de residuos, el textil, el de la construcción, el del envase y embalaje, el de los vehículos a motor o el de la maquinaria y equipos, pueden suponer una oportunidad de negocio para las actividades ligadas a la bioeconomía, a través de la obtención de bioproductos.

Palabras clave: Bioeconomía circular, bioproductos, sectores industriales, Pacto Verde

[1] Director de Lainez Biotrends Consultoria Estratégica, (España), manuel@lainezbtc.com.

1. INTRODUCTION

The Bioeconomy encompasses the set of all economic activities related to the production, transformation and use, directly or indirectly, of resources of biological origin. It consists, according to *Ronzón et al* (2020), of producing and transforming biomass for the supplying of food, feed, materials, energy and services related to citizens.

Traditionally the Bioeconomy has encompassed the production of food, forest products, textiles and energy. However, thanks to the development of different technologies the number of end products derived from it has grown, by obtaining extracts or active compounds, applied to nutrition and pharmacy, and their transformation into diverse biocomposites, such as bioplastics and biofuels.

Thus, the Bioeconomy constitutes a key activity in the European Union and in Spain. According to the Knowledge Bioeconomy Centre (KBC, 2020), belonging to the JRC, in 2017 it employed around 17.5 million people and generated approximately 614 billion euros of added value. This represents around 8.9% of the EU-27 workforce and generates 4.7% of the EU-27 GDP. In Spain, according to the same source, it generated a sales volume of €219 million in 2017, representing added value of €65 million. In addition, it employed 1.42 million people. Therefore, as a country, we represent 8% of employment, 10% of sales, and 11% of the value added of the Bioeconomy Community.

In recent months, the Circular Bioeconomy has been considered an important component in the framework of the architecture of the Green Deal advanced by the President of the European Commission (Ronzón *et al* 2020). This new concept arises from the interaction between the Bioeconomy and the Circular Economy, and common aspects, including the improved use of resources, eco-efficiency, reduced carbon footprints, lower demand for fossil fuels, and waste recovery (Carrol and Dammer, 2018). However, as they indicate in their work, the Circular Economy is not complete without the Bioeconomy, and vice versa.

The European Green Deal has been identified by the European Commission as a way to endow the EU with a sustainable economy, with the understanding that the realisation of this objective will transform climate and environmental challenges into opportunities in all policy areas, achieving a fair and integrative transition for all (EU, 2020). In this article we will endeavour to show why the Bioeconomy lies at the centre of these new policies.

2. THE GLOBAL AND EUROPEAN SOCIO-ECONOMIC CONTEXT

2.1 Climate change

Over the course of the 20th century, and particularly in the last two decades, we have observed a continuous increase in average global temperatures. The years 2015 to 2018 saw the highest average temperatures since measurements were taken and records are available. The global average annual temperature today is (EU, 2019) 0.85ºC higher than at the end of the 19th century. This fact was already analysed at the beginning of this century by Crowle (2000), who concluded that the warming during the last century is unprecedented, and that only about 25% of the increase could be attributed to natural variability, while the rest, most of it, is due to increases in greenhouse gases.

Cramer *et al* (2018) have shown, on the shores of the Mediterranean, that the globally accepted projection that warming by the middle of the

century may stand at 2ºC above pre-industrial levels, is, actually, likely to be exceeded. This rise in temperature will be accompanied by extreme meteorological phenomena, such as longer droughts, higher concentrations of rainfall and floods, etc. All these circumstances will have a devastating effect on nature and will bring about irreversible changes in many ecosystems, with the consequent losses in of biodiversity. It will also translate into huge costs to our economy and undermine our countries' ability to produce food.

2.2 The Circular Economy

Global economic development over the course of the 20th century has occurred in parallel with a growing and uninterrupted demand for natural resources: building materials, biomass, fossil fuels and minerals of all kinds, including industrial ones. This accumulated demand has triggered higher-than-normal growth, especially due to the burgeoning economic development of China, Brazil, Mexico, etc. (Krausmann *et al*, 2009). These authors concluded by pointing to the need to improve efficiency in the use of raw materials and decoupling economic growth from the consumption of materials and energy.

If no decarbonisation and resource usage control strategies are undertaken, said authors predicted an alarming decline in biodiversity and nature; and, in the short term, of some resources, such as land, fresh water, fish, oil and gas of fossil origin, precious metals and those for industrial use, etc. This same team, a few years later, (Krausmann *et al*, 2017) concluded that, to reduce future demand for materials and energy, and Greenhouse Gas Emissions (GGE), it will be necessary to dissociate services from conventional supplies and material flows through, for example, the more intensive use of available resources, longer service lives, and more efficient designs.

In parallel to these scientific works, the Ellen MacArthur Foundation for the Circular Economy published, in 2012, its document "Towards the Circular Economy", which began with the following text: "in the face of sharp increases in the volatility of the world's economy, and signs of resource depletion, the

justification for a new economic model is growing stronger. Many argue that the time is right to take this 'Circular Economy' concept one step further".

In recent years our society has gone from a linear economy, in which we extract raw materials to incorporate them into production processes, obtaining products that go to the market, and disposing of the waste from this after use; to a recycling economy in which we seek to reuse part of the waste from the production and usage chain; to a Circular Economy (Figure 1).

The transition from a linear economy to the Circular Economy requires a progressive reduction in the use of natural resources and an increase in the use of renewable resources. And it entails a different approach to each of the phases of the production process and the service life of products. Below is a summary of some of the essential points (COM, 2020, 98 final):

- Obtaining raw materials: priority must be given to obtaining secondary raw materials; that is, those obtained through the recovery of materials and raw materials from the waste generated in production processes
- Ecodesign: the design of the product, from the outset, must be based on:
  - maximising its service life through the repair and reuse of products that are already in use
  - facilitating the recovery of materials and raw materials after the product's service life
- Production: using secondary raw materials and minimising both waste and the consumption of raw materials
- Use (service life): maximised product durability must be sought, facilitating its repair, maintenance and reuse
- Waste treatment: a focus on its recycling, facilitating its transformation into secondary materials and raw materials originating a new production process.

Figura 1. Diagrama de la economía circular. Fuente: UE.

2.3 European and Spanish policies

The European Union, within the framework of its waste policy, decided to modify its management strategy, shifting from measures based on the elimination of waste, and recovery, through recycling, to another based on preventing generation and preparation for reuse and recycling. At the end of 2015, the European Commission launched the Circular Economy Package.

A good portion of the 54 measures in this package focused on five sectors of the economy: plastics, the agri-food sector, critical raw materials, construction and demolition, and the biomass and bio-based products sector. In each of these sectors general objectives are established, for specific dates, in which countries are obliged to adopt specific measures for the selective collection of waste (urban, biological, textile) and recycling (paper, cardboard, glass, plastics, etc).

The European Union has made a commitment to international efforts to tackle climate change. At the European level, a comprehensive package of policy measures to reduce Greenhouse Gas Emissions (GGE) was put in place through the European Climate Change Program (ECCP). In December 2019 the new European Commission launched the Green Deal, a strategy to respond to global climate and environmental challenges and promote growth in a

modern, prosperous, resource-efficient and competitive, climate-neutral society by 2050 (COM 2019). It proposes a set of transformative policies:

- Climate neutrality in 2050, which aims to reduce emissions between 50-55% by 2030.
- Clean, accessible and safe energy, promoting decarbonisation of the energy system.
- A clean and Circular Economy, based on a new industrial strategy aimed at developing a low-emissions activity, and with sustainable, climate-neutral and circular products and services.
- Sustainable and smart construction, renovation and mobility.
- The health system will seek a transition to a Circular Economy with more efficient production systems, better storage and packaging, healthy consumption, reductions in food losses and waste, more sustainable agricultural transformation and transport, and better-informed citizens.
- Preserve and restore ecosystems and natural capital, based on a new biodiversity strategy, as well as reductions in pollution.

The Circular Economy has been boosted again in the European Union; specifically, by reformulating the Circular Economy package (EIB, 2020).

In Spain, in June 2020, the Spanish Circular Economy Strategy was adopted. In addition, in the months of June and July two drafts of the Waste Law and the Climate Change Law were presented. In the first case, when addressing bio-waste, the obligation of separate collection was established for municipalities starting in 2023. With regards to plastics, the prohibition on single-use plastics is slated for July 3, 2021. The rest of single-use plastics are to be reduced by 50% in 2026, and by 70% in 2030. The second proposes reduction dates and targets similar to those in Europe.

All these policies lead us to a scenario, in the short term, in which it will be necessary to strive for the comprehensive use of resources of biological origin.

What until now were by-products or waste must be recovered and transformed into new products destined for the market. In this way, we simultaneously achieve three objectives: improve efficiency in production processes, extend the economic life of natural resources, and reduce the carbon footprint of all products. In addition, we promote industrial synergy, generating new value chains in the economy.

3. BIOMASS TRANSFORMATION OPPORTUNITIES

The launch of the European Bioeconomy Strategy in 2012 triggered a series of studies to quantify the possibilities of this new area of knowledge and the economy. For this, it was essential, as indicated by M Barek et al (2014), to generate a procedure and a set of databases that would make it possible to quantify the availability of biomass in Europe. In fact, this JRC group published the working procedure and biomass flow in Europe (Gurria *et al*, 2017). They distinguished three large groups of waste, according to their origin: agricultural, fishing and forestry biomass.

In a later work, the same group (*Camia et al*, 2018) stated that agriculture generates 956 Mt of biomass, of which 46% is residual. Part of it may have economic value (for example, when used for animal bedding, or for bioenergy production), although they indicated that it is also important as a provider of ecosystem services, by maintaining organic carbon levels in the soil, and preventing erosion. In the forestry field, they stated that 32% of total aerial woody biomass corresponds to branches, stumps and crowns, as a whole, considered other wood components, representing around 95 Mt per year. Another area described is the total production of macro and microalgae, gauged at 0.23 Mt of wet biomass in 2015 (which corresponds to approximately 0.027 Mt of dry weight).

Thorenz *et al* (2018) carried out a study using similar sources, quantifying agricultural waste in Europe at 107 Mt. Their results identify wheat straw as the most promising source in the agricultural sector, followed by corn stubble,

barley straw and rapeseed straw, which feature a total lignocellulose concentration of more than 80% dry matter. In forestry, the bark from the waste of two species of conifers - fir and pine - is the most promising source, being approximately 70% lignocellulose. They also estimated that only 8% of the total waste was being exploited.

More abundant are the studies that quantify the biomass that can be used for conversion into bioenergy, incorporating other products, such as urban solid waste or sewage sludge; some works (Scarlat *et al.*, 2018, and the Commission's own publications). The provisioning of biomass for bioenergy (i.e. primary energy) in the EU reached 140 Mt in 2016. Of this, 96% came from the EU, and the remaining 4% was imported from non-EU countries. Biomass from the EU is mainly converted into energy in the Member State where it is produced, with only 7.2% being so converted in another Member State.

Hamelin *et al* (2.019) conducted a study to estimate biomass production in the EU and indicate its geographical locations. They include four major biomass-generating activities: agriculture (straw, manure, pruning waste, permanent plantations); forestry (forest waste), the management of urban vegetation (waste from the management of urban green areas and roadside vegetation); and food waste (from agro-industrial food processes, including biodegradable municipal waste). In Figure No. 2 we present the results.

In Spain we can use a combination of studies to quantify the biomass available, among which we can highlight those from the IDAE (2011) and BIOPLAT-SUSCHEM (2017), as well as data from the INE (2018) when quantifying sewage sludge. Within the residual biomass categories we can consider the following groups:

- Residual agricultural biomass, consisting of crop residues such as straw, stems, leaves, silage, as well as that from pruning, which comes to 30.5 Mt
- Forest biomass, from forest crops (mainly woody species produced through cultivation activities on forest lands, harvesting, and, if necessary, from the

processing of harvested raw materials; non-wood forest crops, such as aromatic or medicinal plants, are also considered), forest exploitation (silvicultural operations involving forest masses) or forest residues (cleaning and maintenance of forest masses and green spaces), was evaluated at 18.7 Mt per year.

- Biomass from livestock waste, with this including manure and slurry, bedding for animals and chicken manure. Although there is currently significant demand in the agricultural sector, especially the most solid ones, they can also be allocated for transformation. In Spain they are assessed at 72 Mt per year.
- Residual biomass from fishing and aquaculture, not quantified separately in any of the documents that we have been using as a reference.
- There are special biomasses, from the meat value chain, to which little attention is usually paid, as they are subject to complex regulations: they are By-products of Animal Origin Not Intended for Human Consumption (SANDACH), which include everything from animal carcasses from farms, to seizures from slaughterhouses, to by-products from the meat industries. The volume that is produced in our country, and its richness in certain ingredients (fats, proteins, enzymes and hormones), can warrant its consideration. In Spain, 350 t of this group of by-products are produced per year.
- Residual biomass from the agri-food industry, which includes both non-edible products, such as discarded skins, shells or fish parts, as well as products that do not reach the market because they do not comply with hygiene or quality requirements, such as waste generated in the production processes necessary to obtain food and beverages (cheeses, fats, oils, wine, beer, frozen foods, canned goods, etc.). In Spain, production of 83 Mt per year was estimated.
- Residual biomass from the wood, paper and textile industries, which is estimated, in Spain, at 6 Mt.

- The fermentable fraction of urban solid waste, which includes all organic components, which it will be mandatory to separate in our municipalities as of 2023, as well as sewage sludge. Together they represent around 26 Mt of products.
- Sewage sludge represented 1.2 Mt of dry matter in 2018, which is managed through agricultural use (87%), energy recovery (5.5%) and landfill disposal (7.5%).

Technological platforms, meanwhile, describe the potential use of crops that can be exploited to obtain biomass, which they estimate amounting to some 39.4Mt. They are grouped into herbaceous and woody ones. Herbaceous plants can be classified, according to the main product obtained from them, into:

- Alcoholigenic (alcohol-producing). Types used for the production of bioethanol from processes involving the alcoholic fermentation of simple sugars, with these including starches and insulins.
- Lignocellulosics. Herbaceous species rich in lignocellulose (cellulose, hemicellulose and lignin) and featuring high production.
- Oil-producing plants. Species from which oil-rich fractions (seeds or fruits) are harvested, which are used for the production of biodiesel and other biofuels, as well as other products (for example, for the manufacture of biopolymers, or the preparation of compounds for cosmetics).

Woody crops can also be lignocellulosic (the majority) or alcohol-producing.

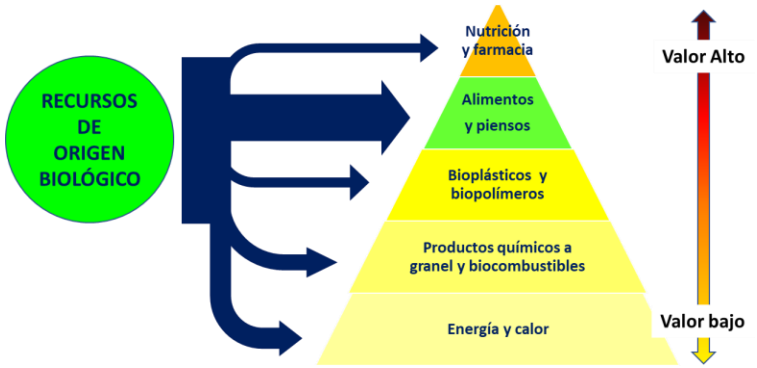
The KBC (2020) has published the biomass flows forming part of the Bioeconomy. According to this information, in Spain 56,246 Mt of biomass are produced annually, which, together with 19,051 Mt imported, and 272 Mt of unknown origin, make 75,569 Mt available. Of this amount, 47,237 Mt go to the food system, 518 Mt to the production of biomaterials, and 27,814 Mt are lost or have unknown destinations. Of those processed, 4,351 Mt are exported. All these figures expressed refer to dry matter. It is evident that we have residual

biomass at our disposal that could be recovered and exploited. In order to have a vision of the future, we must delve deeper into the group of chemical products that are currently being obtained from this raw material.

4. THE POSSIBILITIES OF BIOMASS TRANSFORMATION

Most of the biological resources from agricultural, livestock, extractive fishing and aquaculture activities are used for human consumption; directly or indirectly, after preparation, or after transformation, of varying intensities, it becomes food for consumers. However, the end uses of all these resources of biological origin may vary. In Figure 2 we present a synthesis of their possible uses in the framework of the Bioeconomy. It is possible to extract different compounds with a high added value for the specialised nutrition or pharmacy sectors. They can also be transformed into bioplastics and biopolymers, or bulk chemicals, or biofuels. The last option is to transform these resources into energy or heat if there is no possibility of using it in another way.

Figure 2. Possible uses of biomass within the framework of the Bioeconomy



As shown in the figure, as one goes down the pyramid, the value of the products obtained drops. For this reason, in the use of Biomass, the cascade principle, from the field of waste recovery, is applied: extracting from the biomass, first, the ingredients or products of the greatest value.

Traditionally, food production has been the Bioeconomy's main activity.

In the food sphere, the potential for development and innovation in this sector is unlimited. We will mention them, although we will not go into them in this review. We will classify them according to the objectives they pursue:

- Responding to the diversity and differentiation of consumer demand, in different markets and with reference to different cultures, values, interests, experiences, age groups, nutritional needs and even social commitments.
- Respond to social challenges in terms of sustainability (circularity of processes, environmental footprints, bioplastics, eco-designs, etc.), food safety (with reduced allergens or specific toxicities of certain groups, technologies, such as Blockchain, or pressures and new materials or additives that can, in turn, extend product lives), or nutrition and health (incorporating functionality into some ingredients, or new ingredients with additional functionalities, or reducing the use of certain components)
- Maintain a cost/quality/service ratio allowing them to be a dynamic and competitive sector in the national market and abroad, having the opportunity to work in the organizational sphere, and on the integration of new technologies, both classical (biotechnology, nanotechnology and ecology) and emerging (automation, robotics, sensor-related). Artificial Intelligence, or in the improvement of food preservation, with different combinations of temperatures, pressures, or the incorporation of additives.

We are going to focus more on the potential of biomass in terms of its transformation into products other than food, following the work of Iffland et al (2015). As this same team pointed out in another similar document (Aeschelmann et al, 2017), it is possible to obtain any oil by-product from biomass, using different metabolic routes. In this summary we have also taken into consideration the work of BIOPLAT-SUSCHEM (2017), Pietrowsky et al (2018), Parisi et al (2018), Villarán et al (2018), the OECD (2018), JRC (2019) and Patinha Caldeira et al, 2020. The by-products that we can obtain will be classified into several groups:

- Fuels:

- Biomethane, or biogas (CH4) is created through anaerobic microbial processes, from different raw materials (carbohydrates, fats and proteins).
- Bioethanol: obtained through different processes, raw materials and microorganisms that can USE C5/C6 sugars. Ethanol can also be acquired through anaerobic procedures.
- BTL (Biomass to Liquid) is a synthetic fuel obtained through a multi-stage process that begins with pyrolysis.
- Biodiesel: generated through a transesterification reaction based on different sources of triglycerides of plant or animal origin, including soybean, rapeseed and palm oil. It is a substitute for diesel derived from petroleum.
- Vegetable-based fuel oils: certain vegetable oils can be added directly to the diesel used by motor vehicles. In theory, they can be used directly as gasoline.
- Hydro-treated vegetable oils: a product that comes from hydrogenated vegetable oils. It can be considered similar to biodiesel, but with a longer useful life.

• Basic chemical compounds (building blocks).

- Acetic acid: a basic compound for the production of PVA (polyvinyl acetate), when it reacts with ethylene to form vinyl acetate monomers. The processes for obtaining it are varied, although they are usually based on an acidogenic fermentation.
- Lactic acid: produced through biomass fermentation processes. It is the basis for the formation of polylactic acid (PLA), which can replace polystyrene of fossil origins.
- Succinic acid: an intermediate product of the citric acid cycle and an end product of the anaerobic metabolism of glucose.
- 1,3-propanediol (PDO): can be obtained from the fermentation of glycerol, or using glucose as a raw material. It can be used as a base material for the production of PTT (polytrimethylene terephthalates) fibres.

- 1,4-butanediol (BDO): another important basic chemical as it can replace ethylene glycol for the acquisition of thermoplastic Polybutylene terephthalate (PBT). It can be obtained from succinic acid or the fermentation of sugars with E. coli.
- 5. Hydroxymethylfurfural (HMF): produced from the dehydration of sugars like fructose and glucose. It is a very versatile intermediate product when it comes to synthesizing polymers, offering multiple possibilities. For example, it can be used to produce furandicarboxylic acid (FDCA), which, in turn, can be used to replace PET in bottles, polyamides, polyurethanes, thermosets, and plasticizers.
- Ethylene: this monomer can be obtained through the fermentation of glucose producing ethanol, which is then dehydrated by means of catalysis. It has also been produced from the fermentation of lignocellulosic materials.
- Monoethylene Glycol (MEG): a basic compound for the manufacture of polymers such as PEF and PET. It can also be used alone; for example, to de-ice aircraft, or as a heat transfer agent. It can be synthesized from biomass in several ways; for example, from ethylene, or via glucose and ethanol.
- Isoprene: various raw materials can be used to form biobased isoprene; e.g. glycerol, CO2 or glucose with various microorganisms. In the chemical industry it is used as a starting material to obtain rubber, pesticides and tires. Furthermore, together with bio-based acrylic acid, a reaction can be induced to produce terephthalic acid, which is one of the monomers used in the synthesis of PET.
- Acrylic acid: can be produced from glycerol, as a by-product of the creation of biodiesel. It can be used to form polyacrylic acid, which is an important component in adhesives and coatings. In addition, it can form various copolymers.
- 2,5-furandicarboxylic acid (FDCA): can be obtained through the oxidation of HMF. It features a structure very similar to terephthalate acid, one of the monomers used to obtain PET, which allows it to obtain its furan analogue, PEF.

- Para-xylene (pX): obtained from HMF, causing a reaction with ethylene. It is an important building block for polyester production. In turn, the oxidation of p-xylene gives rise to terephthalic acid, which is an important precursor of PET.
- Terephthalic acid (TPA): can be obtained from P-xylene, or with a cycloaddition of acrylic acid and isoprene of biological origin. TPA is one of the monomers used to make, among other compounds, the following polymers: Poly (trimethylene terephthalate) (PTT), which is used mainly in textile fibres; PBT (Polybutylene terephthalate), a technical polymer for special applications; and PET (polyethylene terephthalate), used in packaging such as bottles.

• Materials for the production of biopolymers:

- Polyethylene: the polymerization of ethylene makes it possible to produce polyethylene.
- Polybutylene succinate (PBS): can be obtained through various polymerization techniques, from 1,4-butanediol and succinic acid. It is a polyester with mechanical properties comparable to polypropylene, but it is biodegradable. In addition, it has thermoplastic possibilities and can be combined with other polymers, such as PLA, changing its properties.
- Polylactic Acid (PLA): produced mainly through the formation of the lactide dimer and subsequent ring-opening polymerization. PLA is an aliphatic thermoplastic polyester with a wide range of applications (e.g., food service items, woven and non-woven fibres, 3D printing) and can be processed with standard equipment in the petrochemical industry.
- Polyhydroxyalkanoates (PHA): can be obtained by fermentation using a large number of substrates (glucose, maltose or sucrose, for example). It is a polyester, with differential characteristics depending on the length of the chains, which may be thermoplastic or elastomeric.
- Polyamides or nylons: can be obtained from castor oil.
- Polyethylene Furanoate (PEF): uses 2,5-FDCA as the monomer, and even the other ethylene glycol monomer can be replaced by BDO to create a new

polymer: PBF. It can replace PET in products like bottles; they feature greater thermal stability, but, at the same time, a lower melting point, so it can be processed at low temperatures.

- Polyethylene terephthalate (PET), made from building blocks, is a well-known biopolymer due to its use for the production of bottles and fibres.
- Polymers obtained from cellulose and starch. Cellulose gives plants their structure, so it is very stable, while starch is a reserve material. Both are, basically, composed of glucose. However, while starch easily breaks down into glucose, in the case of cellulose and hemicellulose fusion with phenolic acids and acetyl groups impede this, requiring the intervention of certain bacteria and fungi to break the bonds within these materials. From there one can obtain:

- Pure cellulose, the basis for the production of fibres (Rayon, Modal, Lyocel) and films (cellophane and sponges)
- Derivatives of celluloses, whose ethers are used as additives, viscosity-increasing agents, and ethers that can be used as thermoplastic foams and composites, or composite materials.
- Polymers made from starch.

- Alkyl glucosides, with a surfactant action: the reaction of glucose with long-chain alcohols. The result is a product with the capacity to form emulsions by combining oil and water phases.
- Hydraulic oils and lubricants: vegetable oils could be used for this purpose.

• Active compounds, which can be extracted for their use as ingredients and additives in the food industry mainly, although they can also be used in pharmacy and agribusiness. The range of ingredients with functional activity that we can find is immense, so we will only refer to large groups of products:

- Carotenoids, which are the red, yellow, orange, and purple pigments in fruits and vegetables, divided into carotenes and xanthophylls. They have applications in specialized nutrition and pharmacy to prevent photosensitivity, genetic damage and neoplastic transformations.

- Phenolic and flavonoid compounds: they have shown a great variety of biological applications: antioxidant, antimicrobial, anti-inflammatory, immunomodulatory, antiviral, anti-proliferative, anti-mutagenic, vasodilator and for the prevention of coronary and neurodegenerative diseases.
- Inulin, with its prebiotic effects, improving the intestinal absorption of minerals, reducing the risk of arteriosclerosis.
- Glucosinates, as metabolites of brassicaceae, with a preventive effect on colon cancer.

• Vegetable derivatives obtained from the biofermentation of agricultural by-products, using microorganisms and biocatalysts (other microorganisms and enzymes) yielding a fluid from which purified products are extracted. The final products that can be obtained are of a diverse nature. We will refer to some groups of them:

- Biological enzymes or catalysts responsible for various metabolic processes. Some examples of enzymes obtained are: amylase, lignocellulase, pectinase, tannase, protease, lipase and invertase.
- Organic acids, which can be used in different sectors (food, pharmaceutical, energy, industrial, etc). Using some species of fungi or bacteria, lactic acid or citric acid have been obtained.

• Other products. We have not mentioned other common uses of biomass that could be improved through the incorporation of processing and preservation technologies. We will refer to two of them:

- Animal feed. This is a common use to which many classes of plant biomass are put. However, they do not undergo stabilization and preservation treatments, to preserve their ingredients.
- Fertilisers. Many types of biomass, both vegetable and animal, are used for fertilizers. Again, there is an opportunity to transform these by-products into specific biofertilizers for certain productions or specific areas.

