



Bioeconomy Paraguay

Innovation and Economic Diversification





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Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
CONACYT	National Council of Science and Technology
CPIP	The Paraguayan Chamber of the Plastics Industry
DINAPI	National Directorate for Intellectual Property
DINAVISA	National Health Surveillance
EPR	Extended Producer Responsibility
FEPAMA	Federation of Wood Producers
FSA	Food Standards Agency
FSC	Forest Stewardship Council
GCF	Green Climate Fund
GCI	Global Competitiveness Index
IICA	Inter-American Institute for Cooperation on Agriculture
INBIO	Institute of Agricultural Biotechnology
MIC	Ministry of Industry and Commerce
PNCB	National Biomass Certification Program
PND 2030	National Development Plan 2030
SENAD	National Anti-Drug Secretariat
STIB	Science and Technology of Biomolecules of Agro-industrial Interest
TCPOP	Technical Committee for the Promotion of Organic Production
UNI	National University of Itapúa
WEF	World Economic Forum
WHO	World Health Organization
WWF	World Wide Fund for Nature

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Executive Summary

This report aims to inform the Government of Paraguay about the economic potential of an innovative bioeconomy to diversify exports and create better jobs. As such, this report provides a platform to develop strategies, policies, and action plans to fulfill this potential and highlights opportunities and challenges shaping Paraguay's sustainable, long-term development vision.

Over 50 countries have used bioeconomy sectors to drive growth and innovation, and benefit from new markets for sustainable goods and services. For example, in 2020, Colombia published a bioeconomy strategy focused on innovation and leveraging its biodiversity, and an action plan to implement it. This plan had an innovation support program which funded 22 projects, trained 738 people, and supported 115 initiatives up until 2022.¹ In the same year, 1,020 patent applications were filed, a new record and a 19% increase over the previous year 2021.² Colombia expects its bioeconomy to create 2.5 million jobs, develop 500 sustainable bioproducts, and contribute 10% to GDP by 2030.

Currently, Paraguay's bioeconomy accounts for nearly 23% of total value added, roughly equivalent to US\$9.5 billion in 2022 and has generated several successful initiatives of small volume but high value-added value chains. This experience, which includes compliance with international standards and certifications in niche markets, is evidenced in Paraguay's export of organic sugar, sesame, cotton, banana and petit grain essential oils. While small, these value chains provide a platform from which to extend innovations, and support employment, rural incomes and sustainability. However, many of Paraguay's SMEs lack capacity, finance and R&D, and bear high shipping costs due to the country's landlocked geography. Thus, Government support is needed to drive synergies, public-private sector collaboration, and enabling environments. Compared with regional peers, Paraguay's merchandise exports are highly concentrated, with nine trading partners accounting for roughly 80% of exports, and five products generating over 70% of export revenue.

There are a number of innovative, biobased sectors with significant growth potential globally and in Paraguay, that could contribute to Paraguay's economic diversification. However, to build on this potential, Paraguay would need to expand its innovation capabilities to enter sectors such as bioplastics, biopharmaceuticals, forestry and wood, ecotourism and other ecosystem services, such as carbon markets for export. A wide range of products can be produced from wood, and wood pulp can serve as an alternative input material for textiles. Besides wood itself, the forests or plantations in which it grows can also provide non-wood forestry products such as cosmetics, biopharmaceuticals, or food additives. Paraguay can also expand its bioplastics production to take advantage of a global market that is expected to grow between 35–45% through 2027. In part, this is because large buyers, such as car manufacturers, have committed to purchase bioplastics. Further market opportunities are also evident in ecotourism and carbon financing, both fast-growing service industries with potential to contribute to conservation of natural capital assets.