5. THE TECHNOLOGIES AVAILABLE FOR THE TRANSFORMATION OF BIOMASSES

In the previous section we identified a wide variety of types of biomass. In addition, within each typology there is a range of heterogeneous products, in terms of their origin, size, moisture content, density and uniformity. Sometimes they may contain inert or unusable material. All this makes their collection, transportation and handling difficult. As a consequence, the use of all these raw materials will require pre-treatments and transformations to condition them and facilitate their recovery. These include size, moisture and densification reduction, and the removal of unwanted components.

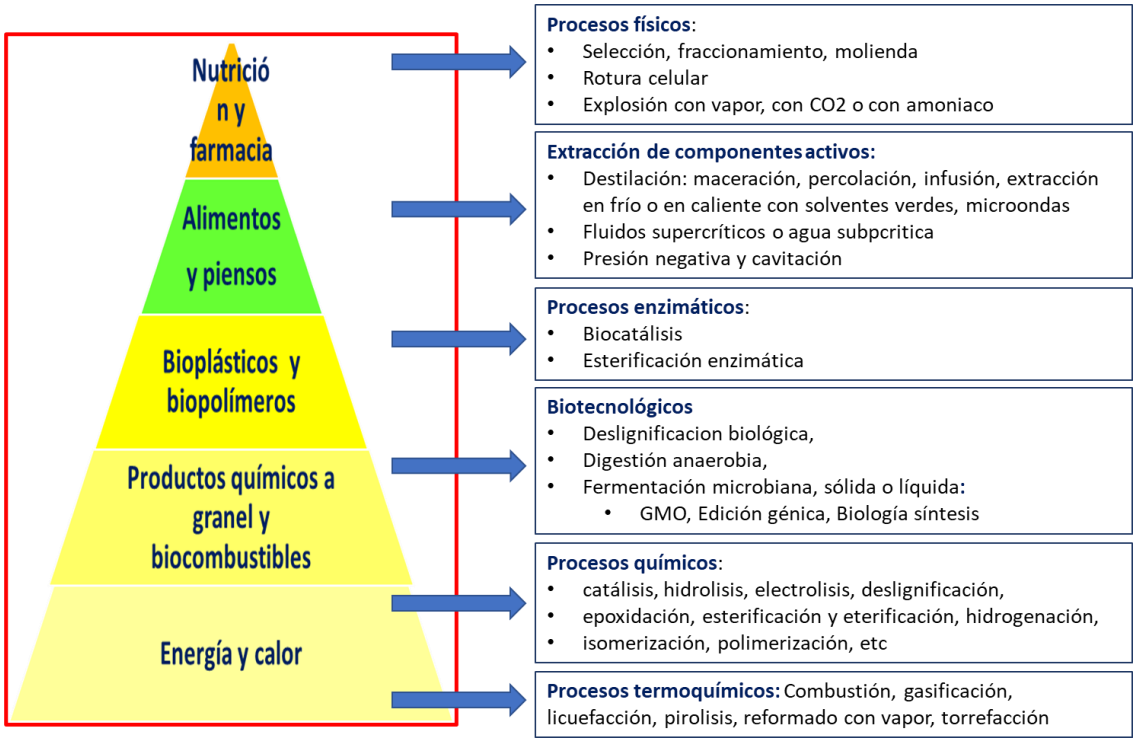
In Figure 3 we present a non-exhaustive summary of the technologies that can be applied to the recovery of biomass within the framework of the Bioeconomy. We have indicated some of the initial physical treatments, and then listed the physical extraction, enzymatic, biological, chemical and thermochemical ones. The sources used for the preparation of this summary are: House of Lords (2014), Villaran *et al* (2018), OECD (2018), BIOPLAT (2017) and Patinha Caldeira *et al* (2020).

Applying the principle of cascade use, the first option would be to obtain bioproducts with some type of functionality. The possibilities presented are the traditional ones, based on cold or hot maceration and extraction with solvents, in which the use of green solvents, such as water or ethanol, or "Natural Deep Eutectic Solvents", is frequent. Sometimes yields are improved through the incorporation of ultrasound or microwaves. Cold compression is also used in the production of oils.

To reduce the consumption of solvents, and improve the efficiency of the processes, other technologies are also employed, such as supercritical fluids, like carbon dioxide, and extraction using electrical pulses or subcritical water. Other options available are negative cavitation pressures, which allow for the extraction of polyphenols, alkaloids, polysaccharides and flavonoids. These

techniques, which are efficient at the laboratory level, can be financially problematic when attempts are made to scale them to the industrial sphere.

Figure 3. Summary of the technologies to be used for the development of the Bioeconomy



Another way to obtain biomass derivatives is to subject the raw material to microbial fermentation processes. However, it is often necessary to break down cell walls to facilitate the action of microorganisms and improve efficiency. In this case, physical or physical-chemical processes are used, such as pressure or explosion with steam, CO2 or ammonia; for example, in the case of steam, saturated steam is injected at high pressures (0.7 to 5 MPa), increasing the temperature (160-260 °C). After a few minutes, or seconds, the pressure is suddenly reduced and the biomass undergoes destructuring, accompanied by the degradation of hemicellulose and a significant part of the lignin. The mixture obtained can be subjected to a hydrolysis treatment, with an excess of water, usually in the presence of a catalyst, by means of which polysaccharides present in the biomass can be hydrolysed, releasing C5 and C6 sugars, together with their isomers and oligomers.

The next phase is the application of biotechnologies that, at low temperatures and speeds, and with the action of microorganisms and/or specific enzymes, degrade the biomass's fermentable substrate. By means of fermentation those raw materials that contain a large percentage of carbohydrates can be transformed, either in simple form, or in the form of starch polymers or cellulose and hemicellulose polysaccharides. In aerobic fermentation, one of the main products obtained is bioethanol, but it is also possible to produce a wide variety of products that are especially valuable to the industry: xylitol, succinic acid, itaconic acid, lysine, 1,3-propanediol, etc. The other biochemical process, anaerobic digestion, occurs in the absence of oxygen, and biomass decomposes into an aqueous suspension of solid products and gaseous products known as biogas, used for electricity or thermal energy. This transformation process can be applied to any type of biomass, especially those with a high moisture content.

Improvements in the efficiency of biotechnological processes often hinge on the availability of microbial populations adapted to the fermentation of certain substrates, as well as the use of precise action enzymes. Hence, technologies for genetic modification, gene editing, or synthetic biologies are essential to improve the technical results of the processes.

Sometimes the biomass is subjected to a composting process to obtain a biofertilizer. This consists of the aerobic decomposition (with oxygen) of organic waste, such as vegetable and animal waste and slurry, through the massive reproduction of thermophilic aerobic bacteria that are naturally present anywhere. Subsequently, fermentation is continued by other species of bacteria, fungi, and actinomycetes. If progress is made in the degradation processes of organic matter, we can obtain humus, which is also used for the production of compost.

In the fermentation processes, primary products are obtained: buildings blocks or biogas. In the first case, it is necessary to apply biochemical

technologies to advance in the synthesis of bio-derivatives apt for release on the market. Some of the reactions will be those of esterification, etherification or transesterification.

Another recovery option is the use of thermochemical processes, which involve the thermal decomposition of the components of the biomass and a release of energy in the form of heat, or the production of intermediate biofuels. There are two main thermochemical processes that transform lignocellulosic biomass into energy and chemicals associated with biorefinery facilities: gasification and pyrolysis. In the first case, the biomass is partially oxidized at high temperature (usually in the range of 600-900 °C), transforming mainly into a gaseous mixture composed of CO, CO2, N2, CH4, H2 and H2O, in different proportions, depending on the technology used and the gasifying agent. The second is a thermal degradation of biomass in the absence of oxygen, in which synthesis gas is generated for fuel, bio-oils, activated carbon and light hydrocarbons (mainly olefins and paraffins).

6. THE BIOECONOMY: CHALLENGES AND OPPORTUNITIES

Limitations affecting the carrying out of business projects in the field of the Bioeconomy can be identified in three areas: procurement logistics, technological difficulties, and the comparative costs of the transformation of resources of fossil origin versus those of biological origin.

In terms of the logistical needs involved in the concentration of by-products and waste, the descriptions of biomass provided indicate that, except in the case of urban solid waste and sewage sludge, other raw materials are dispersed throughout the territory. In the case of agricultural and livestock waste, this is especially relevant. In all these cases we have resources that feature limited energy concentration and, frequently, high humidity percentages. For all these reasons, the logistics involved in the collection and transport to a concentration site for the subsequent extraction of functional ingredients for their transformation into new bioproducts has an economic cost that increases final production costs.

Technological difficulties are concentrated in certain categories of biomass, especially those containing high levels of lignocellulose. The technical problems surrounding the conversion of lignocellulosic biomass into bioproducts have proven to be so unsolvable that only a handful of these biorefineries have become commercially viable, and most of them remain problematic facilities (OECD, 2018). According to this publication, around 40-60% of the total operating cost of a typical biorefinery is related to the raw materials chosen. However, the most significant cost of second-generation cellulosic biofuels may be the conversion of woody biomass into fermentable sugars.

This explains why the development of first-generation biorefineries, which used resources that can be designated for human consumption (cereals, corn, sugar cane, soybean oil or palm oil) as raw materials, was very rapid, while that of second-generation facilities (crop residues, forest products, MSW, etc.) has been more limited.

Kircher (2019) has analysed the opportunities entailed by the Bioeconomy, dedicating an entire chapter of his work to comparing the costs of transforming resources of biological origin to those of fossil origin, concluding that complexity and processing costs are significant competitive hurdles. Fossil fuels and basic chemicals are produced by simply refining mineral oil or processing natural gas (methane). At the same time, the efficiency of the processes must be considered, both in technical terms and in terms of labour: while the carbon from fossil raw materials becomes almost entirely the end product, in the case of those from biomass the carbon efficiency of these processes is lower. Moreover, the intensity of work, in the former case, is lower as compared to the latter.

To illustrate his conclusions he presents a comparative analysis of the number of steps required in each of the production routes of two specific products (ethanol and ethylene) obtained from fossil resources relative to biological resources. In addition, he distinguishes between the categories of biomass used, according to whether they contain lignocellulosic elements or not. He concludes

that more links are needed to obtain the same products, which explains the technical complexity, the labour intensity, and, ultimately, the production cost.

All this leads Kircher (2019) to conclude that the competitiveness of all these products will depend on the price of oil and of biomass. Therefore, we can conclude that as long as a barrel of oil is inexpensive it will be difficult to promote the development of the Bioeconomy, if only economic and market aspects are taken into account.

Notwithstanding the foregoing, we must take into account the opportunities related to each of the challenges.

- Regarding logistics and provisioning, we must remember the policies that will be implemented in Spain and the EU in the coming years, to reduce the waste generated, or to transform it and to recover it, in order for it to ultimately become secondary raw materials, thereby promoting industrial synergy. Legal pressure will force the use of these resources.
- In terms of technologies, we must consider that knowledge related to petroleum chemistry has been developed in the last 120 years, and has allowed for systematic innovation, making it possible to have a huge range of products that meet our needs. Science and innovation related to the Bioeconomy has a much shorter history: around 20 years. Therefore, the development of an efficient Bioeconomy requires an expansion of knowledge and its transfer to the market through innovation. Currently, in the EU and Spain we have had and, we will continue to have, tools to finance the generation of knowledge and innovation. Specifically, we can point to the following:
    - The EU has featured the 8th Research and Innovation Framework Programme, H2020, with a specific area for the financing of the Bioeconomy, for both the generation of knowledge and the promotion of innovation. Within this framework, there has been a public-private collaboration initiative (Biobased Industries), focused on the Bioeconomy, which has financed 118 projects over

the last 6 years, and has a budget of € 3.7 billion. In the next period scheduled, within the framework of Horizon Europe, an increase in general funding and the maintenance of this public-private initiative have been announced. For the next period slated, the farm-to-table strategy, which is included in the Green Deal, addresses the financing of the Bioeconomy as one of the priorities to be considered.

- The Spanish National R&D plan does not include specific sectoral programs. However, hitherto it has incorporated the generation of knowledge and innovation in the Bioeconomy area as priorities. Both in the calls of the State Research Agency and in those of the CDTI (Centre for the Development of Industrial Technology), the Bioeconomy has been consolidated as the second leading area of research and innovation when it comes to capturing resources, after Health. In the future National Plan, forecasts envision the Bioeconomy continuing to play an important role, in accordance with the EU's priorities. Rural development programmes, meanwhile, have thus far included the financing of projects that bolster the development of the Bioeconomy as one of their most important objectives.
- At the CCAA (Spanish regional governments) level, all the RIS3 have considered the Bioeconomy to be strategic, with varying degrees of preference for either primary production or agri-food transformation. Hence, programmes to finance innovation by drawing on regional development funds have been open to financing this area of activity.

- Biobased products, with higher production costs, will face difficulties when it comes to competing in a context of open markets. However, one must take into consideration a series of facts:

- Trends in demand and, especially, distribution, which favour their differentiation in the market through the offering of products entailing reduced GGE.
- European policies, which will promote the labelling of all types of products, to include information clarifying the sustainability of the production process, considering the entire value chain. GGE and carbon footprints will figure prominently on these labels, and it is clear that biobased products boast reduced carbon footprints.
- One of the factors that has the greatest impact on the production cost of any industrial product is the amortisation of the investment, in which financial costs are especially relevant. Investment in projects to develop the Bioeconomy will be particularly prioritized in the coming years, at both the European and national levels.

7. LIFE CYCLE ANALYSIS AS A BASIS FOR PRODUCT DEVELOPMENT

The European Bioeconomy has been built on the principles of efficiency and sustainability (Lainez et al, 2018; Lainez and Periago, 2019). Therefore, it seeks the maximum use of biomass while recognising that the use of resources must guarantee their availability for future generations. The Bioeconomy arose and stands as an alternative to the use of fossil, non-renewable resources, to mitigate the consequences of the systematic use of these types of resources, the most important effect being climate change. Therefore, any biomass recovery project must be combined with a reduction in the impacts, and especially, of the carbon footprints of the final product obtained, obtaining comparative advantages with respect to the same product derived from raw materials of fossil origin.

Kircher (2019), in his study of the Bioeconomy, cites examples in which the carbon footprint of organic products is significantly lower than those of fossil origin. However, he also indicates that obtaining biofuels and biopolymers under

the conditions considered in the examples cited, cannot be achieved without traces of

Greenhouse Gases (GHG). Emissions are generated primarily by agriculture and processing. The use of renewable energy is more effective in processing. Therefore, he concludes that investors placing their trust in bio-based products and processes should carefully analyse the source of raw materials and the energy intensity of a particular process and examine the potential for integration into emissions-free energy systems.

The use of biomass for different purposes is promoted and supported by national and global Bioeconomy policies and strategies, as a consequence of the premise that obtaining biodegradables generates less greenhouse gas than with their fossil-based counterparts. Though the Bioeconomy can be seen as a solution to these global challenges, it can also have adverse impacts on the environment, in terms of land degradation, losses of biodiversity, and a decreased capacity to provide ecosystem services, which need to be analysed (Pursula et al 2018).

Moldan *et al* (2012) when describing environmental sustainability, posit six major areas to take into account within this concept:

- Climate systems (covering the climate and climate change, risk management, mitigation and adaptation).
- Human settlements and habitats (covering cities, urban development, and transportation).
- Energy systems (covering energy use, energy conservation, renewable energy, energy efficiency, and bioenergy).
- Terrestrial systems (encompassing natural and managed ecosystems, forestry, food systems, biodiversity, and ecosystem services).

- Carbon and nitrogen cycles (covering sources and sinks, feedback, processes and links to other systems).

- Aquatic systems (encompassing marine and freshwater ecosystems, fisheries, currents, and biodiversity).

From a scientific point of view, many approaches have taken to measure sustainability. However, at this time Life Cycle Analysis is considered the most objective way to analyse the sustainability of production processes.

The analysis of a product's life cycle is a tool for characterizing the integral environmental footprints of products and production systems. It is viewed as a key tool to ensure a transition towards more sustainable production and consumption patterns. As Notarmicola *et al* (2016) and Holden et al (2018) point out, life cycle thinking is increasingly used to assess systems' sustainability.

It is an approach used to evaluate products, processes and services in terms of their place in the world, the full life cycle required for them to serve society and the environment, and the social and economic consequences of that service. The method has been recognized as the leading approach to incorporating sustainability into decision-making in the United States (NRC, 2014), Europe (JRC, 2012), and elsewhere in the world. The quantitative tool used to implement life cycle thinking is Life Cycle Assessment (LCA), which is formalised by an international standard: ISO 14040/14044.

The JRC has been working to define standards for applying LCA to different value chains of the Bioeconomy. The analyses carried out show a high variability in the results published (Cristóbal et al, 2016). The individual studies reviewed differ from each other with respect to several methodological assumptions: the definition of system boundaries, functional unit, energy recovery, carbon emissions, and storage and allocation methods. All these differences have a considerable impact on environmental results, whose general interpretation and comparison become quite complex. Furthermore, the way

the results are presented varies significantly. All these issues point to a great need for methodological harmonization and coherence for the LCA of Bioeconomy value chains. Similar conclusions were reached by Martin et al (2018)

8. THE IMPACT OF THE BIOECONOMY IN DIFFERENT SECTORS

The JRC keeps updated data on the importance of the Bioeconomy in the European Union and in each of the Member States at its Knowledge Bioeconomy Center. The latest data available is for 2017. In Spain, according to the same source, it generated a sales volume of €219 million in 2017, representing added value of €65 million. In addition, it employed 1.42 million people. We can see that the agricultural and food sectors in Spain are very important, both in terms of employment (81%) and in terms of added value in the Bioeconomy as a whole (78%). It is surprising that some sectors, such as electricity of biological origin, are barely developed in our country.

The specific results for each of the subsectors making up the Spanish Bioeconomy are presented in Table 1. The percentages represented by each of the subsectors are shown, in terms of employment and added value, as well as the added value per person employed in each of the sectors. The most obvious conclusion that we can draw from this information is that the specific weight of the Spanish Bioeconomy continues to be supported by the classic sectors. The biochemicals and bioplastics sectors are less developed, as is the case with bio-based electricity and liquid biofuels.

Table 1.- Comparison of the working population, added value and added value per working person in the different sectors of the Bioeconomy in Spain in 2017 (own work, based on KBC, 2020)

	% Working population	% differential value	Added value / working person
Agriculture	52.4	45.9	40,287
Food and drink	28.7	32.2	51,709
Wood and furniture	5.7	4.1	33,487

Paper	3.2	5.2	75,317
Biotextiles		2.2	31,638
Forest production	1.3	1.5	55,899
Biochemicals and bioplastics	2.6	5.7	102,415
Fishing and Aquaculture	2.9	2.5	39,732
Bioelectricity	0.1	0.3	100,919
Liquid biofuels	0.0	0.3	474,216

Pietrowsky *et al* (2018) conducted an analysis of the Bioeconomy in Europe. In addition to the abundance of sectoral data, they describe the importance of the different classes of chemical compounds originated by biomass. With this data we created Table 2, in which we include the importance of each of these chemical groups, which orients us with regard to sectors that will be able to benefit from them.

Table 2.- The importance of the classes of biobased chemical products produced in Europe (own work, based on Pietrowski et al, 2018)

Product classes	% of the total
Commodities (building blocks)	35.1
Fertilizers	33.3
Polymers	5.4
Detergents	5.4
Vegetable oil	3.6
Adhesives	3.6
Fibres	3.2
Paints	0.9
Dyes and pigments	0.5
Agrochemicals	0.3
Other biobased chemicals	8.7

The JRC has carried out an analysis of the current state of affairs as regards biobased products, both technological and market-related, focused on the following groups: basic chemicals, solvents, polymers for plastics, paints, coatings, inks and dyes, surfactants, cosmetics and personal care products,

adhesives, lubricants, plasticizers (and stabilizers for rubber and plastics) and artificial fibres. From a list of 350 products, 50 were selected. A detailed market assessment of those selected was carried out, covering the EU's production, price, business volume, consumption, trade, the use of raw materials and agricultural land requirements. Based on the analysis of the 50 products, market information on the product categories was collected, covering EU production and market share, dependence on EU imports, future market size, private investment, the importance of Member States and the EU to production, level of maturity, and a SWOT analysis (Spekreijse et al, 2019).

It is a valuable document to check both a given category or a specific product. In the case of categories, a summary sheet of all the information gathered is presented.

In 2018 the Boston Consulting Group produced a circular Bioeconomy Guide for CEOs in which they estimated the impact of the Bioeconomy, globally, at 7.7 trillion between 2018 and 2030 (BCG, 2019). In their view, it generates business opportunities to:

- Create new markets, access new consumer segments, and develop new value chains.
- Provide companies with a business with less environmental impact, attracting other types of talent and new consumers.
- Mitigate the regulatory risks that companies will face in the areas of climate change and waste management, placing companies at the forefront of the sustainability demanded by society.

This paper also identifies the sectors in which a more substantial increase in business opportunities related to the Bioeconomy is expected. For each of them the growth of the Bioeconomy-related market is estimated, in billions of dollars, between 2018 and 2030. Reference is also made to the materials on which this growth will be based. We cite them below:

- Bioenergy and biofuels sector. It is expected to go from 150 to 200, with special attention to solid bioenergy, including wood pellets obtained from by-products and liquid biofuels, including biodiesel, biomethane, ethanol of cellulosic origin and "direct" renewable fuels.

- Food waste, for which growth is estimated at 2,300 to 2,600, in which mention is made of the reuse of waste, and the recycling of organic nutrients, and silk, satin and orange peel rayon fabrics.

- The Pharmaceutical sector, which is expected to grow from 250 to 750, with some areas singled out, such as vaccines from medicinal plants, cancer treatments featuring compounds synthesized from plant substances, and Blockchain technology associated with the production of proteins as a basis for medical treatments.

- The Textile sector, with an increase in value from 400 to 700, in which high-technology fibres obtained from biomass and biological waste; and compostable textiles, including Locel, are considered.

- Construction and construction materials sector, in which an increase from 350 to 700 is projected for wood-based and circular structures, composites reinforced with natural fibres, and bio-based insulating materials.

- Container and packaging sector, with an expected growth of 400 to 500, in which the products identified are recyclable flexible packaging paper and cardboard, paper packaging that replaces plastics (for example, beverage packaging cardboard), recyclable bioplastics and biodegradable starch-plastic blends.

- Motor vehicles and components sector, expected to go from 250 to 550, identifying as products natural fibres like car parts, compostable interior lining based on bioplastics and dandelion-based tires in a closed-circuit system.

- Other forest products sector, with an estimated growth of 150 to 200, featuring bio-lubricants and enzyme-based additives as examples of products.

- In the machinery and equipment sector, they anticipate market growth of 50 to 100, including bioprocess and agricultural engineering as examples.

The MacKinsey on Climate Change Report (2020) also merits special attention, in which reference is made to the development possibilities of some specific sectors, particularly transport, both automobile and air.

9. CONCLUSIONS

The promotion of the Circular Economy, decarbonisation, and the mitigation of climate change are major work strategies promoted by European policies and by many countries, including Spain, poised to bolster the development of the Bioeconomy in the coming years.

In Spain the production of 27,814 Mt of dry matter from residual biomass is estimated to be lost, or its ultimate destination is unknown.

The production of biological resources has traditionally been undertaken with a view to obtaining food to meet people's needs. In addition to continuing to supply food, the Bioeconomy can make use of residual biomass to obtain a great diversity of products, including basic chemical compounds, or building blocks, materials for the acquisition of biopolymers, active compounds, biofermentation derivatives, or fuels.

There is a wide range of technologies available for the recovery of biomass, and their efficiency is continuously being improved. These include physical, active component extraction, biotechnological, chemical and thermochemical processes.

The challenges for the development of the Bioeconomy are the logistics involved in provisioning, and the technological difficulties and the comparative costs entailed by the transformation of resources of fossil origin compared to those of biological origin. Faced with them, opportunities will be generated by changes in the social perception of the importance of sustainability, which will

translate into a modification of demand patterns. Furthermore, European policies, especially those stemming from the Green Deal, will limit certain traditional products' access to the market, and, at the same time, favour investments in the development of Bioeconomy projects.

These projects must be executed guaranteeing the environmental sustainability of the investment and the production process. The tool to carry out this impact analysis will be Life Cycle Analysis.

The development of the Bioeconomy will occur as a result of the placement on the market of products in new economic sectors in which, until now, the presence of bioproducts has not been significant. The waste management and recovery sectors stand out, especially waste from: food, the pharmaceutical industry, textiles, construction and construction materials, containers and packaging, motor vehicles and components, bioenergy and biofuels, other forest products, machinery and equipment.

REFERENCES

BCG (2019). CEO Guide to the Circular Bioeconomy. Recuperado de: https://www.wbcsd.org/Programs/Circular-Economy/Factor-10/News/Leading-companies-endorse-WBCSDs-call-for-a-stronger-circular-bioeconomy.

Bioplat suschem, (2017). Manual sobre las biorrefinerías en España. Recuperado de: file:///C:/Users/mlain/Desktop/bioval/Manual-sobre-Biorrefiner%C3%ADas-en-Espana-Feb-2017.pdf.

CAMIA, A., ROBERT, N., JONSSON, R., PILLI, R., GARCÍA-CONDADO, S., LÓPEZ-LOZANO, R., VAN DER VELDE, M., RONZON, T., GURRÍA, P., M'BAREK, R., TAMOSIUNAS, S., FIORE, G., ARAUJO, R., HOEPFFNER, N., MARELLI, L. & GIUNTOLI, J., Biomass production, supply, uses and flows in the European Union. First results from an integrated assessment, EUR 28993 EN,

Publications Office of the European Union, Luxembourg, (2018), ISBN 978-92-79-77237-5, doi:10.2760/539520, JRC109869.

CARROL, M. & DAMMER, L. (2018). The "Circular Bioeconomy" – Concepts, Opportunities and Limitations. Nova paper #9 on bio-based economy 2018-01.

COM (2019) 640 final Comunicación de la Comisión al Parlamento Europeo, al Consejo Europeo, al Consejo, al Comité Económico y Social Europeo y al Comité de las Regiones el Pacto Verde Europeo. Recuperado de: https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1588580774040&uri=CELEX:52019DC0640.

COM, (2020) 98 final. Nuevo Plan de acción para la economía circular por una Europa más limpia y más competitiva (EUR-Lex — Access to European Union law — choose your language (europa.eu)).

CRAMER, W., GUIOT, J., FADER, M., GARRABOU, J. & GATTUSO, JP. (2018). Climate change and interconnected risks to sustainable development in the Mediterranean. Nature Climate Change, Nature Publishing Group, 2018, 8 (11), pp.972 - 980. ff10.1038/s41558-018-0299-2ff. ffhal-01911390.

CROWLE, T.J. (2000). Causes of Climate Change Over the Past 1000 Years. Science 289, 270 – 277.

EIB 2020 Circular Economy Guide – Supporting the circular transition. Recuperado de: https://www.eib.org/attachments/thematic/circular_economy_guide_en.pdf.

European Commission (2020). The EU Blue Economy Report. 2020. Recuperado de: https://ec.europa.eu/maritimeaffairs/sites/maritimeaffairs/files/2020_06_blueeconomy-2020-ld_final.pdf.

GURRIA, P., RONZON, T., TAMOSIUNAS, S., LOPEZ, R., GARCIA CONDADO, S., GUILLEN, J., CAZZANIGA, N. & M'BAREK, 2017. "Biomass flows in the European Union: The Sankey biomass diagram - towards a cross-set

integration of biomass, JRC Working Papers JRC106502, Joint Research Centre (Seville site).

HAMELIN, L., BORZĘCKA, M., KOZAK, M. & PUDEŁKO, R. (2019). A spatial approach to bioeconomy: Quantifying the residual biomass potential in the EU-27, Renewable and Sustainable Energy Reviews. Renewable and Sustainable Energy Reviews. Volume 100, February 2019, Pages 127-142.

HOLDEN, N., WHITE, E.P., LANGE, M,C. & OLDFIELD, T.L. (2018) Review of the sustainability of food systems and transition using the Internet of Food. Science of Food (2018) 2:18 ; doi:10.1038/s41538-018-0027-3.

IDEA (2011). Recuperado de: https://www.idae.es/uploads/documentos/documentos_11227_e15_residuos_c3ead071.pdf.

IFFLAND, K., SHERWOOD, J., CARUS M., RASCHKA, A., FARMER, T. & CLARK, J. 2015: Definition, Calculation and Comparison of the "Biomass Utilization Efficiency (BUE)" of Various Bio-based Chemicals, Polymers and Fuels, Hürth 2015-11. Download at www.bio-based.eu/nova-papers.

JRC European Commission – Joint Research Centre. (2012). Life cycle indicators framework: development of life cycle based macro-level monitoring indicators for resources, products and waste for the EU-27. European Commission, Joint Research Centre, Institute for Environment and Sustainability.

KBC. Knowledge Bioeconomy Center (2020). Bioeconomy | Knowledge for policy (europa.eu). Acceso 7 de diciembre de 2020.

KIRCHER, M. (2019). Bioeconomy: Markets, Implications, and Investment Opportunities. Economies 2019, 7, 73; doi:10.3390/economies7030073.

KRAUSMANN, F., GINGRICH, S., EISENMENGER, N., ERB, K., HABERL H. & FISCHER-KOWALSKI M. (2009). Growth in global materials use, GDP and population during the 20th century. Ecological Economics 68(10), 2696-2705. Doi: 10.1016/j.ecolecon.2009.05.007.

KRAUSMANNA, F., WIEDENHOFERA, D., LAUKA, K., HAASA, W., TANIKAWAB, H., FISHMANB, T., MIATTOB, A., SCHANDLD, H. & HABER, H. (2017) Global

socioeconomic material stocks rise 23-fold over the 20th century and require half of annual resource use. PNAS February 21, 2017 114 (8) 1880-1885; https://doi.org/10.1073/pnas.1613773114.

LAINEZ, M. & PERIAGO, M.J. (2019). The Bioeconomy: An Opportunity for the Spanish Economy. Chapters, in: Krzysztof Biernat (ed.), Elements of Bioeconomy, IntechOpen. Doi: 10.5772/intechopen.84917.

LAINEZ, M., PERIAGO, M.J., ARRIBAS, N. & MENESES, C. (2018). La bioeconomía como oportunidad para la economía española: la visión desde el observatorio de bioeconomía. Mediterráneo económico, nº 31, 95-118. Recuperado de: https://www.publicacionescajamar.es/publicacionescajamar/public/pdf/publicaciones-periodicas/mediterraneo-economico/31/mediterraneo-economico-31.pdf.

M'BAREK, R., PHILIPIDIS, G., SUTA, C., & SANTINI, F. (2014). Observing and analyzing the Bioeconomy in the EU – Adapting data and tools to new questions and challenges. Bio-based and Applied Economics 3(1): 83-91, 2014. Doi: 10.13128/BAE-14189.

MCKINSEY (2020), Mckinsey on climate change. September 2020. Recuperado de: https://www.mckinsey.com/.

MOLDAN, B., JANOUŠKOVÁ, S. & HÁK, T. (2012). How to understand and measure environmental sustainability: Indicators and targets. Ecological Indicators. Volume 17, June 2012, Pages 4-13.

NOTARMICOLA, B., TASIELLI, G., RENZULLI, P.A., CASTELLANI, V. & SALA, S. (2017). Environmental impacts of food consumption in Europe. Journal of Cleaner Production 140 (2017) 753e765.

NRC. (2014). Sustainability and the U.S. EPA. Committee on Incorporating Sustainability in the U.S. Environmental Protection Agency. Science and Technology for Sustainability Program. Policy and Global Affairs Division. National Research Council of the National Academies. ISBN 978-0-309-21252-6. The National Academies Press. 2014.

OCDE. (2018). Growing a sustainable Bioeconomy Bio-production for the biennium 2015-2016. DSTI/STP/BNCT(2016)1. Recuperado de: http://www.oecd.org/.

PARISI, C. (2018). "Research Brief: Biorefineries distribution in the EU". European Commission – JRC.

PATINHA CALDEIRA, C., VLYSIDIS, A., FIORE, G., DE LAURENTIIS, V., VIGNALI, G. & SALA, S. (2020). Sustainability of food waste biorefinery: A review on valorisation pathways, techno-economic constraints, and environmental assessment, BIORESOURCE TECHNOLOGY, ISSN 0960-8524 (online), 312, p. 123575, JRC118963.

PIOTROWSKI, S., CARUS, M. & CARREZ, D. (2018). European Bioeconomy in Figures 2008-2015. Comissioned by Biobased Industries Consortium. Recuperado de: https://biconsortium.eu/sites/biconsortium.eu/files/documents/Bioeconomy_data_2015_20150218.pdf.

PURSULA, T., AHO, M., RÖNNLUND, I. & PÄÄLLYSAHO, M. (2018) Environmental Sustainability Indicators for the Bioeconomy. En Leal, Roberto y Borges Eds. Towards a Sustainable Bioeconomy: Principles, Challenges and Perspectives. Pag 43 -62. Springer International Publishing AG 2018.

RONZON, T., PIOTROWSKI, S., TAMOSIUNAS, S., LARA, D., CARUS, M. & M`BAREK, R. (2020). Developments of Economic Growth and Employment in Bioeconomy Sectors across the EU. Sustainability 2020, 12, 4507; doi:10.3390/su12114507.

SCARLAT, N., DALLEMAND, JF. & FAHL, F. (2018). Biogas: Developments and perspectives in Europe. Renewable Energy 129: 457-472. https://doi.org/10.1016/j.renene.2018.03.006.

SPEKREIJSE, J., LAMMENS, T., PARISI, C., RONZON, T. & VIS, M. (2019) Insights into the European market of bio-based chemicals. Analysis based on ten key product categories, EUR 29581 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-79-98420-4, doi:10.2760/549564, JRC112989. Recuperado de:

https://publications.jrc.ec.europa.eu/repository/bitstream/JRC112989/jrc_europeanmarket_biochemicals_online.pdf

THORENZ, A, WIETSCHEL, L., STINDT, D. & TUMA, A. (2018). Assessment of agroforestry residue potentials for the bioeconomy in the European Union. Journal of Cleaner Production.Volume 176, 1 March 2018, Pages 348-359

UE. (2019). Causes of climate change. Recuperado de: https://ec.europa.eu/clima/change/causes_en.

VILLARÁN, M.C., CHAVARRI, M., DIETRICH, T. & RODRIGUEZ, E. (2018). Subproductos hortofrutícolas para una bioeconomía circular. Mediterráneo económico, nº 31, 251- 272. Recuperado de: https://www.publicacionescajamar.es/publicacionescajamar/public/pdf/publicaciones-periodicas/mediterraneo-economico/31/mediterraneo-economico-31.pdf.

Policies and Business for the Bioeconomy in LAC: An ongoing process

Hugo Chavarría[1], Eduardo Trigo[1] y Juan F. Martínez[1]

Corresponding Author: hugo.chavarria@iica.int

Abstract:

At the productive level, for more than 30 years, several countries in Latin America and the Caribbean have developed business models related to different bioeconomy pathways. Today some of these countries are leaders in biotechnological applications for agriculture, bioenergies, use of biodiversity and low carbon agriculture. In the political-institutional sphere, the concept of bioeconomy was established in the region through projects assisted by the European cooperation, which promoted the awareness of this topic. In parallel, the countries have elaborated initiatives and regulations for those bioeconomy paths with the greatest potential. Just recently countries started to build policies and strategies specifically dedicated to the bioeconomy. In addition to national efforts, international cooperation has played an important role in promoting regional initiatives for the construction of public goods and the use of good practices and lessons learned. Although important progress has been made in the region, the exploitation of bioeconomy requires greater efforts focused on institution building, policies and market instruments that not only make profitable businesses viable but also ensure a framework of security and sustainability.

Key Words: Latin America and the Caribbean, biotechnology, biofuels, bio-businesses, biodiversity

Políticas y Negocios para la Bioeconomía en ALC: Un proceso en marcha

Hugo Chavarría[1], Eduardo Trigo[1] y Juan F. Martínez[1]

Resumen:

A nivel productivo, desde hace más de 30 años diversos países de América Latina y el Caribe gestan modelos de negocios que transitan por diferentes vías de la bioeconomía. Hoy algunos de esos países son líderes en aplicaciones biotecnológicas para la agricultura, bioenergías, aprovechamiento de la biodiversidad y agricultura baja en carbono. En el ámbito político–institucional, el concepto de bioeconomía llegó a la región de la mano de proyectos impulsados por la cooperación europea, que permitieron avanzar en la sensibilización del tema. En paralelo, los países han desarrollado iniciativas y normativas para aquellos senderos de la bioeconomía de mayor potencial. Solo recientemente los países iniciaron la construcción de políticas y estrategias dedicadas específicamente a la bioeconomía. Además de los esfuerzos nacionales, la cooperación internacional ha desempeñado un papel importante en la promoción de iniciativas regionales para la construcción de bienes públicos y el aprovechamiento de buenas prácticas y lecciones aprendidas. Si bien en la región se han logrado avances importantes, el aprovechamiento de la bioeconomía requiere mayores esfuerzos destinados a la construcción de institucionalidad, políticas e instrumentos de mercados que no solo viabilicen negocios rentables, sino que también aseguren un marco de seguridad y sostenibilidad.

Palabras clave: América Latina y el Caribe, biotecnología, biocombustibles, bionegocios, biodiversidad

[1] Instituto Interamericano de Cooperación para la Agricultura (IICA), (Costa Rica), hugo.chavarria@iica.int, ejtrigo@gmail.com, jfmartinez17@gmail.com

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa

Junta de Andalucía

Andalucía se mueve con Europa

1. THE ADVENT OF THE BIOECONOMY IN LAC

In general terms, it could be stated that the implementation of the Bioeconomy began in Latin America and the Caribbean (LAC) in the early 1970s with the launch of the "Pró-álcool" program in Brazil, in response to the price increase in the international oil industry, which spawned the Organization of Petroleum Exporting Countries (OPEC). Later, in the 1990s, this process was bolstered considerably with the developments linked to emerging biotechnologies, especially the creation of capacities and regulatory frameworks, leading to the rapid adoption in some countries - in particular, Argentina - of the first genetically modified (GM) crops and conservationist agriculture practices. Consequently, the region became a world leader in the implementation of these types of production strategies (Trigo *et al.,* 2009a, 2009b).

The idea of the Bioeconomy as a strategy for sustainable development appeared some time later linked to international cooperation initiatives. Different bi-regional projects between the European Union (EU) and LAC fostered debate on the Bioeconomy as the basis of a vision for sustainable development in the region, affecting public bodies responsible for Science, Technology and Innovation (STI) policies. For example, within the framework of the ALCUE-FOOD project (European Commission, 2008) of EU Programme IV, in 2008 a regional workshop was organized in Buenos Aires, Argentina. At this point an institutional commitment was undertaken to carry out a collaborative effort between the LAC countries and the EU interested in the subject, to promote the development of a shared vision of the Bioeconomy, in addition to a particular and differentiating perspective (Trigo & Henry, 2011).

In parallel, the United Nations Industrial Development Organization (UNIDO) proposed, between 2008 and 2009, the formation of a working group on the subject. This group of experts, hailing from more than ten LAC countries and the EU, delivered a report that highlighted the Bioeconomy opportunities for the region and a series of recommendations for action. These included the designing of policies, decision-making, capacity building and the facilitation of business development in the sector (UNIDO, 2009).

In this context of surging interest in the Bioeconomy, the ALCUE-KBBE project "Towards a Latin America and Caribbean Knowledge Based Bio-Economy in partnership with Europe" was approved within the framework of EU Programme VII. Its objective was to establish a cooperative LAC-EU platform to lay down the foundations of a political and institutional environment conducive to the development of the Bioeconomy. This project featured participation by 11 countries (France, Germany, the Netherlands, Belgium, Portugal, Argentina, Colombia, Costa Rica, Brazil, Uruguay, Mexico) and was carried out between 2011 and 2013 (European Commission, 2013). This period can be considered that of the definitive maturation of the idea of the Bioeconomy as a vision for sustainable development, and that of its incorporation into the region's political agenda (Hodson 2014). This was clearly reflected in the implementation of the ALCUE-NET project ("Latin America, Caribbean and European Union Network on Research and Innovation") in 2012-2017, which formally created a Bioeconomy forum within the structure of the bi-regional political dialogues that sought to implement the decisions of the EU-LAC Heads of State Summits (European Commission, 2017).

2. EARLY ADOPTION AND THE PROMINENCE OF BIOECONOMY BUSINESS: A SHOWCASE EFFECT THAT SERVED TO CONVINCE DECISION-MAKERS

In LAC, Bioeconomy businesses appeared much earlier than policies and strategies focused on the subject. In the mid-1990s the region began to use new technologies to make more efficient and sustainable use of biological resources in agriculture and other economic areas. Although at that time different terms were used, the truth is that several LAC countries were early adopters, trailblazers that today they are world leaders in some Bioeconomy businesses, such as the production and export of biofuels, liquids, biotechnological applications in agriculture, carbon neutrality in agricultural chains, and the sustainable use of biodiversity, among several others.

In the case of bioethanol, for example, about 14 Latin American countries have established mandates for the compulsory mixing of ethanol with

conventional fuels, ranging from 5% in Guatemala and Uruguay, to 27% in Brazil (REN21, 2019). In the latter, sugar cane and its by-products account for more than 17% of primary energy and replace 36% of gasoline. Hence, this country stands as the second-leading producer (behind the United States) and the leading exporter of sugar cane ethanol in the world (Stolf & Oliveira, 2020). In the case of the biodiesel industry, Argentina is the world's third largest producer, second consumer and first exporter. The case of Colombia is of special note, as it is the only country in the region that uses palm diesel to comply with the mandatory inclusion of biofuels (10%), and is the leader in the LAC in the production of biodiesel of this type (CEPAL *et al.* 2019).

Meanwhile, in 1996 Argentina became a pioneer in the introduction and adoption of herbicide-tolerant soybeans, before countries such as Australia and India (James, 1997). Today practically all the soy produced in Argentina (as well as corn and cotton) are GM crops (Trigo, 2016). In addition to Argentina, this type of crop has been expanded to Brazil, Paraguay, Uruguay, Bolivia, Mexico, Colombia, Honduras, Chile and Costa Rica, covering more than 82 million hectares (ISAAA, 2018). The benefits of the adoption of GM crops include higher yields and the generation of favourable impacts in terms of environmental sustainability (Brookes & Barfoot 2018). According to the ISAAA (2018), the use of GMOs in the world's agriculture has conserved 183 million hectares of land and averted the use of 671 million kg of pesticides in the last ten years. In 2016 alone it resulted in a massive reduction in C02 emissions: 27 billion kg (equivalent to taking 16 million cars off the road for one year). The region has now developed its own GM crops, such as beans resistant to the Golden Mosaic Virus (Aragão, 2009) and drought-tolerant soybeans and wheat (Waltz, 2015), and it is progressing in the use of new genetic improvement technologies. For example, in Colombia, varieties of rice resistant to bacterial blight, obtained through genetic editing, have been approved (Montaguth, 2020).

In addition, the region has also been a forerunner and today is a leader in Bioeconomy businesses related to low-carbon agriculture and livestock, through efforts like its Nationally Appropriate Mitigation Actions (NAMA) in the rea of livestock, and coffee in Costa Rica (GIZ, 2019); sustainable livestock in

Brazil, Argentina, Uruguay and Colombia (FAO, 2019); as well as in undertakings based on the sustainable productive-commercial use of biodiversity and ecosystem services; and the recovery and exploitation of waste in agricultural chains, among many others.

In all the above cases Bioeconomy businesses have been forces driving the competitiveness of agriculture, environmental sustainability, and the generation of jobs and income in rural territories. Thanks to this, the issue has begun to gain prominence on the public agenda, and many decisionmakers in the region are now convinced of its potential and the need and opportunity to develop Bioeconomy policies, strategies and initiatives. In this way, not only will business be boosted, but this will also ensure that this occurs in a framework of security and sustainability.

3. POLITICAL COMMITMENTS TO THE INSTITUTIONALIZATION OF THE BIOECONOMY AS A DEVELOPMENT STRATEGY: FROM SPECIFIC INITIATIVES TO STRATEGIES TARGETING THE BIOECONOMY

The experiences of countries in other regions around the world demonstrate that political and institutional dimensions are decisive in the transition towards a bioeconomic model, since leadership, governance and coordination between institutions are essential to promote the developments required (Henry *et al.* 2014). Despite the foregoing, in LAC the institutional framework and public policy instruments related to the promotion of the Bioeconomy are lagging behind compared to progress in bio-businesses. It has not been until recently that decisionmakers have recognized the potential of the Bioeconomy, and that countries have established institutions and policies aimed at promoting it.

Each LAC country has established its own political-institutional Bioeconomy agenda, based on availability and access to biological resources, technological capabilities, production/trade structure, and national development objectives. Annex 1 summarizes the development of institutional frameworks and policies regarding different aspects of the Bioeconomy in the region. The sectors of greatest interest have been the regulatory frameworks for

the use and exploitation of agro-biotechnology, regulations on biofuels, the management of biodiversity, and support for national STI systems.

With regard to national STI systems, although the vast majority of countries have national strategies and plans, and sector programs, the truth is that the financial limitations suffered by the region have meant that public investment in research and development is both lacking and highly concentrated in a few countries, focused on solving problems in traditional areas (crops and livestock) (IFPRI, 2020). As an example, while high-income countries invest around USD 2.81 in research and development for every USD 100 of agricultural production, in LAC only Uruguay, Brazil, Chile and Argentina surpass USD 1.

As regards policies associated with the Bioeconomy in the agro-industrial sectors, there are two cases: biofuels and agrobiotechnology. Public instruments have materialized favouring the production of the former, such as tax benefits, and the establishment of free trade zones (FAO, 2013), due to union associativity and the sector's technical capacity. In Brazil, for example, the development of the country's entire Bioeconomy stemmed from its National Alcohol (Pro-Alcohol) Programme, and the rest of the institutional framework developed to promote the use of ethanol and biodiesel as fuels (RenovaBio and CBIO). This trend then spilled over into technological developments in agriculture, chemicals, and medicine, among other areas. In the case of Argentina, since the 1990s there have been value-adding incentives, today materialized in the Scheme for the Regulation and Promotion of the Sustainable Production and Use of Biofuels, set down in Laws 26.093 and 26.334 of 2006 (CEPAL *et al.* 2019). Similar examples can be found in Colombia and Paraguay, where there are laws and guidelines to promote the sustainable production of biofuels.

In the case of agrobiotechnology, 10 LAC countries have national biosafety frameworks that regulate its use. One of the pioneers was Argentina, which in 1991 constituted the National Biosafety Commission (CONABIA), which made possible the early exploitation of these technologies for productive development (CEPAL *et al.* 2019). Over the years, in addition to Argentina,

countries such as Brazil, Chile, Colombia, Paraguay, Uruguay and Honduras, among others, have managed to consolidate the institutional frameworks and policies for the generation and safe and sustainable use of biotechnologies in agriculture. Now, with new genetic improvement techniques, regulation is expected to promote the creation and bolstering of biotechnology-based companies that generate the region's own varieties.

As regards the sustainable exploitation of biodiversity for new businesses, it is essential to know biological diversity thoroughly, and to conserve it (Hodson *et al.* 2019). This is why all the LAC countries have established at least one policy, plan or programme related to the conservation of biodiversity. However, there are still great challenges in terms of bioprospecting and regulations associated with access to genetic resources, intellectual property and benefits for the bio-businesses that take advantage of this natural wealth.

In addition to advances in national plans on STI and regulations governing bioenergy, biotechnology, and the use of biodiversity, some countries have made inroads in the development of policies exclusively addressing the Bioeconomy, with a view to promoting it as a strategy to achieve the sustainable development objectives of the different countries, territories and chains. These approaches seek to build an institutional framework that reflects the transversal nature of the issue.

In this regard, the efforts of Argentina, Costa Rica, Colombia and Uruguay are of special note:

- Argentina: it was one of the first LAC countries to formally work on the creation of an institutional roadmap for the development of its Bioeconomy, through the signing of inter-ministerial agreements and the institution of a National Bioeconomy Council, under the Ministry of Science, Technology and Innovation (Rodríguez, 2018); and the establishment of a National Bioeconomy Programme as a specific mechanism to coordinate MINAGRO's activities on the subject. In addition, in conjunction with the Buenos Aires Cereal Exchange, the Bioeconomy Group was established as an instrument for the identification and promotion of investments in areas related to the

Bioeconomy (CEPAL *et al.* 2019).

- Costa Rica: in 2020 it became the first country in the region to formalize a national Bioeconomy strategy, which aims to further the country's objectives in terms of decarbonization and the sustainable promotion of competitiveness through an economy based on knowledge and the fair and equitable use of biodiversity. The strategy features five strategic axes: 1) Bioeconomy for rural development; 2) Bioeconomy and development; 3) residual biomass biorefineries; 4) advanced Bioeconomy; and 5) urban Bioeconomy and green cities. This process, which was spearheaded by the Ministry of Science, Technology and Telecommunications, will be implemented in three phases: take-off (2020-2022), escalation (2022-2026) and consolidation (2026-2030) (MICITT, 2020).
- Colombia: in December 2020 the Ministry of Science, Technology and Innovation launched the Bioeconomy Mission, a plan laying out and proposing a national strategy dedicated to the development of the Bioeconomy. This mission has five areas and strategic challenges: 1) Biodiversity and its ecosystem services; 2) Biosmart Colombia; 3) Agri-productive and Sustainable; 4) Biomass and green chemistry and 5) Health and Well-being. The strategy's goals include the Bioeconomy accounting for 10% of GDP and generating 2.5 million jobs by 2030 (MINCIENCIAS, 2020).
- Uruguay: engaged in designing a national sustainable Bioeconomy strategy. The process is being overseen by the Planning and Budget Office (which reports directly to the Presidency of the Republic) (FAO, 2018).

Finally, despite the progress in public initiatives in the region, there is still work to be done on institutional support for the creation of financing instruments, long-term action plans, and measurement systems including adequate indicators for monitoring, follow-up and evaluation. Likewise, the coordination of public sector actions must have a comprehensive vision of the different dimensions of public policies, in addition to fostering efforts by the

private sector to generate employment and sustainable production (Trigo *et al.* 2019).

4. EFFORTS TO PROMOTE COOPERATION BETWEEN THE REGION AND WITH THE REST OF THE WORLD

In addition to the efforts made by the private and public sectors in the last half of the decade, various international organizations have promoted cooperation between countries and the exchanging of good practices, lessons learned, and successful experiences in the region. In the same way, they have promoted joint efforts on research and investment projects. One of the first regional organizations to tackle the issue was the Economic Commission for Latin America and the Caribbean (ECLAC), which continued to work through networks and alliances in the countries after the completion of the LAC-EU projects.

Convinced of the topic's potential, in 2018 the Inter-American Institute for Cooperation on Agriculture (IICA) included in its Medium-Term Plan for 2018-2022 the establishment of a Hemispheric Program for the Bioeconomy and Productive Development, which works in the LAC countries towards the: 1) generation of evidence, enhanced awareness and capacity building regarding new uses of the Bioeconomy among agro-rural sector decision-makers and actors; 2) the formulation and implementation of tools and guides for the construction of differentiated roadmaps for Bioeconomy use, depending on the potential of the different territories and value chains; 3) the devising of policies, strategies, regulations and market instruments that showcase and make possible new productive uses of the Bioeconomy in agriculture and rural areas; and 4) the designing and implementation of strategies, plans, programmes, projects and investments to promote new biomass business models in rural territories and agricultural value chains (IICA, 2019b).

In addition, together with the IICA's efforts in the different countries and with its various partners and allies, the programme has made strides to bolster the positioning of the Bioeconomy in LAC's main technical and political forums, the region, and international conferences discussing the Bioeconomy.

Specifically, in October 2019, the Bioeconomy was a central topic at the ministerial meeting on Agriculture in the Americas, and was the subject of a ministerial declaration (IICA, 2019b). In October 2020, the Institute hosted the 24th International Conference on Applied Bioeconomy (ICABR), which was to be held in Latin America (Argentina) for the first time. However, due to the COVID-19 pandemic it was shifted to a virtual format (IICA 2020b). In November 2020 LAC played an unprecedented role at the *Global Bioeconomy Summit,* of which IICA was one of the five official partners (GBS, 2020).

In addition to IICA and ECLAC, other international and regional organizations, such as the International Labor Organization (ILO), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the Inter-American Development Bank (IDB), and the US Food and Agriculture Organization (FAO), have supported initiatives aimed at fostering regional cooperation in the areas of policy, indicators, technology and capacity building, among others. As a result of these interests, and prompted by an invitation extended by the Argentine government, in 2018 the Latin American Bioeconomy Forum was held in Buenos Aires. There, a Latin America Bioeconomy Network was established, which aims to promote a regional development strategy fostering exchanges of experiences and collaborative projects (MINCyT, 2019).