¹ Minciencias (2022). Balance del Programa Colombia BIO y la Misión Nacional de Bioeconomía. Available at: https://minciencias.gov.co/sites/default/files/upload/paginas/balance_colombia_bio_mision_de_bioeconomia.pdf

² Superintendencia de Industria y Comercio (2024). Available at: <https://www.sic.gov.co/ruta-pi/noviembre-2022/propiedad-industrial/aumento-de-solicitudes-de-patentes%C2%A0colombia-gana-en-innovacion>

TABLE 1 Bioeconomy Sectors and Enabling Factors

TYPE	ENABLING FACTOR	WOOD	BIO-ENERGY	BIO-PLASTICS	BIO-PHARMA	TEXTILE	TOURISM	CARBON FINANCE
Regulatory	Business environment							
	Patent system							
	Public procurement							
	Trade policies							
	Competition policies							
	Waste regulations							
Financial	Entrepreneurship and R&D funds							
	Access to long-term financing (esp. SMEs)							
Information	Standards and labeling							
	Public awareness							
	R&D and innovation							
	Skills and education							
	Demonstration projects							
	FDI promotion							
	Public private collaboration							

Source: Authors

* Importance of horizontal category based on survey results and stakeholder consultations. (Performance of Paraguay in enabling factors indicated by color. Darkest blue defining most important constraint/area for improvement)

Based on the comprehensive review of the Paraguayan market environment and enabling conditions, the following recommendations for the government of Paraguay have been formulated:

To set its strategic direction and priorities, Paraguay should specify a definition of the bioeconomy, and its scope and opportunities. A national bioeconomy strategy and action plan is needed to improve information, coordination and monitoring of the bioeconomy, while a performance evaluation framework is required to monitor progress and measure success. A survey of 158 companies underscored the need for such a strategy to support growth, exports and market access of related sectors. This should be followed with a unified strategy which identifies target markets and asserts the need for government support. Such an approach has the potential to foster economic, social and environmental benefits, and sustainable growth needed to cope with challenges such as climate change and poverty reduction.

Paraguay should strengthen its science, technology, and innovation ecosystem through public-private partnerships, investment in R&D, and improvements to its patent system. Currently, Paraguay's R&D spending, at 0.16% of GDP, is a third of that of Mercosur countries, while patent processing times and limited institutional collaboration retard innovation. More R&D funding would attract the private sector and support the bioeconomy through commercially viable domestic innovations. Partnerships with venture capitalists and collaboration between universities and the private sector would stimulate joint research efforts. Essential needs include reviewing public research and innovation expenditure, a unified national R&D agenda through CONACYT, and policies for patent processing and enforcement through DINAPI. Other needed actions include: analysis and consolidation of innovation policies, assessing initiatives like scholarships and education programs, standardized metrics to assess scientific endeavors, and an impartial council to allocate public funding in CONACYT.

Promoting certification and sustainability in input markets and facilitating market entry through public procurement can help Paraguay to expand its access to high price markets. Currently, a significant portion of Paraguay's bioeconomy value added lacks green standards, labels or certification. As international buyers and brands increasingly demand sustainability certification for sourcing materials, at times even at a price premium, certified environmental compliance is increasingly required to access higher priced markets (e.g., EU Deforestation Regulation). Paraguay can pursue high-quality inputs and outputs through certification, quality assurance standards, and product traceability and increase access to international markets. Additionally, where market entry for bioproducts is not facilitated by existing standards/certifications, green public procurement interventions can help, comprising 25.6% of the general budget in 2022. This presents an opportunity to support firms and growth in the bioeconomy.

Paraguay can align financing mechanisms with bioeconomy goals and leverage green financing to drive bioeconomy growth. According to the 2023 World Bank Enterprise Survey, access to finance is a top concern for businesses of all sizes in Paraguay, with only 60% of small firms having bank loans. Aligning finance with bioeconomy objectives and scope will define the nature and role of finance in the bioeconomy. Initially, FONTAGRO may play a strong role as a unique mechanism to finance agricultural technology in Latin America, the Caribbean and Spain. Later, specific financing mechanisms for bioeconomy start-ups and innovations should be created. Costa Rica, for example, created five financial mechanisms, including a bio-enterprise accelerator program and two dedicated programs for women. Finally, the growing green bond market offers opportunities to finance bioeconomy activities.