5. NOTES ON THE PENDING AGENDA

LAC has a competitive advantage when it comes to making the Bioeconomy an engine driving post-COVID-19 socioeconomic reactivation and a strategic asset for successful insertion into the new environment, given that it is home to 8 of the 17 most megadiverse countries on the planet, and more than 25% of its arable land; and it boasts 33.3% of the world's freshwater resources, which makes it the region with the greatest potential for biomass generation (CEPAL *et al.* 2019).

However, for the Bioeconomy to be a viable and profitable development model for the different types of agriculture and rural territories in LAC, and to generate links with other economic sectors, it is essential that scientific-technological developments be combined with normative and political frameworks, as well as market approaches and inclusive mechanisms

that generate incentives so that economic agents along the value chains make the decision to use biological resources and processes more efficiently in their production, transformation and commercialization models.

The main policies favouring the Bioeconomy are the following: a) environmental, sanitary, agricultural and health regulation frameworks that facilitate the promotion of the Bioeconomy; b) instruments to promote the creation or growth of Bioeconomy markets (public purchases, labelling, standards, market regulation and transparency, etc.); c) economic, financial and fiscal stimuli (financing, differentiated taxes, investment funds, support, etc.); d) the generation and/or strengthening of technical-scientific capacities for innovation; e) industrial location policies for the Bioeconomy (the promotion of clusters, training, Direct Foreign Investment (DFI), technology transfer, etc.); f) political support for biologically-based social change (awareness of potentialities); and g) the promotion of Research and Development through innovation programmes, clusters, pilot programmes, the generation of technologies, the strengthening of enablers, etc.).

In addition to the efforts undertaken in the region, to take advantage of the Bioeconomy as a regional development strategy, supranational initiatives - led by developed countries - are required, with a view to: i) a broader agreement on guiding principles for the formulation of global Bioeconomy policies, ii) a credible bioeconomic indicator framework and iii) an effective Bioeconomy knowledge management platform (Chavarría *et al.* 2020).

REFERENCES

ARAGÃO, F. (2009). First transgenic geminivirus-resistant plant in the field (en línea). *Nature Biotechnology*, 27:1086-1088. doi: https://doi.org/10.1038/nbt1209-1086.

BISANG, R., CHAVARRÍA, H., & TRIGO, E. (2019). ¿Cómo construimos la institucionalidad y las políticas públicas que se necesitan para desarrollar la bioeconomía en América Latina y el Caribe? San José, Costa Rica, IICA. Recuperado de https://repositorio.iica.int/bitstream/handle/11324/8631/BVE20017763e.pdf?sequence=1&isAllowed=y.

BROOKES, G., & BARFOOT, P. (2018). Environmental impacts of genetically modified (GM) crop use 1996-2016: Impacts on pesticide use and carbon emissions (en línea). *GM Crops & Food*, 9(3):109-139. doi: 10.1080/21645698.2018.1476792.

CEPAL (COMISIÓN ECONÓMICA PARA AMÉRICA LATINA Y EL CARIBE, CHILE), FAO (ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA ALIMENTACIÓN Y LA AGRICULTURA, ITALIA)., e IICA (INSTITUTO INTERAMERICANO DE COOPERACIÓN PARA LA AGRICULTURA, COSTA RICA). (2019). Perspectivas de la agricultura y del desarrollo rural en las Américas: una mirada hacia América Latina y el Caribe 2019-2020. San José, Costa Rica, IICA. Recuperado de https://repositorio.iica.int/bitstream/handle/11324/12380/BVE20107947e.pdf?sequence=1&isAllowed=y.

CHAVARRÍA, H., TRIGO, E., VILLARREAL, F., & ELVERDIN, P. (2020) BIOECONOMY: A SUSTAINABLE DEVELOPMENT STRATEGY (en línea). G20 2020. Recuperado de: https://www.g20-insights.org/policy_briefs/bioeconomy-sustainable-development-strategy/.

EUROPEAN COMMISSION. (2005). New perspectives on the knowledge based bioeconomy. Transforming life sciences knowledge into new, sustainable, eco efficient and competitive products. Bruselas, Bélgica.

EUROPEAN COMMISSION. (2008). From European fork to Latin American farm: an innovative networking platform for EU-LAC partnerships in food quality and safety R&D (en línea). Bruselas, Bélgica. Recuperado de: https://cordis.europa.eu/project/id/7176/es.

EUROPEAN COMMISSION. (2013). Towards a Latin America & Caribbean Knowledge Based Bio-Economy (KBBE) in Partnership with Europe (en línea). Bruselas, Bélgica. Recuperado de: https://cordis.europa.eu/project/id/264266/reporting/es.

EUROPEAN COMMISSION. (2017). Latin America, Caribbean and European Union Network on Research and Innovation (en línea). Bruselas, Bélgica. Recuperado de: https://cordis.europa.eu/project/id/311953/es.

FAO (ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA ALIMENTACIÓN Y LA AGRICULTURA, ITALIA). (2013). La bioenergía en América Latina y el Caribe:

el estado de arte en países seleccionados (en línea). Roma, Italia. Recuperado de: http://www.fao.org/3/a-as112s.pdf.

FAO (ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA ALIMENTACIÓN Y LA AGRICULTURA, ITALIA). (2018). Uruguay rumbo a una estrategia nacional en bioeconomía (en línea). Roma, Italia. Recuperado de: http://www.fao.org/uruguay/noticias/detail/es/c/1103089/.

FAO (ORGANIZACIÓN DE LAS NACIONES UNIDAS PARA LA ALIMENTACIÓN Y LA AGRICULTURA, ITALIA). (2019). Cambio climático y seguridad alimentaria y nutricional en América Latina y el Caribe (en línea). Santiago, Chile. 56 pp. Recuperado de: http://www.fao.org/3/ca2902es/CA2902ES.pdf.

GERMAN BIOECONOMY COUNCIL. (2014). Signpost in the Right Direction (en línea). Berlín, Alemania. Recuperado de: https://biooekonomierat.de/en/press/press-releases/press-release-boer-140605/index.html.

GIZ (DEUTSCHE GESELLSCHAFT FÜR INTERNATIONALE ZUSAMMENARBEIT). (2019). NAMA Café de Costa Rica – Hacia un sector café bajo en emisiones (en línea). Recuperado de: https://www.giz.de/en/downloads/giz2019_es_Factsheet_NAMA%20Cafe.pdf.

GBS (GLOBAL BIOECONOMY SUMMIT). (2020). Official Partners of GBS2020 (en línea). Recuperado de: https://gbs2020.net/official-partnerships/.

HENRY, G., PAHUN, J., & TRIGO, E. (2014). La bioeconomía en América Latina: oportunidades de desarrollo e implicaciones de política e investigación (en línea). *FACES* 42(4):(125-141). Recuperado de: http://nulan.mdp.edu.ar/2112/1/FACES_n42-43_125-141.pdf.

HODSON, E. (2014). *Hacia una bioeconomía en América Latina y el Caribe en asociación con Europa*. Bogotá, Colombia, Pontificia Universidad Javeriana.

HODSON, E., HENRY, G., & TRIGO, E. (2019). *La bioeconomía. nuevo marco para el crecimiento sostenible en América Latina* (en línea). Bogotá, Colombia, Pontificia Universidad Javeriana. Recuperado de: http://repositorio2.iica.int/bitstream/handle/11324/8366/BVE190403022e.pdf?sequence=1&isAllowed=y.

IFPRI (THE INTERNATIONAL FOOD POLICY RESEARCH INSTITUTE). (2020). Agricultural Science and Technology Indicators. Outputs for Latin America and the Caribbean (en línea). Recuperado de: https://www.asti.cgiar.org/lac-outputs.

IICA (INSTITUTO INTERAMERICANO DE COOPERACIÓN PARA LA AGRICULTURA, COSTA RICA). (2019a). Informe de la Conferencia de Ministros de Agricultura de las Américas y de la Vigésima Reunión Ordinaria de la Junta Interamericana de Agricultura (en línea). San José, Costa Rica. Recuperado de: http://repositorio.iica.int/bitstream/handle/11324/8503/BVE20017732e.pdf.

IICA (INSTITUTO INTERAMERICANO DE COOPERACIÓN PARA LA AGRICULTURA, COSTA RICA). (2019b). Programa de bioeconomía y desarrollo productivo: abordajes conceptuales y metodológicos para la cooperación técnica (en línea). San José, Costa Rica. Recuperado de: https://repositorio.iica.int/handle/11324/7909.

IICA (INSTITUTO INTERAMERICANO DE COOPERACIÓN PARA LA AGRICULTURA, COSTA RICA). (2020a). Los biocombustibles líquidos en las Américas: situación actual y potencial de desarrollo (en línea). San José, Costa Rica. Recuperado de: http://biblioteca.iica.int/cgi-bin/koha/opac-detail.pl?biblionumber=139983.

IICA (INSTITUTO INTERAMERICANO DE COOPERACIÓN PARA LA AGRICULTURA, COSTA RICA). (2020b). Mayor encuentro global de bioeconomía reúne sector privado y representantes de universidades (en línea). San José, Costa Rica. Recuperado de: https://www.iica.int/es/prensa/noticias/mayor-encuentro-global-de-bioeconomia-reune-sector-privado-y-representantes-de.

ISAAA (INTERNATIONAL SERVICE FOR THE ACQUISITION OF AGRI-BIOTECH APPLICATIONS, ESTADOS UNIDOS DE AMÉRICA). (2018). Global Status of Commercialized Biotech/GM Crops in 2018: Biotech Crops Continue to Help Meet the Challenges of Increased Population and Climate Change. Ithaca, Nueva York, Estados Unidos de América. (ISAAA Brief No. 54).

JAMES, C. (1997). Global Status of Transgenic Crops in 1997 (en línea). Ithaca, Nueva York, Estados Unidos de América, ISAAA. Recuperado de:

https://www.isaaa.org/resources/publications/briefs/05/download/isaaa-brief-05-1997.pdf.

MICITT (MINISTERIO DE CIENCIA, TECNOLOGÍA Y TELECOMUNICACIONES, COSTA RICA). (2020). Estrategia Nacional de Bioeconomía Costa Rica 2020-2030 (en línea). San José, Costa Rica. Recuperado de: https://www.micit.go.cr/sites/default/files/estrategia_nacional_bioeconomia_cr_corregido.pdf.

MINCIENCIAS (MINISTERIO DE CIENCIA, TECNOLOGÍA E INNOVACIÓN, COLOMBIA). (2020) Misión de Bioeconomía para una Colombia Potencia viva y diversa: Hacia una sociedad impulsada por el Conocimiento. Bogotá, Colombia.

MINCyT (MINISTERIO DE CIENCIA, TECNOLOGÍA E INNOVACIÓN, ARGENTINA). (2019). Primer Simposio Latinoamericano de Bioeconomía (en línea). Recuperado de: http://www.cursobioeconomia.mincyt.gob.ar/1er-simposio-latinoamericano-de-bioeconomia/.

MONTAGUTH, S. (2020). Arroz editado genéticamente obtiene luz verde en EEUU y Colombia (en línea). Bogotá, Colombia, Agro-Bio. Recuperado de: https://www.agrobio.org/arroz-editado-geneticamente-obtiene-luz-verde-en-eeuu-y-colombia/.

OECD (ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT, FRANCIA). (2010). The bioeconomy to 2030: Designing a policy agenda (en línea). París, Francia. Recuperado de: https://www.oecd.org/futures/longtermtechnologicalsocietalchallenges/thebioeconomyto2030designingapolicyagenda.htm.

REN21. (2019). Renewables 2019 Global Status Report (en línea). París, Francia. Recuperado de: https://www.ren21.net/wp-content/uploads/2019/05/gsr_2019_full_report_en.pdf.

RODRÍGUEZ, A. (2018). Bioeconomía en América Latina y el Caribe, 2018 (en línea). Santiago, Chile, Naciones Unidas. Recuperado de: https://repositorio.cepal.org/bitstream/handle/11362/44241/1/S1800922_es.pdf.

STOLF, R., OLIVEIRA, A. (2020). The Success of the Brazilian Alcohol Program (Proálcool) - A Decade-by-Decade Brief History of Ethanol in Brazil (en línea).

Engenharia Agrícola, Jaboticabal, 40(2), 243-248. doi: http://dx.doi.org/10.1590/1809-4430-eng.agric.v40n2p243-248/2020.

THE WHITE HOUSE OFFICE. (2012). National Bioeconomy Blueprint (en línea). Washington D. C., Estados Unidos de América. Recuperado de: https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/national_bioeconomy_blueprint_april_2012.pdf.

TRIGO, E. (2016). Veinte años de cultivos genéticamente modificados en la agricultura argentina (en línea). Buenos Aires, Argentina, ArgenBio. Recuperado de: https://www.fiba.org.ar/wp-content/uploads/2016/12/informe20gm.pdf.

TRIGO, E., & HENRY, G. (2011). Una bioeconomía para América Latina y el Caribe: oportunidades y retos desde una perspectiva de políticas (en línea). Cali, Colombia, Oficina CIRAD ALCUE-KBBE, CIAT. Recuperado de: https://agritrop.cirad.fr/567664/1/document_567664.pdf.

TRIGO, E., CAP, E., MALACH, V., & VILLARREAL, F. (2009a). Innovating in the Pampas: Zero-tillage soybean cultivation in Argentina (en línea). Spielman, DJ; Pandya-Lorch, R. *In Millions Fed: Proven successes in agricultural development* (pp. 59-64). Washington, D. C., Estados Unidos de América, IFPRI. Recuperado de: http://ebrary.ifpri.org/cdm/ref/collection/p15738coll2/id/130818.

TRIGO, E., CAP, E., MALACH, V., & VILLARREAL, F. (2009b). The Case of Zero-Tillage Technology in Argentina (en línea). Washington, D. C., Estados Unidos de América, IFPRI. Recuperado de: https://www.ifpri.org/publication/case-zero-tillage-technology-argentina.

TRIGO, E., REGÚNAGA, M., COSTA, R., & COREMBERG, A. (2019). Bioeconomía en Argentina: alcances, situación actual y oportunidades para el desarrollo sustentable (en línea). *In* Hodson, E., Henry, G; Trigo, E. La bioeconomía. *Nuevo marco para el crecimiento sostenible en América Latina* (pp. 25-47). Bogotá, Colombia, Pontificia Universidad Javeriana. Recuperado de: http://repositorio2.iica.int/bitstream/handle/11324/8366/BVE190403022e.pdf?sequence=1&isAllowed=y.

UNIDO (UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION). (2009). Report of UNIDO's Expert Group Meeting on Knowledge Based Bio Economy

as Basis for Economic Development and Industrial Sustainability (en línea). Viena, Austria. Recuperado de: https://silo.tips/download/concepcion-chile-november-30-december-2-2009.

WALTZ, E. (2015). First stress-tolerant soybean gets go-ahead in Argentina (en línea). *Nature Biotechnology,* 33, 682. Recuperado de: https://doi.org/10.1038/nbt0715-682.

MONOGRAPH: The INNOVAGRO Network and the Bioeconomy

Martha Escalante[1] y Lucía Reguillo[2]

Autor de Correspondencia: opi02.op@ceia3.es

Abstract:

We are now facing a changing scenario full of global challenges characterised by an interconnection between countries. Dependence on fossil resources and the depletion of natural ones give rise to a critical panorama that urgently requires action by society and the public and private sectors. In this regard, the Bioeconomy, constitutes a multidisciplinary and collaborative tool to address these global challenges. In order to put it into practice from different perspectives, cooperation at the level of international institutions sharing common objectives is an important step towards this important and necessary shift. This monograph is presented in this context, aiming to make known the role of the INNOVAGRO Network and explain its actions through posters featuring useful and simplified information from the various members of the Network in the field of the Bioeconomy.

Keywords: Competitiveness, sustainable development, bioeconomy, Latin America, cooperation

MONOGRÁFICO: La red INNOVAGRO y la bioeconomía

Martha Escalante[1] y Lucía Reguillo[2]

Resumen:

Nos encontramos ante un escenario cambiante lleno de desafíos globales con interconexión entre países. La dependencia de recursos fósiles y el agotamiento de los recursos naturales, configuran un panorama crítico que requiere de manera urgente que se adopten medidas a nivel de la sociedad y de los sectores público y privado. En este sentido, la bioeconomía, es una herramienta multidisciplinar y colaborativa para abordar los citados desafíos globales. Para su puesta en práctica, afrontada desde distintas perspectivas, la cooperación a nivel internacional de instituciones con objetivos comunes supone un importante paso para ser parte de tan importante y necesario cambio. En este contexto, se presenta este monográfico, que tiene como objetivo exponer el rol de la Red INNOVAGRO y ejemplificar su acción mediante posters, con la información útil y simplificada de los distintos miembros de la Red en el ámbito de la bioeconomía.

Palabras clave: competitividad, desarrollo sustentable, bioeconomía, Iberoamérica, cooperación

[1] Red INNOVAGRO, Instituto Interamericano de Cooperación para la Agricultura (IICA), (México), martha.escalante@iica.int

[2] Campus de Excelencia Internacional Agroalimentario (ceiA3), (España), opi02.op@ceia3.es

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa

Junta de Andalucía

Andalucía se mueve con Europa

1. THE INNOVAGRO NETWORK AND THE BIOECONOMY

Today the world faces a number of interconnected global challenges, such as dependence on fossil resources, food security, population growth, globalization, the effects of climate change, biodiversity loss, and the scarcity of natural resources. Before this scenario, it is vital that we rethink our production models and our development paradigms, from the local to the global levels, to ensure sustainable agri-food systems in the medium and long term. The bioeconomy and its transversal nature represent a response to a currently worrying environment and a multidisciplinary, collaborative tool to tackle global challenges.

In the face of the aforementioned scenario, the need arises to shed an outdated vision of the agricultural sector as a generator of primary goods, and to see agriculture as a biomass industry and the central force in new times in societies that aspire to be more efficient in the use of natural resources and less dependent on fossil resources. For this climate-responsible production models are required, in which the bioeconomy expresses this transformative vision, to promote sustainable and smart agricultural development based on the broad base of biological resources that we possess (FAO. 2019).

In Ibero-America different countries have opted to undertake regional and national initiatives and policies to promote innovation oriented towards sustainable production and the Circular Economy.

With a more global nature, the Inter-American Institute for Cooperation on Agriculture (IICA), in its 2018-2022 medium-term plan, includes "Bioeconomy and Productive Development" as its first core programme.

Meanwhile, in Europe, at the Community, national and regional levels, the importance of and need for the bioeconomy in the current context has been highlighted. In this regard, based on the 2018 Action Plan published by the European Commission, a bioeconomy strategy has been implemented that rests on the cornerstones of said action plan: (i) strengthening the sector with potential

in the development of bioeconomic products, (ii) the rapid implementation of the local bioeconomy throughout Europe and (iii) knowing the limits of the bioeconomy.

According to data from the Ministry of Agriculture, Fisheries and Food, in 2019 the weight of the Spanish agri-food sector in the European Union increased 9.1% off the previous year, being the leading producer in citrus and olive oil, and fifth in gross value contributed to the European Union. Spain, therefore, is a country key to the international commitments taken on within the framework of the UN Sustainable Development Goals, in which the agri-food and fishing sectors are components vital to the fulfilment of a large portion of them.

Public entities such as the Campus of International Agri-food Excellence, ceiA3, are strategic, as stated in various documents on the development of new resilient models in the Agri-food sector.

For the Agri-food Sector Innovation Management Network (INNOVAGRO), as a platform that promotes innovation in the agri-food ecosystems of the rural economies in the 15 countries (Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, El Salvador, Spain, the United States of America, the Netherlands, Mexico, Nicaragua and the Dominican Republic), represented through their 72 members in the public and private sectors (Research centres, public sector institutions, universities, companies, foundations, regional networks and systems; civil society organizations, international organizations and financial institutions), the objective is to bolster productivity, competitiveness and sustainable development from an economic, social and environmental perspective.

Hence, the bioeconomy constitutes a high-priority issue, based on innovation, knowledge, technology transfer, sustainable production models, food security, caring for natural resources, and their biological exploitation to find innovative solutions to global challenges.

Different aspects of the bioeconomy have been discussed at the Annual Meetings of the Network, for the purpose of fostering reflection that contributes

to the devising of strategies and action plans to strengthen innovation ecosystems in different countries. As examples of these meetings, in 2019 "The Bioeconomy and Innovation Ecosystems" was the central theme of the 9th Meeting of the INNOVAGRO Network; and in 2020 the focus was on "Pathways of Innovation for a Sustainable and Resilient Agri-food sector". Innovation, the bioeconomy and sustainability were key subjects addressed at these events, which consist of seminars, innovation routes and networking sessions that highlight the importance of the Agri-food sector at a global level and the need to forge international alliances that strengthen and promote the objectives described above.

In order to provide useful information illustrating cooperation within the framework of the INNOVAGRO Network, its main members, strongly aligned with the Bioeconomy, are shown below. The content contains a brief introduction to each one of them, relevant projects and initiatives, and their alignments on the subject.

SOCIO DE LA RED INNOVAGRO	**PAÍS**
BIOFÁBRICA S.XXI	MÉXICO
BIOKRONE. Excellence in biotechnology	MÉXICO
ceiA3	ESPAÑA
CIMMYT. Centro internacional de mejoramiento de maíz y trigo	MÉXICO
CIREN CHILE. Centro internacional de recursos naturales	CHILE
CTA Y LA BIOECONOMÍA CIRCULAR. Corporación tecnológica de Andalucía	ESPAÑA
FITTACORI Y LA BIOECONOMÍA. Fundación para el Fomento y Promoción de la Investigación y Transferencia de Tecnología Agropecuaria de Costa Rica	COSTA RICA
FUNICA. Fundación para el desarrollo tecnológico agropecuario y forestal de Nicaragua	NICARAGUA
ICAT/UNAM. Instituto de ciencias aplicadas y tecnología/Universidad Nacional Autónoma de México	MÉXICO
IICA. Instituto Interamericano de Cooperación para la Agricultura	COSTA RICA
SNIA. Sistema nacional de investigación agrícola	MÉXICO
TECNOVA CENTRO TECNOLÓGICO	ESPAÑA
UCR. Universidad de Costa Rica	COSTA RICA
UNALM. Universidad Nacional Agraria La Molina	PERÚ
AGROPOLO CAMPINAS-BRASIL VER	BRASIL
WUR. Wageningen University Research.	HOLANDA

Biofábrica Siglo XXI

Biofábrica Siglo XXI se fundó en el año 2003 para abordar un problema creciente: La necesidad de buscar alternativas productivas, ecológicas y económicas para mejorar la producción agrícola. Estas alternativas las encontramos en la agro-biotecnología, que nos ofrece los instrumentos para una transformación radical del actual modelo de producción a uno mas productivo y sustentable.

Biofábrica surgió a partir de un convenio de licencia tecnológica, celebrado con el Centro de Ciencias Genómicas, de la Universidad Nacional Autónoma de México (UNAM). Con este convenio la UNAM le transfirió a Biofabrica el uso del desarrollo biotecnológico que tenia más de 20 años de investigación. Este desarrollo se basa en el uso de microorganismos benéficos para la agricultura.

A partir de estos microorganismos benéficos licenciados por la UNAM, Biofábrica desarrolló sus primeros productos agro-biotecnológicos en el año 2004.

Desde nuestro origen, hemos tenido la función de articular la investigación científica con la producción agrícola, actualmente tenemos convenios de colaboración con la Universidad Nacional Autónoma de México (UNAM), con el Instituto Politécnico de Nacional (IPN), con el Concejo Nacional de Ciencia y Tecnología (CONACYT), con el Instituto Nacional de Investigaciones Agrícolas y Pecuarias (INIFAP), entre otras instituciones de Investigación de alto nivel del país.

El 24 de Mayo de 2019 inauguramos nuestra nueva planta de Investigación y Producción de Bioinsumos. Iniciando así una nueva etapa con la que buscamos impulsar un nuevo modelo de Agricultura Rentable y Sustentable, basado en el uso de la Agro-Biotecnología.

Logros

- Pionera en la producción de insumos biotecnológicos en México.
- Desarrollo de un esquema de innovación y desarrollo basado en la vinculación Investigación – Producción.
- Convenios de colaboración con las instituciones mas importantes del país (y de América Latina).
- 200 mil hectáreas biofertilizadas anualmente.
- Reducción del uso de fertilizantes químicos de entre el 20 y el 50% en parcelas Biofertilizadas.
- Reducción en el uso de pesticidas.

El Dr. Marcel Morales, director general de Biofábrica y el Secretario de Agricultura (Izquierda) durante la Inauguración de la planta de investigación y producción de Bioinsumos de Biofábrica Siglo XXI

Objetivo

El desarrollo de alternativas a la producción agropecuaria, articulando el trabajo de la investigación científica con la producción, en una perspectiva económica, productiva y ecológica

Biofábrica y la Bioeconomía

El modelo de trabajo de Biofábrica se basa en el impulso de la Bioeconomía

Tenemos más de 15 años promoviendo el uso de la biotecnología para mejorar la sustentabilidad del campo mexicano.

Inicialmente nos especializamos en la investigación, desarrollo y comercialización de Inoculantes Benéficos (Biofertilizantes) **para reducir el uso de agroquímicos y elevar el rendimiento, calidad y sanidad de las cosechas**. Actualmente tenemos proyectos de Investigación y Desarrollo y proyectos para el impulso de la Agro-Biotecnología como alternativa para mejorar la producción agrícola Mexicana

Programa de Agricultura sustentable

Es un programa integrador que vincula al sector académico, gubernamental y productivo para transformar el sistema de producción agrícola en el país. En la primera etapa arrancará en el Estado de Morelos, líder en la producción de diversos cultivos agrícolas.

Nuestra propuesta es que es posible incrementar la rentabilidad y sustentabilidad de los cultivos mediante el uso de la biotecnología y otras prácticas de conservación. Este proyecto propone:

- Disminuir la fertilización química en un 70 – 80%
- Disminuir y en algunos casos eliminar el uso de pesticidas
- Incrementar la rentabilidad de los cultivos mediante:
  - La disminución de los costos de producción
  - El incremento en el rendimiento de los cultivos
  - Incrementar los ingresos derivados del aumento en la calidad, sanidad e inocuidad de los cultivos
- Utilizar prácticas y tecnologías que fomenten la conservación y restauración de los suelos agrícolas.
  - Promover la captura de carbono en las parcelas agrícolas. Esto permitirá
    - Disminuir los gases de efecto invernadero
    - Aumentar la materia orgánica del suelo

El objetivo es traducir este programa en políticas publicas para mejorar la sustentabilidad y rentabilidad de los cultivos mediante el uso de la biotecnología

Durante la Inauguración de la Planta de Bioinsumos de Biofábrica se realizó la firma del convenio para el impulso de una agricultura rentable y sustentable, entre el gobierno del Estado de Morelos y la Financiera Nacional de Desarrollo.

Biotecnologías y prácticas del paquete tecnológico impulsado en el Programa de Agricultura sustentable

- Biofertilizantes (Inoculantes para la promoción del crecimiento y regeneración del suelo)
- Biopesticidas (Inoculantes para el control de plagas y enfermedades)
- Bioencapsulados de lenta liberación de fertilizantes. Son tecnologías biológicas basadas en el uso de compuestos orgánicos que secuestran los fertilizantes y los liberan lentamente.
- Minerales no procesados químicamente
- Biocarbón
- Composta (producida mediante el aprovechamiento de recursos regionales)
- Labranza de conservación
- Abonos verdes

Proyectos e iniciativas

Nuestro modelo de vinculación entre Instituciones académicas, empresas de base biotecnológica, entidades gubernamentales y productores agrícolas nos ha permitido desarrollar proyectos en varias líneas, los siguientes son algunos de nuestros proyectos principales:

- **Programa de Agricultura Rentable y Sustentable (descrito arriba)**
- **Investigación y Desarrollo de Bioinsumos Agrícolas**
  - Desarrollo de Bioencapsulados de lenta liberación de fertilizantes químicos.
  - Aprovechamiento de recursos regionales para la elaboración de compostas inoculadas con Biofertilizantes y Biopesticidas.
  - Aislamiento y selección de Cepas microbianas de alta efectividad.
    - Cepas promotoras de crecimiento vegetal.
    - Cepas para el control de plagas y enfermedades.
  - Desarrollo de procesos de producción industrial de productos Agro-biotecnológicos.
  - Formulación de nuevos productos Agro-biotecnológicos
- **Capacitación y transferencias de tecnología**
  - Formación de técnicos especializados en el uso y manejo de abro-biotecnologías.
- **Establecimiento de parcelas experimentales y demostrativas**
  - Seguimiento de resultados en cultivo:
    - Evaluación de Rendimiento, calidad y sanidad de los cultivos.
  - Seguimiento de resultados en suelo:
    - Evaluación de diversidad y actividad microbiana del suelo
    - Evaluación de Fertilidad
    - Evaluación de Estructura (Agregados del suelo)
    - Evaluación de captura de carbono en el suelo.
      - Materia orgánica del suelo
      - Carbono orgánico del suelo

www.biofabrica.com.mx
Dr. Marcel Morales Ibarra. Director General
marcel.morales@biofabrica.com.mx contacto@biofabrica.com.mx
(52) 55 5550 3858 – 55 5550 2827

Resultados

En 15 años de trabajo con inoculantes microbianos, comprobamos que el efecto sobre los cultivos es holístico, ya que no sólo tienen efectos nutricionales, también mejoran la calidad y la sanidad de los cultivos. Un ejemplo es la resistencia que inducen sobre la roya del café (derecha), enfermedad que devastó a este cultivo en México, mermando más del 50% e la producción nacional.

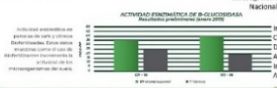
Resultados en Campo

Calidad Rendimiento Sanidad

Resultados en vivero

Efecto sobre la regeneración de la estructura del suelo

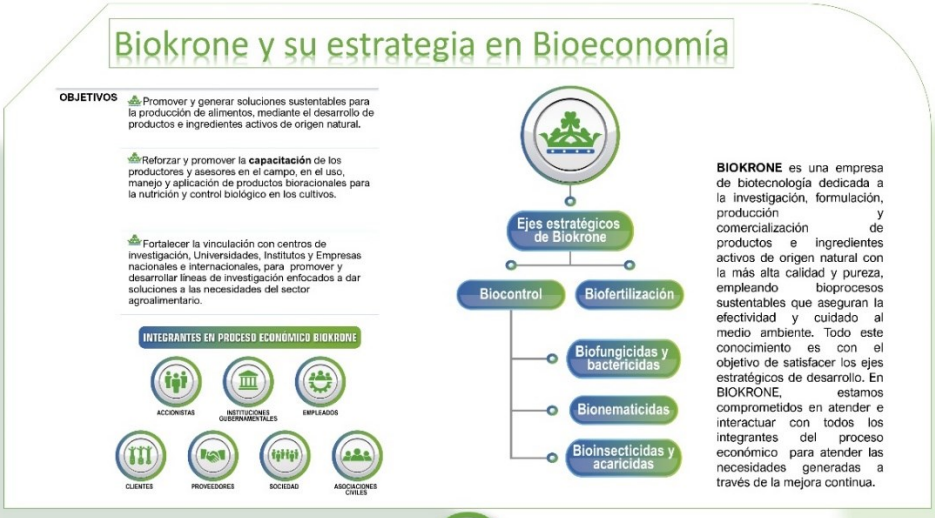
ACTIVIDAD MICROBIANA



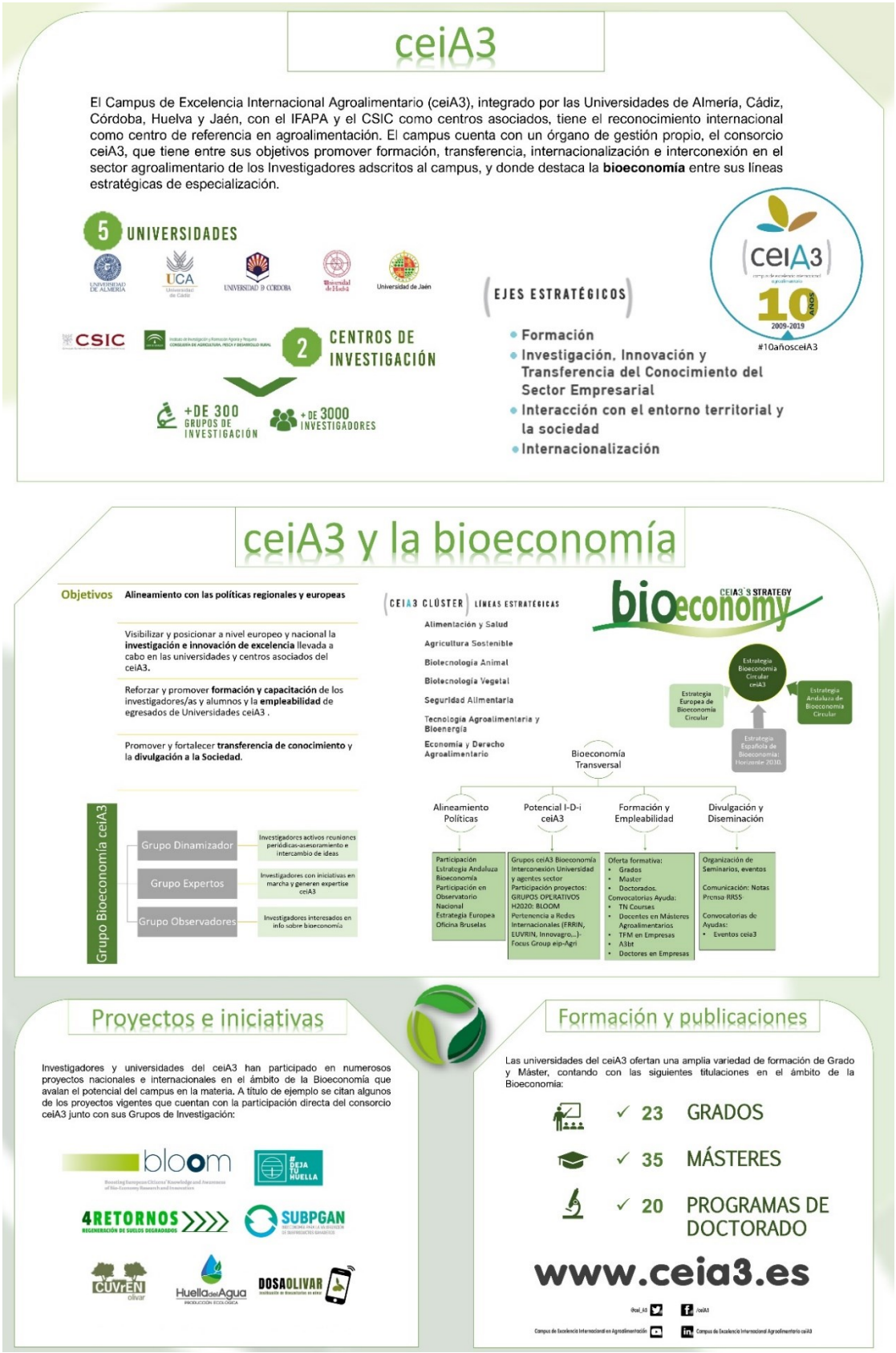
Investigación realizada con la Universidad Nacional Autónoma de México

Investigación realizada con el Centro de Investigación Disciplinaria en Relación al Suelo, Agua, Planta y Atmósfera del Instituto de Investigaciones Agrícolas y Pecuarias (INIFAP)


Biokrone
excellence in biotechnology
Biokrone es una empresa Mexicana que desarrolla soluciones ecológicas a través de la investigación aplicada para fortalecer una agricultura sostenible. La empresa tiene como compromiso proporcionar bienestar económico, social y ambiental en toda la cadena productiva de los diferentes desarrollos. Esto nos lleva a la búsqueda de soluciones innovadoras ante la demanda global de alimentación, pues aprovechamos la biotecnología, la genética y otros recursos científicos en el desarrollo de nuevos insumos agrícolas como biofertilizantes, biofungicidas y bioinsecticidas (biocontrol), con el objetivo de obtener alimentos para el consumo humano de alta calidad, donde la biodiversidad microbiológica es un factor clave para el desarrollo sostenible.
El desarrollo de los productos en Biokrone se logran, gracias al Sistema de Gestión de Tecnología, donde se identifican áreas de oportunidad y el departamento de investigación del Centro de Biotecnología Biokrone desarrolla los proyecto de innovación.
VINCULACIONES ESTRATÉGICAS
GOBIERNO
CONACYT
COFUPRO
SE
CENTROS DE INVESTIGACIÓN
CIDESI
cimav
Cinvestav
inifap
UNIVERSIDADES
SISTEMA DE GESTIÓN DE TECNOLOGÍA
VIGILANCIA TECNOLÓGICA
PLANEACIÓN TECNOLÓGICA
HABILITACIÓN TECNOLÓGICA
PROTECCIÓN TECNOLÓGICA
IMPLANTACIÓN TECNOLÓGICA
01
02
03
04
05


Biokrone y su estrategia en Bioeconomía
OBJETIVOS
Promover y generar soluciones sustentables para la producción de alimentos, mediante el desarrollo de productos e ingredientes activos de origen natural.
Reforzar y promover la capacitación de los productores y asesores en el campo, en el uso, manejo y aplicación de productos bioracionales para la nutrición y control biológico en los cultivos.
Fortalecer la vinculación con centros de investigación, Universidades, Institutos y Empresas nacionales e internacionales, para promover y desarrollar líneas de investigación enfocados a dar soluciones a las necesidades del sector agroalimentario.
INTEGRANTES EN PROCESO ECONOMICO BIOKRONE
ACCIONISTAS
INSTITUCIONES GUBERNAMENTALES
EMPLEADOS
CLIENTES
PROVEEDORES
SOCIEDAD
ASOCIACIONES CIVILES
Ejes estratégicos de Biokrone
Biocontrol
Biofertilización
Biofungicidas y bactericidas
Bionematicidas
Bioinsecticidas y acaricidas
BIOKRONE es una empresa de biotecnología dedicada a la investigación, formulación, producción y comercialización de productos e ingredientes activos de origen natural con la más alta calidad y pureza, empleando bioprocesos sustentables que aseguran la efectividad y cuidado al medio ambiente. Todo este conocimiento es con el objetivo de satisfacer los ejes estratégicos de desarrollo. En BIOKRONE, estamos comprometidos en atender e interactuar con todos los integrantes del proceso económico para atender las necesidades generadas a través de la mejora continua.


Impacto: social, ambiental y económico
Equipo Biokrone
Contacto:
/biokrone
www.biokrone.com
ventas@biokrone.com
Impactos y resultados
40 GRADOS ACADÉMICOS
2 RECONOCIMIENTOS NACIONALES
23% RENTABILIDAD
2 RECONOCIMIENTOS INTERNACIONALES
20% CRECIMIENTO ANUAL DE VENTAS GLOBALES


ceiA3
El Campus de Excelencia Internacional Agroalimentario (ceiA3), integrado por las Universidades de Almería, Cádiz, Córdoba, Huelva y Jaén, con el IFAPA y el CSIC como centros asociados, tiene el reconocimiento internacional como centro de referencia en agroalimentación. El campus cuenta con un órgano de gestión propio, el consorcio ceiA3, que tiene entre sus objetivos promover formación, transferencia, internacionalización e interconexión en el sector agroalimentario de los Investigadores adscritos al campus, y donde destaca la bioeconomía entre sus líneas estratégicas de especialización.
5 UNIVERSIDADES
CSIC
2 CENTROS DE INVESTIGACIÓN
+DE 300 GRUPOS DE INVESTIGACIÓN
+DE 3000 INVESTIGADORES
EJES ESTRATÉGICOS
Formación
Investigación, Innovación y Transferencia del Conocimiento del Sector Empresarial
Interacción con el entorno territorial y la sociedad
Internacionalización
ceiA3 10 AÑOS 2009-2019
#10añosceiA3
ceiA3 y la bioeconomía
Objetivos
Alineamiento con las políticas regionales y europeas
Visibilizar y posicionar a nivel europeo y nacional la investigación e innovación de excelencia llevada a cabo en las universidades y centros asociados del ceiA3.
Reforzar y promover formación y capacitación de los investigadores/as y alumnos y la empleabilidad de egresados de Universidades ceiA3 .
Promover y fortalecer transferencia de conocimiento y la divulgación a la Sociedad.
Grupo Bioeconomía ceiA3
Grupo Dinamizador
Investigadores activos reuniones periódicas-asesoramiento e intercambio de ideas
Grupo Expertos
Investigadores con iniciativas en marcha y generen expertise ceiA3
Grupo Observadores
Investigadores interesados en info sobre bioeconomía
CEIA3 CLÚSTER LÍNEAS ESTRATÉGICAS
Alimentación y Salud
Agricultura Sostenible
Biotecnología Animal
Biotecnología Vegetal
Seguridad Alimentaria
Tecnología Agroalimentaria y Bioenergía
Economía y Derecho Agroalimentario
bioeconomy CEIA3'S STRATEGY
Estrategia Bioeconomía Circular ceiA3
Estrategia Europea de Bioeconomía Circular
Estrategia Andaluza de Bioeconomía Circular
Estrategia Española de Bioeconomía: Horizonte 2030.
Bioeconomía Transversal
Alineamiento Políticas
Participación Estrategia Andaluza Bioeconomía
Participación en Observatorio Nacional Estrategia Europea
Oficina Bruselas
Potencial I-D-i ceiA3
Grupos ceiA3 Bioeconomía
Interconexión Universidad y agentes sector
Participación proyectos: GRUPOS OPERATIVOS H2020: BLOOM
Pertenencia a Redes Internacionales (FRRIN, EUVRIN, Innovagro...)-Focus Group eip-Agri
Formación y Empleabilidad
Oferta formativa:
Grados
Master
Doctorados.
Convocatorias Ayuda:
TN Courses
Docentes en Másteres Agroalimentarios
TFM en Empresas
A3bt
Doctores en Empresas
Divulgación y Diseminación
Organización de Seminarios, eventos
Comunicación: Notas Prensa RRSS
Convocatorias de Ayudas:
Eventos ceia3
Proyectos e iniciativas
Investigadores y universidades del ceiA3 han participado en numerosos proyectos nacionales e internacionales en el ámbito de la Bioeconomía que avalan el potencial del campus en la materia. A título de ejemplo se citan algunos de los proyectos vigentes que cuentan con la participación directa del consorcio ceiA3 junto con sus Grupos de Investigación:
bloom
DEJA TU HUELLA
4RETORNOS
SUBPGAN
CUVREN olivar
Huella del Agua
DOSAOLIVAR
Formación y publicaciones
Las universidades del ceiA3 ofertan una amplia variedad de formación de Grado y Máster, contando con las siguientes titulaciones en el ámbito de la Bioeconomía:
✓ 23 GRADOS
✓ 35 MÁSTERES
✓ 20 PROGRAMAS DE DOCTORADO
www.ceia3.es

CIMMYT MR

Centro Internacional de Mejoramiento de Maíz y Trigo

Desde **1966**, trabaja en el mundo en desarrollo con el fin de mejorar los medios de vida de las personas y promover sistemas de **maíz y de trigo** más productivos y sostenibles

Presencia en el mundo

Más del **70%** del trigo que se siembra en países en desarrollo y más del **50%** de las variedades mejoradas de maíz se derivan de materiales de mejoramiento del CIMMYT

Más de **10,000** científicos y expertos agrícolas capacitados en el CIMMYT

Sede central ubicada en **México**

Presente en **40** países

MasAgro

El programa MasAgro, es un proyecto de innovación, investigación y desarrollo rural de la Secretaría de Agricultura y Desarrollo Rural (SADER) y CIMMYT, que promueve prácticas agrícolas sustentables para la generación de sistemas agroalimentarios, incluyentes, sustentables y resilientes.

MasAgro desarrolla investigación y capacidades dirigidas a incrementar la rentabilidad y estabilidad de los rendimientos del maíz y del trigo en México, mediante esquemas de investigación colaborativa, el desarrollo agroalimentario y la difusión de variedades de semillas adaptadas de tecnologías y prácticas agronómicas sostenibles e inteligentes.

COMPONENTES

- Biodiversidad
- Maíz
- Trigo
- Productor
- Masificación

INFRAESTRUCTURA

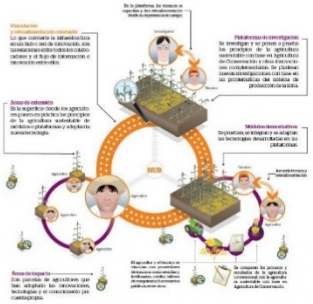
12 HUBS

- ✓ Aumentar el ingreso de los productores mexicanos.
- ✓ Sustentabilidad de sistemas agroalimentarios en maíz y trigo en México.
- ✓ Fortalecimiento de la seguridad alimentaria con investigación y desarrollo, generación de capacidades y transferencia de tecnología

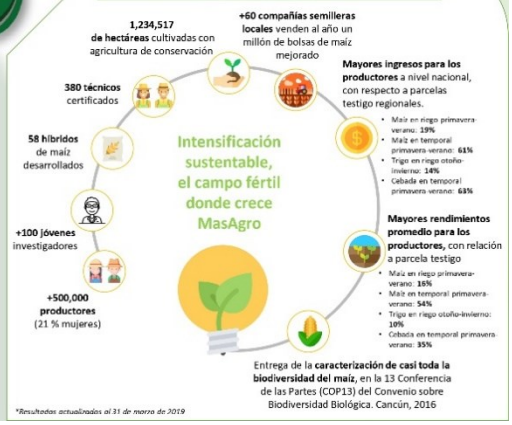
Nodos de innovación o *hubs*

El sistema hub permite al agricultor visualizar la nueva tecnología en acción, cultivada bajo condiciones locales, en lugar de basarse en argumentos abstractos sobre su superioridad científica

Los hubs generan cooperación entre agricultores, aprendices e investigadores.

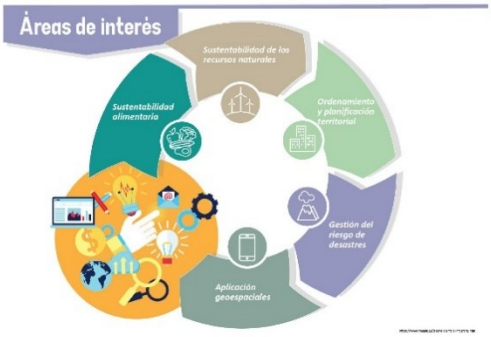


Resultados



CIREN CHILE

El Centro de Información de Recursos Naturales, CIREN, es un instituto tecnológico que por más de 30 años ha proporcionado información de valor sobre los recursos naturales y productivos de Chile.
Como servicio de apoyo al Ministerio de Agricultura, trabaja para asegurar la calidad en la provisión de bienes públicos y en la generación de nuevos productos y servicios de alto valor, que contribuyan a la planificación, toma de decisiones y diseño de políticas de desarrollo productivo y de ordenamiento territorial.



- ✓ *Mas de 30 años de experiencia*
- ✓ *Alto nivel tecnológico y profesional*
- ✓ *Poseedor de la mayor base de datos georreferenciada de suelos, recursos hídricos y forestales.*
- ✓ *Realizadores a nivel nacional de catastro frutícola y de propiedad rural.*
- ✓ *Premio INNOVAGRO 2018 categoría innovación institucional*

CIREN y la Bioeconomía

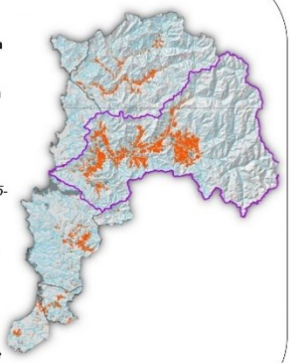
Objetivos

- Desarrollar un sistema de monitoreo basado en el uso de tecnologías de teledetección y análisis, que permitan la actualización periódica de la información sobre granjas hortícolas en cada región.
- Caracterizar y cuantificar el sector hortícola de cada región con el fin de conocer sus fortalezas, debilidades, amenazas y oportunidades, teniendo en cuenta los factores naturales, productivos y comerciales en los que se desarrollan.
- Incorporar la plataforma web SITMHOR (Sistema de Información Territorial para el monitoreo hortícola), que permite visualizar, analizar y difundir información productiva hortícola, haciendo posible el acceso al conocimiento actualizado.

Análisis de balance hídrico para la región de Valparaíso

Este proyecto generó información para contribuir a:

- ✓ *Determinar la evolución espaciotemporal de las zonas irrigadas en la región de Valparaíso, entre los años 2005-2016.*
- ✓ *Determinar la relación oferta-demanda de agua de riego en el sector agrícola.*
- ✓ *Estimar la variación de los indicadores económicos del producto agrícola regional, dependiendo del suministro de agua.*



Proyectos e iniciativas

- CIREN desarrolla diferentes proyectos a lo largo de Chile, no solamente relacionados con la bioeconomía, sino que también ligados al ordenamiento territorial, la gestión de desastres socionaturales, la reconversión productiva, entre otros

SitRural

Modelos locales climáticos para nuevas especies en el secano

Formación y Capacitaciones

- La institución realiza continuamente capacitaciones orientadas a la utilización experimental y práctica sobre el mundo de los Sistemas de Información Geográfica (SIG), para su uso en estudios, proyectos y catastros territoriales, tanto para particulares, como funcionarios públicos del Estado de Chile.


CTA y la bioeconomía circular
Corporación Tecnológica de Andalucía (CTA) es una fundación privada con más de 160 empresas miembros y más de 13 años de experiencia, impulsada en su origen por la Junta de Andalucía, con gestión privada y dedicada al fomento de la I+D+i empresarial y la transferencia de tecnología. CTA mantiene una firme apuesta por la bioeconomía circular desde hace varios años. Financia proyectos empresariales de I+D+i con fondos propios en este ámbito, organiza eventos sobre esta temática para movilizar nuevos proyectos e impulsar este sector desde Andalucía y ha asesorado a las Administraciones Públicas en el desarrollo de sus estrategias de bioeconomía y economía circular. Además, ofrece apoyo técnico y legal en procesos de Compra Pública de Innovación "verde" (Green Public Procurement) y participa en proyectos europeos que promueven la bioeconomía circular. Como miembro del BioIndustries Consortium (BIC), CTA participa en el diseño de los programas europeos de financiación en bioeconomía de la BioBased Industries Joint Undertaking (BBI JU).
Proyectos de bioeconomía circular donde participa CTA
Superbio
Cofinanciado por el Programa "Horizonte 2020" de la Unión Europea
SuperBIO es un proyecto con 10 socios de 6 países europeos y financiado por el programa Horizonte 2020. SuperBIO ha construido más de 40 nuevas cadenas de valor innovadoras en bioeconomía de carácter internacional. Ha prestado servicios de innovación, financiados al menos en un 75%, a más de 37 pymes para madurar sus modelos de negocio y dar lugar a cerca de 40 nuevas tecnologías, bioprocesos y bioproductos.
http://www.h2020-superbio.eu/
ICT-Biochain
Cofinanciado por el Programa "Horizonte 2020" de la Unión Europea
La Consejería de Agricultura, Pesca y Desarrollo Rural de la Junta de Andalucía y CTA participan, junto a otros 6 socios, en el proyecto europeo ICT-BIOCHAIN, financiado por la iniciativa conjunta BBI JU en el marco de Horizonte 2020, para impulsar la digitalización de las cadenas de suministro de biomasa. El proyecto lanzará dos Digital Innovation Hubs, uno de los cuales se ubicará en Andalucía como región piloto.
https://ictbiochain.eu/
EXCornsEED
Cofinanciado por el Programa "Horizonte 2020" de la Unión Europea
El proyecto EXCornsEED aglutina a 13 socios de 8 países europeos y cuenta con un presupuesto de 7,2 M€ para desarrollar tecnologías sostenibles que permitan obtener ingredientes funcionales para alimentación, productos químicos y cosmética a partir de los efluentes secundarios de biorrefinerías de maíz, bioetanol y biodiésel. CTA lidera los análisis de sostenibilidad y las tareas de explotación de resultados del proyecto.
https://www.excornseed.eu/
UrBIOfuture
Cofinanciado por el Programa "Horizonte 2020" de la Unión Europea
El proyecto UrBIOfuture, con un presupuesto de cerca de 1M€ cofinanciado por la BBI JU en el marco de H2020, pretende fomentar la educación europea en bioeconomía a través de la creación de carreras universitarias, nuevos programas formativos y actividades de investigación en un sector en pleno crecimiento.
https://www.urbiofuture.eu/
EMPORIA4KT
El proyecto europeo EMPORIA4KT, financiado por el programa Interreg-Espacio Atlántico, centrará sus esfuerzos en ayudar a transferir los resultados de investigación para crear valor e impulsar la Economía Azul europea, que es aquella que representa todas las actividades económicas relacionadas con los océanos, mares y zonas costeras e incluye industrias como la pesca, la construcción naval, el turismo y la energía oceánica.
@EMPORIAKT
Contacta con CTA
www.corporaciontecnologica.com | (+34) 954 46 13 52
bioeconomia@corporaciontecnologica.com

fittacori

La Fundación para el Fomento y Promoción de la Investigación y Transferencia de Tecnología Agropecuaria (FITTACORI), es el ente financiero del Sistema Nacional de Investigación, Innovación y Transferencia de Tecnología Agropecuaria (SNITTA).
Es una Fundación privada de utilidad pública, sin fines de lucro, que tiene como misión contribuir al desarrollo agropecuario de Costa Rica a través del fomento de la innovación y la transferencia de la ciencia y la tecnología agropecuaria.