Introduction

The main objective of this analysis is to inform Paraguay about the economic potential of innovating in the bioeconomy to spur export diversification and better jobs. As such, this report provides a platform to develop policies and action plans for Paraguay to fulfill its bioeconomy potential. Developing its bioeconomy will help Paraguay to mitigate and adapt to climate change and to clarify a sustainable and long-term development vision for the country.

The bioeconomy refers to activities that convert biological materials from agriculture, forests, the marine environment, and waste, into products, processes and services that have a net beneficial effect on social wellbeing and nature.³ As countries prioritize their bioeconomy sectors, it is critical that national environmental regulations and standards promote sustainability of their biological inputs. To date, over 60 countries globally have dedicated or integrated bioeconomy strategies to improve competitiveness, innovation, climate change response, employment, food security, energy security, and rural development. In Latin America, this includes Costa Rica, Colombia, Brazil (State of Pará) and Argentina.

The bioeconomy is a subset of the green and blue economies that provides sustainable biobased and innovation-driven products. The bioeconomy differs from climate-smart agriculture, agroecology, and sustainable agriculture, as these focus on the promotion of more sustainable agricultural products and practices, which mainly serve as input materials to the bioeconomy.

This analysis is structured around three chapters as follows:

- **Chapter 1** presents an overview of economic opportunities for Paraguay to diversify its exports. It then describes how other countries have leveraged their bioeconomy strategies for innovation-led growth, as their approaches provide a framework that may be instructive to Paraguay.
- **Chapter 2** covers value chains and sectors in which Paraguay could grow its bioproducts and bioservices, including wood, bioenergy, biopharmaceuticals, bioplastics, textiles, ecotourism and carbon markets.
- **Chapter 3** provides recommendations based on a taxonomy of bioeconomy policies that target improving sustainable sourcing of inputs and their certification, the science, technology and innovation needs of the bioeconomy, financing, and proactive public awareness.

The methodology includes a multicriteria analysis of opportunities for Paraguay, thorough stakeholder consultation, and a survey of private market players in the bioeconomy. In the survey, stakeholders from the private sector, were asked how they perceived opportunities in the bioeconomy; they also took part in a semi-quantitative survey on their viability in terms of market growth, and economic and ecological benefits and challenges. Additionally, interviews with academia, NGOs and local associations were conducted.

³ The exact definition of the bioeconomy is subject to national legislation and interpretation. This includes the selection of priority sectors, and the inclusion and exclusion of certain activities and products, such as high environmental risk or basic commodity products.

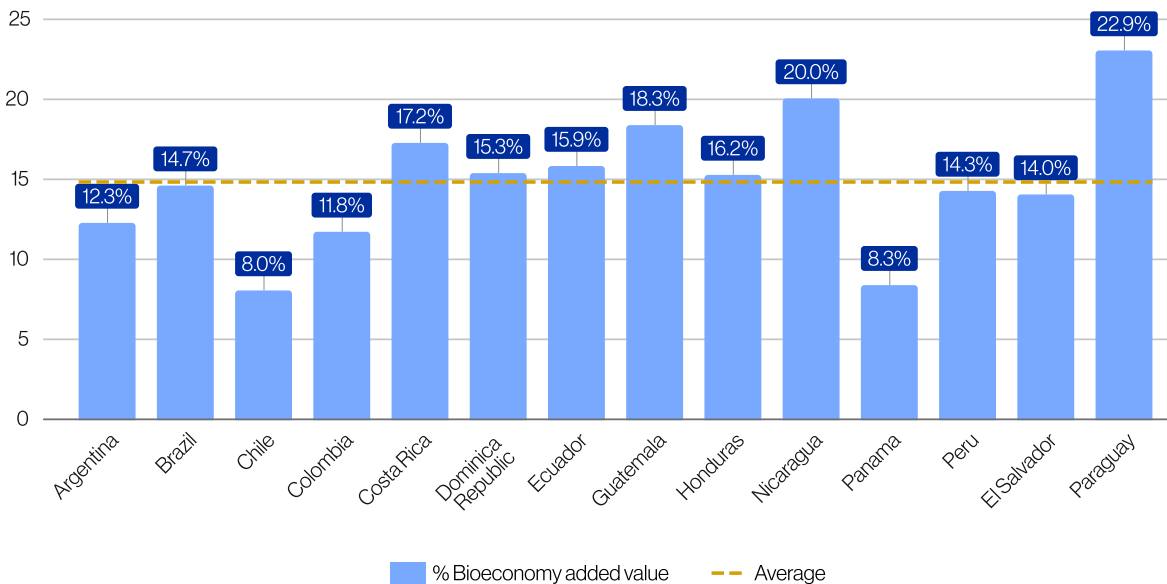
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The Bioeconomy - a Source of Innovation and Growth