- PITTAs
(Programas de Investigación y Transferencia de Tecnología Agropecuaria)
  - Identifican, integran y priorizan las necesidades de innovación, investigación y transferencia de tecnología en las actividades productivas consideradas, de forma conjunta con instituciones del sector agropecuario y los productores.

FITTACORI y la bioeconomía

- Los proyectos de la Fundación están vinculados a los ODS y las políticas del sector, con el fin de responder a las necesidades agropecuarias presentes y futuras del país utilizando tecnología innovadora, e integrando:
  - Estímulo de nuevos mercados
  - Desarrollo de estrategias productivas
  - Fortalecimiento del encadenamiento de la producción
  - Transferencia del conocimiento y tecnologías generadas
  - Interdisciplinariedad
  - Sostenibilidad ambiental
  - Impacto socioeconómico

Proyectos

Investigadores(as) y productores(as) de diversas áreas trabajando juntos(as) en más de 90 proyectos agropecuarios.

Formación y publicaciones

- ✓ Más de 42 000 Productores(as) y técnicos(as) capacitados(as)
- ✓ Más de 100 Publicaciones

www.fittacori.or.cr
https://es-la.facebook.com/Fittacori/
Correo: info@fittacori.or.cr

FUNICA

La Fundación para el Desarrollo Tecnológico Agropecuario y Forestal de Nicaragua (FUNICA) es una fundación de naturaleza civil, apolítica y sin fines de lucro, con personalidad jurídica y gobierno propio, constituida por 24 instituciones del sector público y privado que incluyen gremios de productores agropecuarios y forestales, universidades, ONG y asociaciones de profesionales de las ciencias agropecuarias. Constituida según escritura No 7 del 01 de Noviembre del 2000 y Decreto legislativo No. 2867 del 5 de Abril del 2001, publicado en la Gaceta No. 71 del 17 de Abril del 2001.

FUNICA
Fundación para el Desarrollo Tecnológico Agropecuario y Forestal de Nicaragua
Promoviendo la Innovación

MISION: Contribuir al crecimiento económico inclusivo y sostenible de las poblaciones rurales mediante la gestión del conocimiento para la innovación tecnológica de servicios y procesos.

VISION: Ser un referente en la gestión de la innovación agropecuaria y forestal, en el sector rural.

Redes Miembro:

- Red Latinoamericana para Servicios de Extensión Rural (RELASER).
- Red INNOVAGRO, Foro Global para los Servicios de Asesoría Rural (GFRAS).
- Red Nacional de Información y Documentación Agraria de Nicaragua (RENIDA)

Con quienes trabaja FUNICA:

- Productores individuales organizados en cooperativas, asociaciones de productores, técnicos, empresas oferentes de productos y servicios tecnológicos, micro empresas rurales, emprendedoras rurales, grupos de mujeres y jóvenes rurales.
- Articula alianzas estratégicas con actores de las diferentes cadenas de valor para complementar servicios tecnológicos que promuevan la innovación. Además apoya a otros actores públicos y privados tales como universidades, ONG, centro de formación técnica y profesionales individuales para promover las innovaciones tecnológicas.

Programas y logros

Programas y acciones:

- Fomento de asistencia técnica, productos y servicios tecnológicos en la cadena de valor, para asegurar que los productores adopten nuevas tecnologías en sus sistemas de producción, transformación y comercialización.
- Emprendimiento rural y desarrollo empresarial, centrado en desarrollar e impulsar la asociatividad, el movimiento de empresas rurales, autogestionarias y eficientes.
- Desarrollo institucional de FUNICA y sus asociados, orientado a la consolidación de la Fundación.

Experiencia en implementación de proyectos y programas:

La fundación ha invertido fondos para el mejoramiento de capacidades productivas y de mercado de pequeños y medianos productores (as). Promover el mercado de tecnologías en los oferentes y demandantes, gestión del conocimiento. La finalidad es contribuir al mejoramiento de sus ingresos y el nivel de vida de familias en condiciones climáticamente adversas con equidad de género. Todo esto con el apoyo de las organizaciones como: Fondo Internacional de Desarrollo Agrícola (FIDA), Agencia Suiza para el Desarrollo y la Cooperación (COSUDE), Cooperación al Desarrollo de Dinamarca (DANIDA), Reino de los Países Bajos de Holanda, Fundación Ford, Agencia de Estados Unidos para el Desarrollo Internacional (USAID), Banco Mundial, JICA, Rainforest Alliance/UTZ, CAINCO-Unión Europea.

Logros obtenidos:

- Las familias apoyadas por FUNICA han logrado cambios en su condición de vida, mejorando su autoempleo y sus ingresos económicos.
- Aportes sustanciales en conocimiento para la construcción de políticas y estrategias nacionales para los servicios de extensión e investigación.
- Construcción de una plataforma de diálogo y consenso que articula a los principales actores del sector.
- Consolidación del mercado de servicios y tecnologías.
- Articulación del sistema de investigación agropecuaria y forestal a la extensión.
- Incremento de la oferta de diferentes servicios de asistencia técnica, empresariales y tecnológicas, beneficiando a más de 300 organizaciones y 30 mil familias nicaragüenses.
- Disponibilidad de tecnologías amigables con el medio ambiente, a bajos costos y en diferentes zonas del país, para más de 40 mil familias productoras.

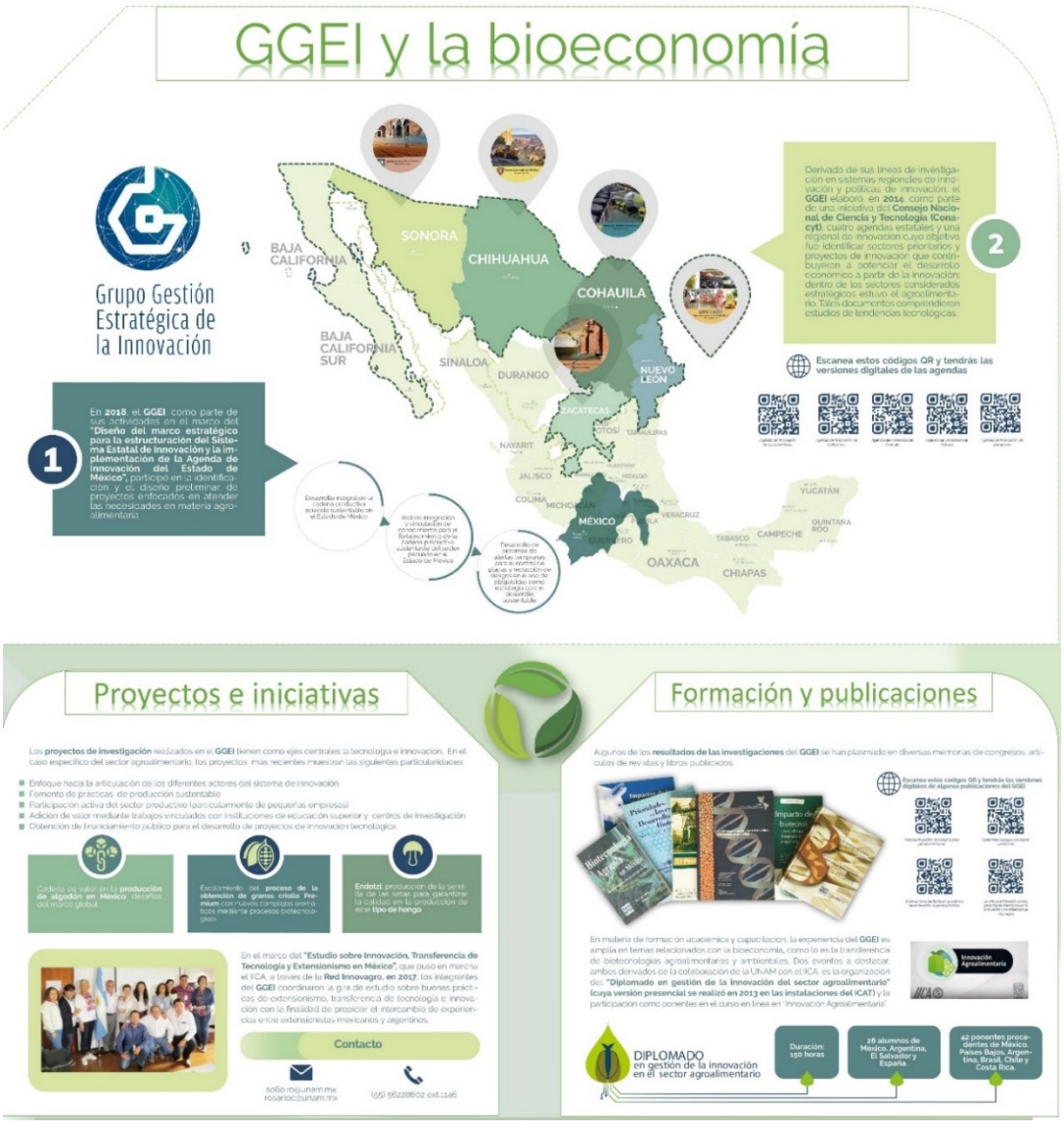
Productos y servicios

- Ofrecemos incentivos para desarrollar el mercado de servicios tecnológicos a los actores. las cadenas de valor; administración de fondos competitivos, formulación de proyectos y planes de negocios.
- Servicios de desarrollo empresarial rural a través del Centro de Gestión e Innovación empresarial (CGIE-FUNICA); análisis técnico, económico y financiero de rubros y servicios especializados; capacitación, formación vocacional y transferencia de tecnología.
- Asesorías de expertos especializados en temas de sistemas de innovación agrícola, prospección tecnológica, empresarial y de negocios.
- Promovemos la conformación de alianza y redes para asegurar el abordaje integral de los rubros agropecuarios
- Desarrollamos capacidades para la investigación agropecuaria y forestal; estudios de mercado de productos y servicios agropecuarios, sectoriales y sub sectoriales para políticas y estrategias.
- Asistencia a través de la Escuela de Negocio; Asistencia técnica para producción y comercialización en rubros agropecuarios.
- Fomentamos el desarrollo empresarial a cooperativas y emprendedores individuales; Gestión y desarrollo organizacional de cooperativas de base; fortalecimiento de capacidades de las cooperativas y emprendedores individuales.

Publicaciones

- Nicaragua; Tecnología Agropecuaria. Su rol en una política del sector agropecuaria
- La demanda manda. Igual de oportunidades de género en el Fondo de Asistencia Técnica.
- Evolución del Fondo de Asistencia Técnica en Las Segovia 2004-2009
- Fondo de Asistencia Técnica. Experiencias de la primera fase y futuras acciones
- Un servicio de atención básica de salud de plantas.
- Para combatir el hambre y la pobreza. Experiencias de FUNICA en la implementación del Bono Productivo Alimentario en el occidente de Nicaragua.
- Estudio de Impacto de los servicios de asistencia técnica en el occidente del país.
- Servicios y tecnologías agrícolas en Las Segovia: una valoración externa del estado actual.
- Experiencias en el desarrollo de mercados locales de tecnologías agropecuarias.
- Guía metodológica para la formulación de planes de negocios de iniciativas de Tecnologías Agropecuarias.
- Cd catálogo de tecnologías Agropecuarias y Forestales.
- Sistematización de las experiencias de FUNICA en el desarrollo de mercados locales de tecnologías 2006-2008
- Contacto www.funica.org.ni, correo electrónico: comunicacion@funica.org.ni


GGEI/ICAT-UNAM
El Grupo Gestión Estratégica de la Innovación (GGEI) forma parte del Instituto de Ciencias Aplicadas y Tecnología (ICAT) de la Universidad Nacional Autónoma de México (UNAM). Liderado por los doctores José Luis Solleiro y Rosario Castañón, el GGEI tiene por objetivo desarrollar metodologías, modelos y análisis de casos, entre otras contribuciones académicas, originales y relevantes para la gestión estratégica de la innovación en diferentes ambientes institucionales, así como promover la aplicación de los conocimientos generados a través de la prestación de servicios especializados y la formación de recursos humanos en diversos sectores.
Integrantes del grupo
José Luis Solleiro
Rosario Castañón
Norma Solís
Erendira Velázquez
Laura Martínez
Líneas de investigación
Políticas de innovación
Gestión de transferencia de tecnología
Sistemas regionales de innovación
Vinculación universidad-empresa
Gestión de la innovación tecnológica
Premio INNOVAGRO 2016
La Red INNOVAGRO otorga el presente
DIPLOMA
3ER LUGAR EN INNOVACIÓN INSTITUCIONAL
A el Centro de Ciencias Aplicadas y Desarrollo Tecnológico de la UNAM


GGEI y la bioeconomía
Grupo Gestión Estratégica de la Innovación
SONORA
CHIHUAHUA
BAJA CALIFORNIA
BAJA CALIFORNIA SUR
COHAUILA
SINALOA
DURANGO
NUEVO LEON
ZACATECAS
NAYARIT
JALISCO
COLIMA
MICHOACÁN
MÉXICO
VERACRUZ
YUCATÁN
QUINTANA ROO
CAMPECHE
TABASCO
OAXACA
CHIAPAS
1
En 2018, el GGEI como parte de sus actividades en el marco del "Diseño del marco estratégico para la estructuración del Sistema Estatal de Innovación y la implementación de la Agenda de Innovación del Estado de México", participó en la identificación y el diseño preliminar de proyectos enfocados en atender las necesidades en materia agroalimentaria.
2
Derivado de sus líneas de investigación en sistemas regionales de innovación y políticas de innovación, el GGEI elaboró en 2014, como parte de una iniciativa del Consejo Nacional de Ciencia y Tecnología (Conacyt), cuatro agendas estatales y una regional de innovación cuyo objetivo fue identificar sectores prioritarios y proyectos de innovación que contribuyeran a potenciar el desarrollo económico a partir de la innovación; dentro de los sectores considerados estratégicos estuvo el agroalimentario. Tales documentos comprendieron estudios de tendencias tecnológicas.
Escanea estos códigos QR y tendrás las versiones digitales de las agendas

Proyectos e iniciativas
Los proyectos de investigación realizados en el GGEI tienen como ejes centrales la tecnología e innovación. En el caso específico del sector agroalimentario, los proyectos más recientes muestran las siguientes particularidades:
Enfoque hacia la articulación de los diferentes actores del sistema de innovación
Fomento de prácticas de producción sustentable
Participación activa del sector productivo (particularmente de pequeñas empresas)
Adición de valor mediante trabajos vinculados con instituciones de educación superior y centros de investigación
Obtención de financiamiento público para el desarrollo de proyectos de innovación tecnológica
Cadena de valor en la producción de algodón en México
Escalamiento del proceso de la obtención de grano criollo Premium
Endotzi: productor de la semilla de las setas para garantizar la calidad en la producción de este tipo de hongo
En el marco del "Estudio sobre Innovación, Transferencia de Tecnología y Extensionismo en México", que puso en marcha el ICA, a través de la Red Innovagro, en 2017, los integrantes del GGEI coordinaron la gira de estudio sobre buenas prácticas de extensionismo, transferencia de tecnología e innovación con la finalidad de propiciar el intercambio de experiencias entre extensionistas mexicanos y argentinos.
Contacto
solleiro@unam.mx
rosarioc@unam.mx
(55) 56228602 ext.1146
Formación y publicaciones
Algunos de los resultados de las investigaciones del GGEI se han plasmado en diversas memorias de congresos, artículos de revistas y libros publicados.
Escanea estos códigos QR y tendrás las versiones digitales de algunas publicaciones del GGEI
En materia de formación académica y capacitación, la experiencia del GGEI es amplia en temas relacionados con la bioeconomía, como lo es la transferencia de biotecnologías agroalimentarias y ambientales. Dos eventos a destacar, ambos derivados de la colaboración de la UNAM con el ICA, es la organización del "Diplomado en gestión de la innovación del sector agroalimentario" (cuya versión presencial se realizó en 2013 en las instalaciones del ICAT) y la participación como ponentes en el curso en línea en "Innovación Agroalimentaria".
Innovación Agroalimentaria
DIPLOMADO en gestión de la innovación en el sector agroalimentario
Duración: 150 horas
28 alumnos de México, Argentina, El Salvador y España.
42 ponentes procedentes de México, Países Bajos, Argentina, Brasil, Chile y Costa Rica.

El **IICA** es el organismo especializado en agricultura del Sistema Interamericano. Su misión es estimular, promover y apoyar los esfuerzos de los estados miembros para lograr su desarrollo agrícola y el bienestar rural por medio de la cooperación técnica internacional de excelencia.

76 años de historia

34 países miembros en las Américas

España es país asociado y es la sede de la Oficina Permanente para Europa (OPE), ubicada en el Ministerio de Agricultura, Pesca y Alimentación, en Madrid.

19 países observadores en Europa y Asia.

La Junta Interamericana de Agricultura es su máximo órgano de gobierno, compuesta por Ministros y Secretarios de Agricultura de los 34 países miembros.

Más de **650 técnicos** y especialistas en agricultura y más de **2.500 consultores**

El modelo de cooperación técnica del **IICA** se fundamenta en **5 programas hemisféricos y dos ejes transversales:**

Programa de Bioeconomía y Desarrollo Productivo del **IICA**

El **Programa de Bioeconomía y Desarrollo Productivo** del IICA tiene como lineamientos impulsar la visión, las políticas y las innovaciones que propicien el desarrollo basado en la bioeconomía, así como el desarrollo basado en cadenas productivas de este sector.

Áreas de trabajo del programa

- **Evidencia, sensibilización y formación de capacidades:** investigaciones, estudios, talleres, seminarios y cursos para fomentar capacidades orientadas a nuevos aprovechamientos de la bioeconomía en tomadores de decisión y actores del sector agrícola y rural.
- **Hojas de ruta:** formulación e implementación de herramientas para la construcción de hojas de ruta diferenciadas por país para aprovechar la bioeconomía.
- **Marcos políticos, regulatorios y normativos:** apoyo a gestión de políticas, normativas y estímulos de mercado que viabilicen y posibiliten nuevos usos productivos de la bioeconomía en la agricultura y el mundo rural.
- **Inversiones y estrategias en cadenas:** apoyo al diseño e implementación de estrategias, proyectos e inversiones para fomentar nuevos modelos de negocios de la bioeconomía en los territorios rurales y las cadenas de valor de la agricultura.

Fortalezas del IICA para alianzas estratégicas y proyectos

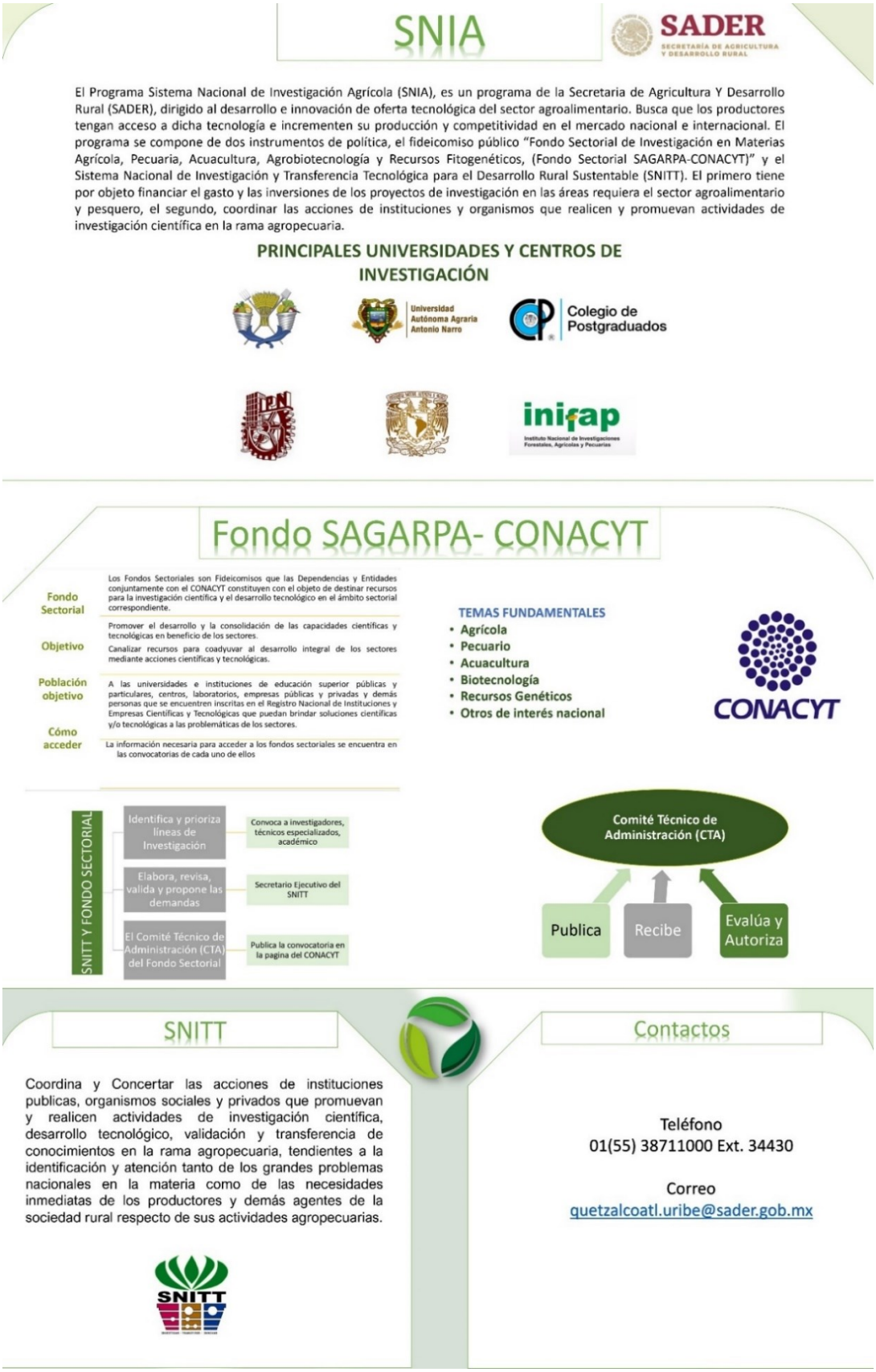
- Alta presencia técnica y política en **34 países** de las Américas.
- Coordinación con **mecanismos de cooperación** e integración regional, como CAS, CAC, CARDI, CATIE y SICA, entre otros.
- **Articulación** con actores nacionales y regionales para consorcios internacionales.
- Formulación de proyectos para **financiación internacional:** BID, UE, Banco Mundial, entre otros.
- Interacción con **redes de conocimiento** como INNOVAGRO, CIAO, CGIAR, GBS, ICABR, etc.
- **Trabajo conjunto** con socios internacionales como CIRAD, CIAT, FAO, CEPAL, Fraunhofer, etc.
- Relacionamiento con **sector privado nacional y transnacional,** por ejemplo con Bayer y Microsoft.

Actividades **2019**

Área	Evidencia, sensibilización y formación de capacidades	Hojas de ruta	Marcos normativos y políticas	Inversiones y estrategias para las cadenas
Hemisféricos	• Estimación de bioeconomía al desarrollo • Curso virtual bioeconomía en América Latina y el Caribe (ALC) • Documento para Reunión Ministerial • Policy brief: Bioeconomía en ALC • Seminario Allbiotech • Webinars	Guía para construcción de hojas de ruta de aprovechamiento de la bioeconomía en la agricultura y los territorios rurales.	• Guía para análisis de marcos normativos y políticas para fomento de la bioeconomía • Observatorios para la bioeconomía en ALC.	• Guías para construcción de modelos de negocios de la bioeconomía en las cadenas y territorios • Prospección tecnológica para nuevos aprovechamientos de la bioeconomía.
Regionales y nacionales	Organización de talleres, seminarios, cursos virtuales y giras de campo para sensibilización y formación de capacidades para aprovechamiento de bioeconomía en 14 países de ALC.	Identificación de aprovechamientos de bioeconomía en Bolivia, Costa Rica y Ecuador.	Apoyo al fortalecimiento de políticas para la bioeconomía en Argentina, Belice, Costa Rica, Ecuador y Uruguay.	Estrategias para modelos de negocios de la bioeconomía en cadenas de café, cacao, aguacate y miel en ocho países de ALC.

Contactos
Costa Rica. Hugo Chavarría • hugo.chavarria@iica.int • Gerente Programa Bioeconomía y Desarrollo Productivo
México. Martha Escalante • martha.escalante@iica.int • Secretaria Ejecutiva Red INNOVAGRO
España. Soraya Villarroya • soraya.villarroya@iica.int • Coordinadora OPE

Más información: **www.iica.int • www.redinnovagro.in/bioeconomia.php**


SNIA
SADER
SECRETARÍA DE AGRICULTURA Y DESARROLLO RURAL
El Programa Sistema Nacional de Investigación Agrícola (SNIA), es un programa de la Secretaria de Agricultura Y Desarrollo Rural (SADER), dirigido al desarrollo e innovación de oferta tecnológica del sector agroalimentario. Busca que los productores tengan acceso a dicha tecnología e incrementen su producción y competitividad en el mercado nacional e internacional. El programa se compone de dos instrumentos de política, el fideicomiso público "Fondo Sectorial de Investigación en Materias Agrícola, Pecuaria, Acuacultura, Agrobiotecnología y Recursos Fitogenéticos, (Fondo Sectorial SAGARPA-CONACYT)" y el Sistema Nacional de Investigación y Transferencia Tecnológica para el Desarrollo Rural Sustentable (SNITT). El primero tiene por objeto financiar el gasto y las inversiones de los proyectos de investigación en las áreas requiera el sector agroalimentario y pesquero, el segundo, coordinar las acciones de instituciones y organismos que realicen y promuevan actividades de investigación científica en la rama agropecuaria.
PRINCIPALES UNIVERSIDADES Y CENTROS DE INVESTIGACIÓN
Universidad Autónoma Agraria Antonio Narro
Colegio de Postgraduados
inifap
Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias
Fondo SAGARPA- CONACYT
Fondo Sectorial
Los Fondos Sectoriales son Fideicomisos que las Dependencias y Entidades conjuntamente con el CONACYT constituyen con el objeto de destinar recursos para la investigación científica y el desarrollo tecnológico en el ámbito sectorial correspondiente.
Objetivo
Promover el desarrollo y la consolidación de las capacidades científicas y tecnológicas en beneficio de los sectores.
Canalizar recursos para coadyuvar al desarrollo integral de los sectores mediante acciones científicas y tecnológicas.
Población objetivo
A las universidades e instituciones de educación superior públicas y particulares, centros, laboratorios, empresas públicas y privadas y demás personas que se encuentren inscritas en el Registro Nacional de Instituciones y Empresas Científicas y Tecnológicas que puedan brindar soluciones científicas y/o tecnológicas a las problemáticas de los sectores.
Cómo acceder
La información necesaria para acceder a los fondos sectoriales se encuentra en las convocatorias de cada uno de ellos
TEMAS FUNDAMENTALES
Agrícola
Pecuario
Acuacultura
Biotecnología
Recursos Genéticos
Otros de interés nacional
CONACYT
SNITT Y FONDO SECTORIAL
Identifica y prioriza líneas de Investigación
Convoca a investigadores, técnicos especializados, académico
Elabora, revisa, valida y propone las demandas
Secretario Ejecutivo del SNITT
El Comité Técnico de Administración (CTA) del Fondo Sectorial
Publica la convocatoria en la pagina del CONACYT
Comité Técnico de Administración (CTA)
Publica
Recibe
Evalúa y Autoriza
SNITT
Coordina y Concertar las acciones de instituciones publicas, organismos sociales y privados que promuevan y realicen actividades de investigación científica, desarrollo tecnológico, validación y transferencia de conocimientos en la rama agropecuaria, tendientes a la identificación y atención tanto de los grandes problemas nacionales en la materia como de las necesidades inmediatas de los productores y demás agentes de la sociedad rural respecto de sus actividades agropecuarias.
SNITT
Contactos
Teléfono
01(55) 38711000 Ext. 34430
Correo
quetzalcoatl.uribe@sader.gob.mx

Centro Tecnológico Tecnova

La Fundación para las Tecnologías Auxiliares de la Agricultura es el **Centro Tecnológico de la Industria Auxiliar de la Agricultura, la Postcosecha y el Envasado**, aportando valor, a través de la innovación y la tecnología, a la cadena de valor de las frutas y hortalizas, desde la producción hasta la tecnología post-cosecha y transformación de alimentos.

- Se creó en 2001.
- Centro Tecnológico Andaluz desde 2007
- Centro Tecnológico Nacional desde 2015.
- Agente local de la Red PIDI perteneciente al CDTI.
- Oficina de proyectos europeos.
- Entidad de Transferencia de la Tecnología y el Conocimiento Andaluza
- OTRI nº registro 236 reconocido por Ministerio de Economía y Competitividad.

Conforma un **Cluster de la agroindustria**, con diferentes agentes del sector y 105 empresas de los diferentes subsectores de la Industria Auxiliar de la Agricultura, que aportan innovaciones a la cadena de valor agroalimentaria.

CT Tecnova y la bioeconomía

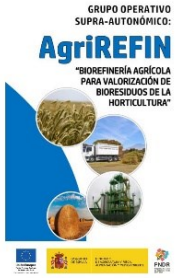
CT TECNOVA ofrece al sector:

- Un equipo de 25 investigadores especializado.
- Involucración en iniciativas internacionales en el marco de la bioeconomía y contacto con los principales agentes europeos.
- Instalaciones para la I+D+i y el desarrollo de cadenas de valor en la bioeconomía:

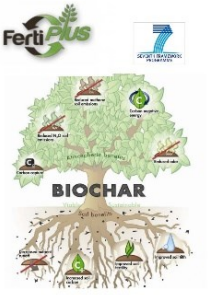
Miembros del Cluster de Bioeconomía Andaluza

estrategia andaluza de **bioeconomía circular**

Proyectos e iniciativas



Proyectos e iniciativas



UNIVERSIDAD DE COSTA RICA

La Universidad de Costa Rica es una institución de educación superior y cultura dedicada a la enseñanza, la investigación, la acción social, el estudio, la meditación, la creación artística y la difusión del conocimiento. El área de Ciencias Agroalimentarias de la Universidad de Costa Rica cuenta con una Facultad que lleva el mismo nombre, la cual está integrada por cuatro escuelas: Agronomía, Zootecnia, Economía Agrícola y Agronegocios y Tecnología Alimentos. Además de sus múltiples opciones académicas de bachillerato y licenciatura, esta área cuenta con varios posgrados asociados a su quehacer tanto a nivel de maestría como de doctorado. El área además cuenta con seis centros de investigación, dos estaciones experimentales y un instituto de investigación.

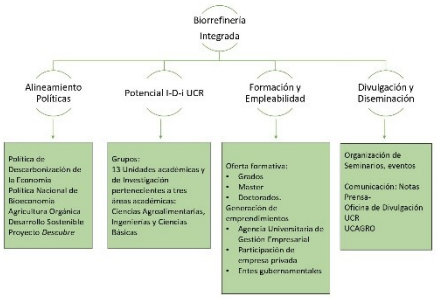
EJES ESTRATÉGICOS

- Docencia
- Investigación e innovación
- Vinculación con el sector agroindustrial
- Acción social
- Internacionalización
- Trabajo interdisciplinario

La UCR y la Bioeconomía

Objetivos

Valorizar los residuos biomásicos utilizando un modelo de biorrefinería para obtener energía, biofertilizantes y productos químicos de alto valor industrial.
Establecer un equipo de investigadores de diferentes disciplinas que contribuyan de manera integral a la valorización de los residuos agrícolas.
Aprovechar los recursos materiales de diferentes Unidades de la UCR y contrapartes internacionales para contribuir a la valorización de los residuos biomásicos desde un enfoque de biorrefinería
Fortalecer las capacidades de las diferentes unidades para realizar la investigación interdisciplinaria.
Involucrar de manera activa a los productores en el equipo de invetigación.



CONSORCIO de Unidades de la UCR que aportan a la bioeconomía

Escuelas:
- Agronomía
- Zootecnia
- Economía Agrícola
- Tecnología de Alimentos
- Química
- Ingeniería en Biosistemas
- Ingeniería Química

Unidades de Investigación:
- Centro de Investigaciones Agronómicas
- Estación Experimental Fabio Baudrit
- Centro Nacional de Ciencia y Tecnología de Alimentos
- Centro de Investigaciones en Electroquímica y Energía Química
- Centro de Investigaciones en Biología Celular y Molecular
- Centro de Investigaciones en Productos Naturales

Información de contacto:
Luis Felipe Arauz, 506-2511-8734, felipe.arauz@ucr.ac.cr
Lideth Uribe Loría, 506-2511-2077, lideth.uribe@ucr.ac.cr

Formación

La universidad de Costa Rica ofrece una amplia variedad de carreras de Grado, Máster y Doctorado relacionadas con la Bioeconomía:

✓ 9 GRADOS

✓ 11 MÁSTERES

✓ 3 DOCTORADOS

https://www.ucr.ac.cr/

@UniversidadCR /UniversidadCostaRica

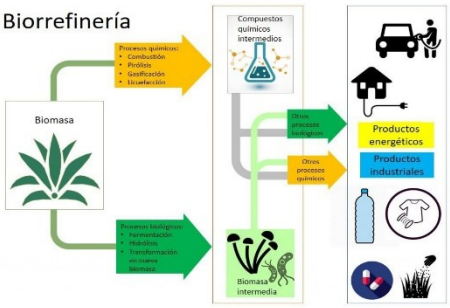
Proyectos e iniciativas

Valorización de residuos de cultivos tropicales bajo el concepto de biorefinería integrada en la Universidad de Costa Rica

La Universidad de Costa Rica posee una importante capacidad científica y laboratorios de punta en diferentes Escuelas y Centros de Investigación. Sin embargo los esfuerzos para valorizar la biomasa residual de la agricultura han sido aislados lo cuál no ha propiciado una inserción eficiente en el tema de la bioeconomía. En Costa Rica se producen 27 millones de toneladas por año de residuos agrícolas orgánicos (RAO), principalmente: caña de azúcar, piña, palma aceitera, aserraderos, café, banano, arroz, naranja, ganadería de leche y carne, avicultura y porcicultura. Un enfoque de biorrefinería integrada permitiría la obtención de energía y productos químicos de interés industrial a partir de dicha biomasa residual, contribuyendo a la reducción de la producción de gases de efecto de invernadero y abriendo la oportunidad a nuevos emprendimientos basados en materiales subutilizados.

Para atender esta necesidad, se plantea el presente programa con el objetivo de valorizar, en primera instancia, los residuos de cosecha de la piña, el café y del arroz utilizando un modelo de biorrefinería para obtener energía, bioinsumos y productos químicos de alto valor industrial, aprovechando la capacidad instalada en la Universidad de Costa Rica.

La estrategia: Biorrefinería Integrada




UNIVERSIDAD NACIONAL AGRARIA
LA MOLINA
La Universidad Nacional Agraria La Molina (UNALM) es una institución educativa universitaria especializada en la formación de profesionales competentes para los sectores agrosilvopecuario, pesquero, alimentario y económico. La UNALM, pretende alcanzar el nivel de liderazgo, basado en la enseñanza-aprendizaje, investigación, extensión universitaria y proyección social, de calidad, y ser referente en los sectores agrosilvopecuario, pesquero, alimentario y económico, promoviendo el manejo de los recursos naturales y la conservación del ambiente para el desarrollo del país.
La UNALM, adicionalmente de participar en la Red Innovagro, también forma parte de la RED IDi, asociación de universidades peruanas que conecta ciencia y tecnología, con el sector empresarial y gubernamental
RED DE INVESTIGACIÓN, DESARROLLO E INNOVACIÓN - RED IDi
RED IDi
Investigación, Desarrollo e innovación
UNALM y la Bioeconomía
Objetivos
-Asegurar la calidad de la formación profesional de los estudiantes de pre y posgrado
-Fortalecer la Investigación, desarrollo e innovación en la UNALM
- Fortalecer la extensión universitaria y la proyección social en la UNALM
- Fortalecer y modernizar de la gestión institucional
LINEAS DE INVESTIGACIÓN
❖Economía de la Innovación agrícola, desarrollo rural y seguridad alimentaria
❖Economía ambiental, de los recursos naturales y del cambio climático
❖Economía y aprovechamiento forestal
❖Materia prima y productos terminados procedentes de bosques naturales y plantaciones forestales
❖Sistemas de producción agrícola sustentable
❖Innovación empresarial agrícola
❖Procesos de transformación química de los productos forestales maderables y no maderables
❖Tecnología para la pequeña agricultura
FACULTADES
FACULTAD DE AGRONOMÍA
FACULTAD DE ECONOMÍA Y PLANIFICACIÓN
Proyectos e iniciativas
Investigadores de la UNALM están participado en numerosos proyectos nacionales e internacionales en el ámbito de la Bioeconomía que avalan el potencial del campus en la materia. A continuación se citan algunos de los proyectos vigentes de la UNALM:
✓ Valorizando la biodiversidad del Perú
✓ Evaluación de las existencias comerciales y estrategia para el manejo sostenible de la caoba (Swietenia macrophylla) en el Perú.
✓ Aprovechamiento sostenible de los hongos pigmentadores de madera para su uso comercial en el desarrollo de artesanías y turismo vivencial en Madre de Dios.
✓ Obtención de biocombustibles sólidos mediante los procesos de torrefacción y densificación de biomasa residual de caballerizas con alto contenido de cascarilla de arroz (Oryza sativa).
✓ Utilización de la técnica de dobles haploides en el aprovechamiento de la biodiversidad del maíz peruano para su uso como alimento nutracéutico.
Formación y publicaciones
Las UNALM oferta una amplia variedad de formación de Grado, Máster y Doctorado con relación a la Bioeconomía:
✓ 5 GRADOS
✓ 11 MÁSTERES
✓ 3 PROGRAMAS DE DOCTORADO
www.lamolina.edu.pe
YouTube

Innovación en Bioeconomía en Brasil

agropolo CAMPINAS • BRASIL

Agropolo Campinas-Brasil se creó en junio de 2015, en un esfuerzo por desarrollar un ecosistema de innovación de clase mundial con énfasis en Bioeconomía en la Ciudad de Campinas, Brazil. Durante el período 2015-2018 las actividades del Agropolo se concentraron en el desarrollo de un "roadmap tecnológico" para Bioeconomía Tropical en 12 áreas estratégicas. Se elaboró un Proyecto de Políticas Públicas en Bioeconomía – PPPBio, apoyado por la Fondación de Apoyo à la Investigación del Estado de São Paulo (FAPESP), con el objetivo de guiar el desarrollo de la Bioeconomía en São Paulo.

Conectando Personas & Asociando

Agropolo Campinas-Brazil es una plataforma interinstitucional basada en conceptos de **Innovación Colaborativa**

Como una nueva estrategia para promocionar la investigación, el desarrollo tecnológico, y productos y servicios innovadores. La plataforma será construida para incrementar las conexiones entre las instituciones de educación superior e investigación y el sector privado, resultando en una investigación diferenciada por proveer mejores oportunidades de empleo y rentabilidad para las actividades de Bioeconomía

Gobernanza & Asociación

Fundadores

Stakeholders

Parcerías Técnicas y Apoyos

12 Áreas Estratégicas en Brasil

- RESIDUALES agrícolas y urbanos
- AGRICULTURA DE PRECISIÓN
- ACEITES ESENCIALES, AROMÁTICOS y PLANTAS MEDICINALES
- Sistemas de PRODUCCIÓN ANIMAL
- Uso sustentable del AGUA
- Nueva Industria: CAFÉ y CÍTRICOS
- INGREDIENTES y Alimentos PROCESADOS FUNCIONALES
- PAQUETES para Alimentos y Bebidas
- TECNOLOGÍAS DE PROCESAMENTO para Alimentos y Bebidas
- BIOCOMBUSTIBLES Avanzados
- Biomasa para QUÍMICOS
- ENZIMAS & QUÍMICA VERDE

BIOECONOMÍA TROPICAL

Roadmap Tecnológico y Directivas para el Desarrollo de la Bioconomía en São Paulo-Brasil

EN CONSTRUCCIÓN,
(Octubre, 2019)

Contacto

www.agropolocampinasbrasil.org
agropolo@agropolocampinasbrasil.org
+55 19 2137.0621

Wageningen University & Research (WUR)

"Explorar el potencial de la naturaleza para mejorar la calidad de vida" Ésta es la misión de Wageningen University & Research (Universidad y Investigación). Contamos con 6.500 trabajadores y 10.000 estudiantes de aproximadamente 100 países que trabajan bajo nuestra supervisión sobre alimentación saludable y medio ambiente en todo el mundo ya sea para los gobiernos como para las empresas privadas. El poder de Wageningen University & Research radica en la fusión de institutos de investigación especializada y la universidad de Wageningen y en la colaboración de las diferentes disciplinas como naturaleza, tecnología y ciencias sociales. De ésta manera se logran los avances científicos de una manera rápida en la práctica y se traduce en la educación. Éste es el enfoque de la Universidad de Wageningen.

La especialidad de la universidad de Wageningen radica en las siguientes tres áreas centrales relacionadas:

WAGENINGEN UNIVERSITY & RESEARCH

- Alimentos, forrajes, combustibles y productos biobasados
- Medio ambiente
- Salud, estilo y condiciones de vida

WUR y la bioeconomía

Llevar resultados de lab a piloto

Temas de Investigación :

- Potenciales de biomasa y movilización en sistemas terrestre y acuatico
- Logística de biomasa
- Intermedios de biomasa para el mercado
- Fitomejoramiento de plantas para aplicaciones en la bioeconomía
- Uso de tierra sostenible y la producción de biomasa para nutrición, biomateriales y bioenergía
- Combinaciones y compensaciones de producción de biomasa con mitigación de gases efectos invernaderos y proteccion de biodiversidad

Temas de Investigación :

- Biorefineria & cadenas sostenibles
- Químicos & combustibles biobasados
- Materiales biobasados y renovables
- Nuevas fuentes de proteínas
- Valorización de biomasa

Vea también clip: https://www.youtube.com/watch?v=ZiY1yTlkRUs

Proyectos e iniciativas

Investigadores y universidades del WUR han participado en numerosos proyectos nacionales e internacionales en el ámbito de la Bioeconomía que avalan el potencial del campus en la materia. A título de ejemplo se citan algunos de los proyectos vigentes que cuentan con la participación directa del WUR:

BECOOL · AGRI FOR VALOR · B4est · bloom · Magic · POWERBIO · biocore · biomonitor · Monitoring the Bioeconomy · S2Biom

Formación y publicaciones

WUR oferta una amplia variedad de formación de Grado y Máster, contando con titulaciones (grados, Másteres y programas de doctorado en el ámbito de la Bioeconomía. Aprenda más sobre los programas en Wageningen a continuación.

https://www.wur.nl/es/La-Educacion-y-la-formacion/Licenciatura.htm

Wageningen es la universidad número uno del mundo en el campo de las ciencias agrícolas según el Ranking Nacional de Taiwán 2018.

WAGENINGEN UNIVERSITY & RESEARCH

http://twitter.com/Unieageningen
https://www.facebook.com/wageningenuniversity

REFERENCES

Bioeconomy: the European way to use our natural resources. Action Plan 2018. Recuperado de: https://ec.europa.eu/research/bioeconomy/pdf/ec_bioeconomy_booklet_2018.pdf#view=fit&pagemode=none.

FAO: Retos y oportunidades en un mundo globalizado. (2019). Recuperado de: http://www.fao.org/3/ca4305es/ca4305es.pdf.

IICA: Plan de Mediano Plazo 2018 – 2022. Recuperado de: http://repositorio2.iica.int/handle/11324/7191

Red Innovagro. Memoria del IX Encuentro: Bioeconomía y ecosistemas de innovación. Disponible en: https://www.redinnovagro.in/pdfs/ENCUENTROINNOVAGRO2019.pdf.

Enhancing the agri-food chain through innovation: Grupo La Caña

Beatriz Molina[1]

Corresponding Author: beatriz.molina@grupolacana.com

Abstract:

The concepts of the bioeconomy, the circular economy and sustainability are timely ones today, prompting us to ask whether there really are companies that are based on them, with these ideas shaping their strategies and them assigning enough importance to sustainability at a strategic level (Junta de Andalucía, 2018). The answer is yes, at both the normative and legislative levels, as the orientations of companies are, in fact, headed in this direction. As an example of this, the Grupo La Caña is presented, a producer, marketer, exporter and importer of horticultural products based on Granada's "Tropical Coast" and operating throughout the Andalusia region. Through sustainable socioeconomic development, it stands out for a business model characterised by its efficient use of tools and natural resources. Hence, it has been crucial to carry out an optimisation of the processes, methods and protocols that provide goods and services well-adapted to the management of the industry, as well as to reduce waste generated and its effect on the immediate environment.

Keywords: Bioeconomy, Circular economy, Sustainability, Agri-food industry, Functional food

Revalorización de la cadena agroalimentaria a través de la innovación: Grupo La Caña

Beatriz Molina[1]

Resumen:

Actualmente los conceptos de bioeconomía, economía circular y sostenibilidad se han convertido en tendencia. Nos podríamos preguntar si realmente hay empresas que se basan en estos conceptos para marcar su estrategia y si se da la suficiente importancia a la sostenibilidad a nivel estratégico dentro de una empresa (Junta de Andalucía, 2018). La respuesta es que sí, tanto a nivel normativo como a nivel legislativo, la orientación de las empresas va en esta dirección. Como ejemplo de ello, se expone el caso del Grupo La Caña, empresa productora, comercializadora, exportadora e importadora de productos hortofrutícolas que tiene su sede en Costa Tropical de Granada, y trabaja en toda la región de Andalucía. A través del desarrollo socioeconómico sostenible, destaca su modelo de negocio mediante el uso eficiente de herramientas y recursos naturales. Por ello, ha sido crucial llevar a cabo una optimización de procesos, métodos y protocolos que proporcionen bienes y servicios adecuados para la gestión de la industria, así como reducir los residuos generados y su efecto en el entorno más inmediato.

Palabras clave: Bioeconomía, Economía circular, Sostenibilidad, Industria agroalimentaria, Alimentación funcional

[1] Grupo Empresarial La Caña, Motril, Granada (ESPAÑA), beatriz.molina@grupolacana.com

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa

Junta de Andalucía

Andalucía se mueve con Europa

1. EXAMPLES OF THE APPLICATION OF BIOECONOMY: R+D+I PROJECTS OF THE GRUPO LA CAÑA

The strategic Research, Development and Innovation lines currently translate into projects aimed at cleaner, more sustainable and efficient food production (reducing the number of by-products and co-products), with the ultimate goal of returning to the beginning of the product cycle. The working lines defined to realise these goals are based on the maximum use of raw materials, the recovery of by-products or co-products from the activity, and environmental care and conservation. Some of the R&D&I projects of the Grupo La Caña will be shown below as an example of the implementation of the bioeconomy.

1.1 BioREFINA project

The BioREFINA project is an initiative that arose from a heightened awareness of the volume of non-commercial category product that is currently generated at the Grupo La Caña. In this regard, the Agri-food industry adopts as this project's main objective the exploitation of plant waste, such as that from pruning, fruit detritus, and organic debris (Kennet & Winterhalder, 2006) from the company's activity, from the field to the industry itself. These, together with organic waste from livestock, such as pig slurry, are ultimately transformed for use as biofertilizer, compost and even biogas.

The creation of biorefineries is one of the potential results of the project; that is, facilities to transform biomass into bioenergy and/or sustainable bioproducts. Work is ongoing along this line in which, in addition to overcoming the limitations that have arisen over the course of the project, a scenario has arisen integrating producers from different areas of the fruits and vegetables sector at the national level.

Figure 1. Biodigester

1.2 "Efficient use of water in greenhouse horticultural crops" project

In relation to water consumption, agricultural activity accounts for an estimated consumption of 70-75% of the total, the rest for urban networks and industry. Specifically, Eastern Andalusia features an intensive greenhouse cultivation area of more than 35,000 hectares, distributed between the provinces of Almería, Granada and Málaga. Around 6 million kilos of vegetables are produced each growing season. As a result, any improvement in efficiency has a direct impact on water use and availability. In this regard the "Efficient use of water in greenhouse horticultural crops" Regional Operative Group has made it possible to establish irrigation strategies that minimize spending on water for greenhouse horticultural crops, using low-cost sensors.

The use of systems that make it possible to control the use of water, and nutrients, as well as the leachates that are generated, the crop's production and environmental factors, combine to optimise its use, at both the environmental and economic levels. In this way, the project promotes precision agriculture, with a maximum use of irrigation water and the efficient use of supplies (fertilizers and biostimulants), which seeks to reduce the contamination of natural resources and contribute to the maintenance of natural ecosystems and environmental sustainability (Harris, 1989).

1.3 AVOCEMTUM Project

Within the by-product recovery lines, the AVOCEMTUM project stands out, consisting of a specific range of a certain product on the market: the use of avocados for the development of functional guacamoles having healthy properties by incorporating new ingredients obtained from the recovery of co-products. This line stands out for its functionality, as the Grupo La Caña focused on obtaining a product with properties healthy for the consumer, such as its antioxidant and fibre content, and limited fat.

Food is taking a 360-degree turn, going from sophisticated or ready-to-eat products to what today we commonly consider the consumption of traditional and fresh products of agricultural and livestock origin, the primary basis of our diets. But, could these primary resources be considered unlimited? Is it possible to get everything we want, when we want, from natural resources? These questions can be answered as follows: we know that resources are limited, to which we must add global population growth. Therefore, society, governments and the sector have the obligation to (i) become aware of the limitations of natural resources and the impact of their exploitation (ii) strategically plan industries' policies and procedures (iii) distribute food as efficiently as possible, reducing waste and ensuring zero hunger. This is why at the Grupo La Caña, aware that we must look for alternatives to the consumption of food as it is currently conceived, and continuing with our strong commitment to improving the organoleptic qualities of our fresh products, we are taking another step aimed at processed foods that, minimally processed at a certain stage, can maintain their organoleptic properties and have their shelf lives extended. These are what have been called "ready-to-eat" products.

The increase in population and global climate change are significant obstacles calling for a commitment to sustainable agricultural production over time, due to the limitations of available arable land. Thus, it is necessary to explore new food sources with high production capacities, that do not require fertilization, and are less sensitive to environmental effects, such as drought, pests and diseases. Coupled with this, a reduction in meat consumption is

detected in Western diets, associated with health factors and trends towards vegetarianism and veganism, with a market opportunity being detected, given the growing demand for plant products as alternative options.

As can be seen in Figure 2, within the framework of this project, different formats of Guacamoles (original premium, light, fibre and antioxidant) have been introduced, all in collaboration with the University of Granada and the Functional Food Technology Center (CIDAF). Based on these premises, we have worked on a laboratory scale on the formulation of food matrices yielding five recipes for each. Each recipe has been subjected to different analyses to determine its microbiological and nutritional/compositional quality and physicochemical classification. Using these formats, a sensory analysis was carried out to select the winning recipe for the final consumer. Additionally, it was possible to guarantee, at both a microbiological and nutritional level, that it was a stable product over time and complied with the quality parameters established. Once the productive stages for its conservation were defined, cold pasteurization using high hydrostatic pressures was selected, which was key to obtaining a stable, high-quality product. The last phase of the study has been the pre-commercial validation of the formats and their functional properties through a population intervention trial to validate claims regarding antioxidants and their high fibre content, through analysis of the blood plasma of consumers at different times relative to consumption to determine their antioxidant capacity and their "high fibre content" functionality. Based on the results of the project, the Grupo Empresarial La Caña launched its new line of ready-to-eat functional products, constituting a new business initiative called Caña Nature, S.L., in which it produces and markets these products, among others.

Figure 2. Functional guacamoles

1.4 ACTILIFE project

Meanwhile, the ACTILIFE Project addresses the interrelation between physical activity, health, and quality of life. To function optimally and prevent disease, the human body needs physical activity. We must emphasize that part of the population is aware of this and exercises to improve its physical condition. Coupled with this, a complete, varied diet must be followed, with the necessary amounts of food. Hence, specific food products must be created that feature all the macronutrients and micronutrients necessary to satisfy the requirements of an amateur athlete, in order to contribute to the maintenance of his health. This is the main objective of this project, which also delivers a technological innovation by developing a mobile application that includes a knowledge network, from sports to nutritional medicine, obtained through a nutritional intervention trial. With this information a personalized profile will be created for each user based on his activity, the types, amounts and doses of food consumed, and the optimal time for consumption. For all these reasons, three companies in the food sector have become involved in the framework of this project, covering the contribution of ingredients in order to meet the needs and expectations of an active society that demands healthy food, together with a management tool favouring a healthy lifestyle and improved diet. This project is currently in the production phase for two liquid-based food matrices for

consumption before and after exercise. The nutritional needs of the amateur athlete have been studied to be able to define the food product to be developed, and the food products have been selected through an analysis and description of the different raw materials from a nutritional point of view.

1.5 FOOD4STROKE project

Continuing with the strategy to develop a food product focused on improving the healthiness of people's lives, the FOOD4STROKE project focuses on the senior market as a target, the health problems associated with an aging population, and other public health problems related to the increased prevalence of certain chronic diseases, such as vascular conditions that can cause neurodegenerative disorders. The trend in a society aware of this problem has led to the more responsible consumption of food, as people realise that a balanced diet delivers nutrition and support, and also that these foods play a key role in shaping people's quality of life. Thus, this project arose from the need to research and develop new functional foods, with added value, based on the investigation of raw materials with which we regularly work at the Grupo La Caña. These raw materials have a beneficial neuroprotective effect, with potential for the prevention of neurodegenerative diseases.

The project's major innovation is that, once these functional components are known, it explores combinations of the raw materials selected in search of synergistic effects on the previously unexplored neuroprotective effect. In order to reinforce this strategy, while promoting an adequate diet, the agri-food industry is faced with the challenge of developing new foods having a preventive effect against these diseases, especially given that in recent decades there has been change in food trends in developed countries, and the concept of a balanced diet has come to mean maintaining an adequate diet based on the consumption of foods that promote health and improve social well-being.

1.6 AGUACAVALUE project

To close the circle, and as an example of the Circular Economy, the AGUACAVALUE project is presented. Society is increasingly concerned about the impact of industrial activity on the environment, and demanding environmental legislation promoting actions towards more sustainable activity by means of practices and processes that protect the environment. In this case, we focus on by-products or co-products generated by the Agri-food industry, defined as products that, commercially, do not meet quality standards, or that have some type of defect. In Spain, in general, there are many products rich in bioactive components that have beneficial effects, the recovery of which entails a reduction in the total cost of waste treatment, thereby increasing the sustainability of production processes. This project is focused on avocado as a product, especially since, to meet demand for it, the area cultivated has increased nationwide in recent years. Today lifestyles, health concerns, and a lack of time to cook, among other factors, have led to an increase in the marketing and consumption of prepared foods. Avocado consumption is mainly fresh and prepared in guacamoles and sauces. 3% of the by-product is generated fresh, and 30% is generated as prepared food. In Spain, approximately 2,000 tons of eggs and avocado skin are discarded, which is a problem for industries; on the one hand, due to the economic cost of their management and, on the other, the ecological impact of their disposal. Thus, these raw materials must be reused, reduced and recycled, as they are bioactive resources of significant commercial value, and healthy, which makes them potential sources to develop and recover a new processed product. Avocado skin is composed of components with antioxidant, antimicrobial, bioadsorbent and even insecticidal capacities. Its seeds, moreover, are even richer, as, in addition to the previously mentioned capacities (with the exception of their use for insecticides), they feature antihypertensive and antidiabetic, anticancer properties, are a source of dietary fibre, and have hypocholesterolemic, dermoprotective, colouring, thickening and biofuel effects. (Brown et al., 2008).

In short, the recovery of these by-products results in a significant

increase in the environmental sustainability of the fruit's exploitation. The transformation and use of these by-products reduce the negative impact that their elimination can generate. The complexity of the treatments may vary (fertilizers, composting, combustion, anaerobic digestion, etc.), their conversion into a recovered product with greater added value being important. All these factors can have a direct impact on employment, requiring the intervention of biotechnology companies for their subsequent use in sectors like nutraceuticals, foods, cosmetics, pharmaceuticals or animals. In the agri-food industry, fresh raw materials can be used in two ways: fresh or processed. Given the major production of by-products that are not commercial, and certain parts of fruits that, after being processed, are not valuable to the food matrix, there will be a potential environmental impact that should be placed in the crosshairs of the agri-food industries, for its proper management. The large volume of these by-products, featuring a high percentage of water, makes them challenging, mainly due to the rapid degradation of the by-product if it is not dried or processed immediately and properly. The existence of these by-products and co-products has a great impact from the economic, social and nutritional points of view, especially in the event of ineffective or inappropriate management, which may mean it ends up contaminating natural resources, soil, water and air. This impact can be significantly reduced through the transformation of these by-products, recovering their use, with this representing a source of opportunities through the rational usage of these components for their conversion into useful products. To obtain products delivering added value, several previous stages must be taken into account, from their treatment to the formulation of the final products, obtaining and monitoring bioactive compounds throughout the entire process.

Aware of the agri-food chain, from the farmer to the consumer, the Grupo La Caña undertakes the challenge of responding to demands for more sustainable and environmentally friendly production, for which it has adopted innovative technologies taking into account sustainability, food safety and

quality criteria for its products.

REFERENCES

JUNTA DE ANDALUCÍA (2018). Estrategia Andaluza de Bioeconomía Circular. Recuperado de: https://www.juntadeandalucia.es/export/drupaljda/Estrategia_Andaluza_Bioeconomia_Circular_EABC_18.09.2018.pdf

KENNETT, D.J., & WINTERHALDER, B. (Eds.). (2006). *Behavioral ecology and the transition to agriculture*. Berkeley: University of California Press.

Bioeconomy as a strategic line of the Agri-food Campus of International Excellence, ceiA3

M. Dolores de Toro-Jordano[1]

Corresponding Author: gerente@ceia3.es

Abstract:

Awareness of the importance of the Bioeconomy and the promotion of its transfer to promote progress towards a circular economy in productive systems linked to agri-food calls for the implementation of a series of actions and strategies at the territorial and regional levels, and the involvement of different agents serving as driving forces and energising initiatives, with a bottom-up and multi-actor approach. This is where the Agri-food Campus of International Excellence, ceiA3, through its Bioeconomy strategy, aligned with the Andalusian RIS3, stands as a key instrument for the Andalusian region. The campus promotes scientific dissemination and awareness of the Bioeconomy in society and the productive fabric while favouring the alignment of the institutions that make up the campus with policies in this field, stimulating interaction between universities and research groups, as well their interconnection with the agri-food sector, to respond to its specific Bioeconomy-related demands in relation to education, training and teaching, as well as in R&D and transfer through a quadruple helix open innovation model.

Keywords: Bioeconomy, RIS3, Agri-food, Transfer, Dissemination

La Bioeconomía como línea estratégica del Campus de Excelencia Internacional Agroalimentario, ceiA3

M. Dolores de Toro-Jordano[1]

Resumen:

La concienciación sobre la importancia de la Bioeconomía y el fomento de la transferencia para promover avances hacia una economía circular en los sistemas productivos vinculados con la agroalimentación precisa de la implementación de acciones y estrategias, a nivel territorial y regional, y la implicación de diferentes agentes que sirvan de tractor y dinamicen iniciativas con un enfoque botón-up y multi-actor. Aquí es donde el Campus de Excelencia Internacional Agroalimentario, ceiA3, a través de su estrategia bioeconomía, alineada con la RIS3 andaluza, se posiciona como un instrumento clave para la región de Andalucía. El campus promueve la divulgación científica, la concienciación de la sociedad y del tejido productivo en materia de Bioeconomía, asimismo favorece el alineamiento de las instituciones integrantes del campus con las políticas en ese ámbito, dinamizando la interacción entre Universidades y entre grupos de investigación así como su interconexión con el sector agroalimentario para dar respuesta a las demandas específicas del mismo en bioeconomía tanto el formación, capacitación y docencia como en I+D y transferencia a través de un modelo de innovación abierta cuádruple hélice.

Palabras clave: Bioeconomía, RIS3, Agroalimentario, Transferencia, Divulgación

UNIÓN EUROPEA
PROYECTO COFINANCIADO POR EL FONDO EUROPEO DE DESARROLLO REGIONAL (FEDER)
Una manera de hacer Europa

Junta de Andalucía

Andalucía se mueve con Europa

[1] Campus de Excelencia Internacional Agroalimentario (ceiA3), Córdoba (ESPAÑA), correo electrónico: gerente@ceia3.es

1. CONCEPTUAL AND POLITICAL FRAMEWORK

The Bioeconomy is the production, use and conservation of biological resources, including related knowledge, science, technology and innovation, to provide information, products, processes and services to all economic sectors, with the aim of moving towards a sustainable economy (FAO, 2018).

In Europe, after an initial Bioeconomy Strategy in 2012, in November of 2019 the Council adopted its conclusions on the updated Bioeconomy Strategy entitled "A sustainable Bioeconomy for Europe: strengthening the connection between the economy, society and the environment".

As defined in the European Bioeconomy Strategy "The Bioeconomy encompasses all sectors and systems based on biological resources (animals, plants, microorganisms and derived biomass, including organic waste), their functions and principles. It includes, constituting a nexus between them, terrestrial and marine ecosystems and the services they provide; all primary production sectors that use and produce biological resources (agriculture, forestry, fisheries and aquaculture); and all those economic and industrial sectors employing resources and biological processes to produce food, feed, bioproducts, energy and services. To be successful, the European Bioeconomy must be developed around sustainability and circularity. This will promote the renewal of industries, the modernization of primary production systems, environmental protection, and will also enhance biodiversity (European Commission, 2018).

In line with Europe, at the national level the Spanish Bioeconomy Strategy "Horizon 2030" was revamped in 2016, whose following strategic objectives should be highlighted:

- To improve the competitiveness and internationalization of existing companies.

- New economic activities and jobs with new scientific and technological developments.
- The positioning of the Bioeconomy as a knowledge-based area of strategic innovation.
- Reach development potential in 15 years.

The strategy's scope "incorporates as sectors receiving attention agri-food, made up of agriculture, livestock, fishing, aquaculture and food processing and marketing, as one of those that is functioning as an engine driving our exports; the forestry and wood by-products sector; in addition to industrial bio-products, obtained with or without the biochemical or biological transformation of organic matter generated by our society, and not used in human and animal consumption; as well as bioenergy obtained from biomass, and services associated with rural environments".

At the regional level, in the Circular Bioeconomy Strategy of Andalusia (Junta de Andalucía, 2018), approved in 2018, the strategic objectives set were:

- Improve the sustainability and competitiveness of the agri-food, fisheries, and forestry sectors, promoting the use of innovative practices that favour and develop a Circular Economy
- Promote the competitiveness of industries that work with biological resources, furthering innovation, the generation of knowledge and technology transfer
- Encourage the reuse of resources, water, gases, nutrients and the use of waste and plant waste to obtain other products, uses and energy
- Promote research, innovation and qualification related to the Bioeconomy and
- Strengthen inter-administrative coordination and foster synergies with other plans and work programmes in different areas.

Finally, it is worth underscoring, as key messages of the 2018 World Bioeconomy Summit Communiqué, the urgent call for increased dialogue and collaboration on sustainability in R&D and training: "with a view to the great challenges of society, we call for an urgent increase in multilateral dialogue and collaboration in R&D related to the Bioeconomy; in particular research on sustainability and global change, governance and capacity building" (Global Bioeconomy Summit Communiqué, 2018).

2. ceiA3 STRATEGIC ROLE TOWARDS A SUSTAINABLE AGRI-FOOD FABRIC

2.1 Campus of International Excellence Programme

After this introduction to the conceptual framework of the Bioeconomy and the importance of promoting sustainable production systems, it is necessary to clarify the aim of the Campus of International Excellence, which is an initiative promoted in 2008 by the Government of Spain related to the process by which to modernize the Spanish university and "aimed at the strategic aggregation of universities, institutions related to the Knowledge Triangle, and the productive sector, which, acting in a specialized environment, or campus, seek their reference points and positioning in the international context." Its objectives are the recognition and endorsement of internationally renowned campus projects in teaching, innovation and transfer, research, and the interconnection between the university and the productive sector.

2.2. Agri-food Campus of International Excellence

In 2009, in Andalusia, five Universities - Córdoba, Almería, Cádiz, Huelva and Jaen - backed the joint Campus of International Excellence initiative, the result of the alliance of these five institutions, coordinated by the University of Cordoba and with a specialization in Agri-Food. The ceiA3 International Agri-food Campus of Excellence's purpose is to promote university-business interconnections, train qualified professionals in line with the needs of the sector

and support its transformation towards a sustainable model.

Since its inception, the project has been strengthened with transfer actions, entrepreneurship, the funding of scholarships and grants, the promotion of infrastructures, collaboration with the CSIC and IFAPA as associated centres, and the creation of the ceiA3 consortium as a management body of the campus.

For this reason, ceiA3's main objective and founding principle is to promote the university's link with the Andalusian agri-food sector, and to promote its professionalization through training and capacity-building, and innovation through knowledge transfer.

The conception of the ceiA3 as an aggregator of institutions, with a specialization in Agri-food, means that one of its main challenges is its alignment with both the Andalusian Smart Specialization Strategy (RIS3) and the main strategies and transversal sectoral policies to position itself as a key element shaping their design.

2.3 ceiA3's potential in the field of the Bioeconomy

The universities that make up the ceiA3 teach a regulated Agri-food education curriculum, with a large percentage of this containing and stressing content related to the Bioeconomy; in 24 of the 100 degree programmes, 18 of the 80 Master's, as well as in specialized classes such as the ceiA3 Training Network Courses, in which the Bioeconomy has been prioritized in the last three programmes.

The campus, made up of 5 universities and 2 associated centres, comprise an R&D entity featuring 302 research groups and nearly 4,000 researchers structured into 7 clusters key to the Bioeconomy, such as Agri-Food Technologies, Bioenergies and Sustainable Agriculture. Its research lines range from the improvement and optimisation of resources for production, plant or

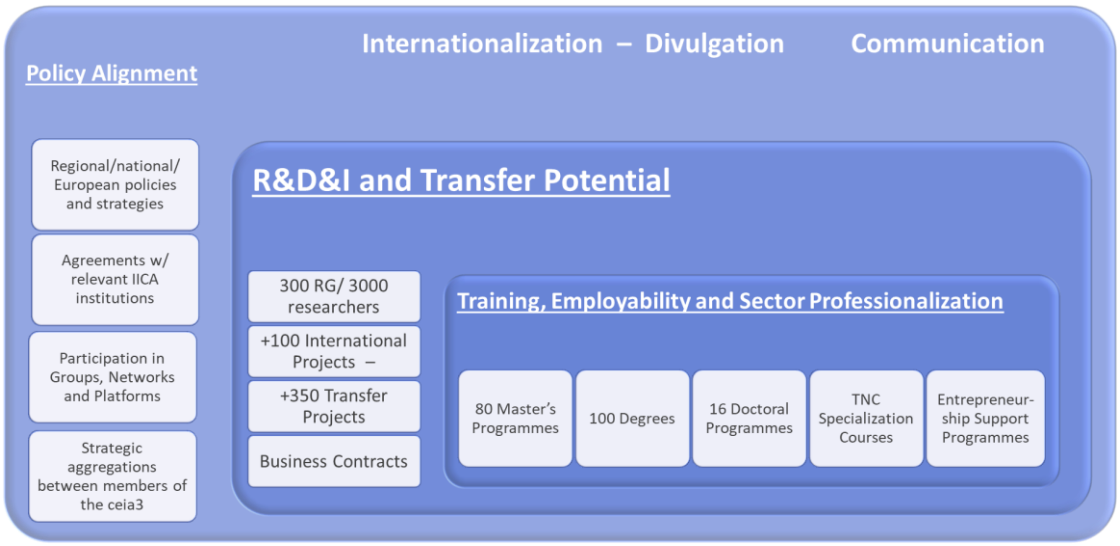
animal, to economic and legislative aspects. Due to the breadth of the Bioeconomy, there are multiple areas in which researchers carry out their activity and are key elements for innovation in the field, such as: biodiversity and the environment, bioenergy, food quality, safety, technology, and enhanced production; nutrition and health, and the recovery of by-products. Transfer is one of the key founding principles of the ceiA3. The campus is defined as an element of cohesion between the scientific community, the Government and the sector, promoting the development of multiple joint activities in the Agri-food sphere. It is also worth highlighting its participation in projects and the alignment of research with the topics included under the Bioeconomy concept carried out in recent years, and future prospecting, where it is worth stressing the special experience of GO in innovative projects, both regional and national, whose main purpose is innovation linked to sustainable agri-food systems and the promotion of rural territories through collaboration between sector agents, with their knowledge.

Both at the level of the ceiA3 consortium itself and at that of ceiA3 researchers, they have participated in about 20 projects related to the Bioeconomy, both towards their specific H2020 challenge, as well as in other European programmes, such as LIFE, Coal and Steel, the 7 Framework Programme, and different ERA-NETs.

Among the support actions promoted by the CEI related to entrepreneurship, the A3BT awards are held annually to acknowledge the best corporate ideas and projects.

Finally, both the consortium and the institutions making up the ceiA3 have a recognized Scientific Culture Unit to promote scientific dissemination and support actions aimed at society.

Figure 1. The ceiA3's R&D and transfer potential and policy alignment.



3. THE CAMPUS OF EXCELLENCE'S BIOECONOMY STRATEGY

3.1 Rationale for the ceiA3's strategy on the Bioeconomy

After a first approach to the conceptual framework, the different strategies all coincide in recognizing that the challenge is to develop sustainable bio-based production systems based on circularity. Moreover, due to the Agri-food sector's environmental, economic and social importance, special attention is to be paid to it as one of the main production systems to take into account at the European, national and regional levels.

In a context in which research and innovation take on special importance in the implementation of innovative solutions to promote production through sustainable systems stressing the sustainable use and recirculation of biological resources, and the minimization of waste, new value chains are developed based on the production of bioproducts, and their added value is augmented through the use of by-products, universities and innovation centres with proven experience in the development of such lines, playing a strategic role in helping companies in to achieve these objectives, while favouring sustainable innovation in production systems.

Innovation requires combining production systems with specialized

education and training in the field of the Bioeconomy, which is also considered a key need to favour innovation ecosystems and the professionalization of the sector. In this area, support for new companies that foster innovation processes is also considered essential.

All this must be combined with heightened awareness and co-participation in the designing of actions by all the actors in the chain, including consumers and society itself, which are fundamental to guarantee, in the medium and long term, the success of measures implemented through a bottom-up process.

Standing out in the Andalusian Community is its RIS3 smart specialization strategy. And, among the regional advantages of supporting "Research and innovation in agribusiness and healthy eating" is that the region benefits from the ceiA3 as a high-profile asset for the promotion of synergies between actors.

In 2016 the Organization for Economic Cooperation and Development (OECD) produced a thorough report on the political framework of the "knowledge triangle" for the integration of research, education and innovation, analyzing 16 national case studies on higher education ecosystems in the knowledge triangle in Europe. *The Knowledge Triangle: Draft Synthesis Report* (OECD, 2016) cited and analysed the ceiA3 as an important case in Spain, highlighting how it favours the creation of communities oriented towards excellence in different spheres of knowledge, fulfilling specialization objectives and, therefore, the internationalisation of its activities.

3.2 Aims of the strategy

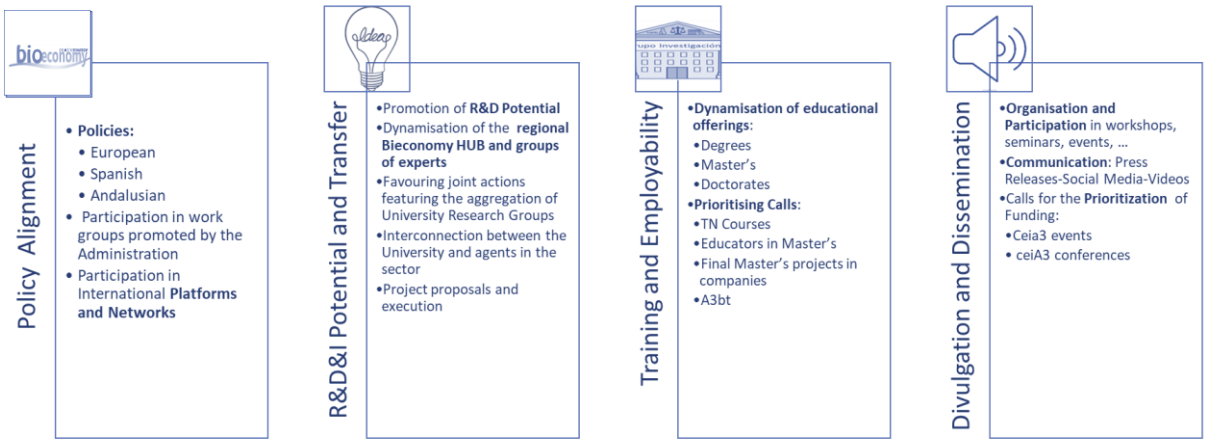
The Bioeconomy, linked to sustainable agri-food production systems, and in the current environmental and political context, should constitute a transversal line of prioritization for the campus whose groups are conducting Bioeconomy research, conferring a greater specialization on the actors, with this matter being tackled in the training and actions of the ceiA3 itself, "transversalizing"

the Bioeconomy, in all its areas, as a top priority.

Thus, taking into account the aforementioned, and the principles of the CEI itself, the ceiA3's Bioeconomy strategy was designed as a transversal line of specialization towards the making of special efforts, with its main objectives being:

- To favour the alignment of all the different areas and actions of the members of the CEI with regional, national and European policies and strategies in the Bioeconomy area.
- To promote and strengthen joint actions in R&D and knowledge transfer whose purposes are aligned with sustainable agri-food production.
- To reinforce and promote education and training, the professionalization of the sector, and the employability of graduates of ceiA3 Universities in the Bioeconomy.
- To publicise and position the research and innovation of excellence carried out at the ceiA3's universities and associated centres, promoting their dissemination and social awareness of them.

Figure 2. Summary of the ceiA3's objectives



3.3 Lines of action and case studies in the Bioeconomy sphere

In line with the principles of the aggregation and specialization of institutions, it

is proposed to carry out a series of actions that will be undertaken in a transversal way by the different areas of the campus and that, ultimately, will help to achieve the strategy's objectives.

Key examples of actions to be taken in each of the blocks proposed are highlighted:

With regard to reinforcing the alignment of ceiA3 with regional, national and international policies, initiatives and strategies in the field of Bioeconomy, standing out as a success story is the active participation by both ceiA3 researchers and the campus itself in the corresponding national and regional strategies, through their participation in the Spanish Bioeconomy Observatory and in the design of the Andalusian Circular Bioeconomy Strategy, bringing together and representing the interests of its member institutions and contributing its experience in the field.

Also standing out in this block, due to its importance to the Agri-food sector, is the alignment of the ceiA3 with the European eip-Agri initiative, materialized through participation in events and activities related to the Bioeconomy, like focus groups, the launching of Operational Groups, and the execution of innovative projects, all linked to sustainable production, as well as the Green Deal and Horizon Europe commitment: to promote participation in consortium projects aligned with this subject.

In order to promote a ceiA3 curriculum in the field of the Bioeconomy, of special note is the reinforcement of the implementation of educational content on the subject, publicising Master's and PhD programs, promoting specialised training in the Bioeconomy, such as the Training Network Courses; and prioritising assistance lines in this strategic area.

The vitalisation of the R&D&I potential of the research groups attached to the ceiA3 in the field of Bioeconomy is a key action that will be undertaken through the revamping and vitalisation of capacities as regards groups' research and innovation in the area of the Bioeconomy, the categorization of potential, the digitization of information through a platform that facilitates

searches for capacities, and the constitution of Bioeconomy Expert Groups.

In line with the previous objective, but oriented towards the promotion of transfers and links with the sector, the organization of meetings, workshops and projects in this area will be promoted, along with the identification of synergies and the pursuit of innovative solutions to sector problems, furthered through a multi-stakeholder approach, a bottom-up design, and a search for possible sources of public and private financing. All this will culminate in the carrying out of innovative projects, such as those organised by the eip-Agri's operating groups, and transfer and innovation projects financed with European funds. Of special note is the PAIDI regional project for Agroindustry 4.0 and Bioeconomy transfer, which has provided financial support for the development of the strategy.

Finally, within the block of actions aimed at publicity and information dissemination, this will be done through the ceiA3's Scientific Culture Unit and the generation of instructive content, news and videos. In this block, the actions carried out within the framework of Europe's H2020 BLOOM project stand out, whose aim is to raise social awareness of the importance of the Bioeconomy, with the ceiA3 taking responsibility for the development of the project's Web platform and coordinating to bolster the Spanish Hub. Within the framework of the Spanish Bioeconomy Hub, specialising in Agri-food, and promoted by the ceiA3, after a mapping of relevant actors in the region, experts from universities, agents in the productive sector and the territory, and the administrations themselves, got involved. The HUB is constituted as a multi-stakeholder group, and its main task has been the joint designing, through a methodology of co-creation, of different "outreach" activities to promote social awareness, with special attention to the productive sector and groups of schoolchildren. The main actions taken have been the creation of materials for faculty, participation in events like a "researchers' night", demonstrative innovation routes for companies exhibiting an acute awareness of the Bioeconomy, and the development of ancillary contents and audio-visual material.

Finally, of note was reflection on the importance of disseminating the innovative scientific knowledge that led to the launch of the C3 Bioeconomy Scientific-Technical Journal, to promote the diffusion - both scientific and technical - of innovations, experiences and achievements by the agri-food fabric of knowledge and production as relates to the Bioeconomy.

REFERENCES

Organización de las Naciones Unidas para la Alimentación y la Agricultura, FAO (2018). Cambio climático. Recuperado de: http://www.fao.org/climate-change/our-work/issues/bioeconomy/es/.

Comunicación de la Comisión al Parlamento Europeo, al Consejo, al Comité Económico y Social Europeo y al Comité de las Regiones (2018). Recuperado de: https://ec.europa.eu/transparency/regdoc/rep/1/2018/ES/COM-2018-673-F1-ES-MAIN-PART-1.PDF .

Comunicado Cumbre Global de Bioeconomía 2018. Global Bioeconomy Summit 2018. Recuperado de: https://gbs2018.com/fileadmin/gbs2018/Downloads/Communique%CC%81GBS2018_final_Spanish.pdf.

The knowledge triangle: draft synthesis report. Organización de Cooperación y Desarrollo Económico, OCDE (2016). Recuperado de: https://one.oecd.org/document/DSTI/STP/TIP(2016)10/en/pdf.

Junta de Andalucía (2018). Estrategia Andaluza de Bioeconomía Circular. Recuperado de: https://www.juntadeandalucia.es/export/drupaljda/Estrategia_Andaluza_Bioeconomia_Circular_EABC_18.09.2018.pdf.

Boosting European Citizen´s knowledge and awareness of Bio-Economy Research and Innovation. Recuperado de: https://bloom-bioeconomy.eu/.