The bioeconomy offers a framework to rethink how natural capital is used and monetized. To realize the potential for regenerative and sustainable bioeconomy sectors, the country needs to focus on innovation and improve the business environment for entrepreneurs.

Paraguay already has robust bioeconomy sectors which have grown the economy by exporting soybeans, beef, soy flour and corn. With hydropower, these products accounted for around 70% of exports in 2023 (Figure 2).⁴ Paraguay stands out in terms of these basic products of the bioeconomy – from agriculture, agro-industry, food, bioenergy, textiles and leather products. These sectors account for nearly 23% of total value added, roughly equivalent to US\$9.5 billion in 2022.⁵ Paraguay’s reliance on natural resource and commodity producing sectors is higher than that of most countries in the region, with the primary sector contributing 17.8% of value added and employing roughly 20% of the country’s workforce.⁶

FIGURE 1 Share of Bioeconomy Value Added per Country (% Of Total Value Added)



Source: Author’s calculation based on Vargas, Mondaini & Rodríguez, 2023 and ECLAC, 2022.

Note: The analysis year is 2018 for all countries, except for the Dominican Republic (2016) and Panama (2017).

Estimates are based on the quantity of bioeconomic inputs in intermediate consumption.⁷

⁴ Banco Central del Paraguay – Anexo Estadístico del Informe Económico Enero 2024.

⁵ It is important to note that this figure is a rough estimate based on the 2011 input-output table, and it assumes that the share of the bioeconomy sector has been relatively stable over the last decade.

⁶ Author’s elaboration based on a 2011 input and output table, following Vargas (2023). The value-added share for soy and industrial crops is based on Cicowiez (2015).

⁷ Vargas, R., Mondaini, A. & Rodríguez, A. G. (2023). Cuentas satélite de bioeconomía para 13 países de América Latina y el Caribe: Metodología y resultados. Economic Commission for Latin America and the Caribbean (ECLAC). <https://repositorio.cepal.org/server/api/core/bitstreams/19f09d4d-6bbc-43a7-9dec-579c7b7583f0/content>

Paraguay's experience with bioeconomy exports generated several successful lower volume value chains which are a basis for further innovation and economic diversification. Paraguay's experience, including compliance with international standards and certifications in a range of niche markets is evidenced by its exports of certified organic sugar, sesame, cotton, banana or petit grain essential oils. These businesses also create employment, diversify rural incomes and advance sustainability. Yet, many of Paraguay's SMEs lack capacity, access to finance, and R&D, and carry high shipping costs due to Paraguay's landlocked geography. Government support is needed to unlock synergies, increase public-private sector collaboration, and create enabling environments.

Over the last 15 years, over 50 countries have adopted bioeconomy innovations to drive growth and diversification, and as strategies to enter new markets for sustainable goods and services. In the region, Costa Rica, Colombia and Argentina are pioneering the bioeconomy, while countries worldwide use the concept for their sustainable development. For example, Thailand has adopted a Bio-Circular-Green Economy Model, that is based on 4 priority sectors. These are adapted by region and include, moving food and agriculture sectors from low-value commodities to premium products and product diversification, building capacity to increase biopharmaceutical production, and increasing the use of biomaterials, bioenergy and biochemicals to achieve energy security and to convert biomass to high-value commodities. Thailand further focusses on high-quality culinary, wellness and cultural tourism, leveraging its biodiversity and cultural diversity. Talent and entrepreneur development and frontier research in areas such as bioprocess engineering or complex microbiota should enable Thailand's transition.⁸ On the other hand, New Zealand is developing a combined bioeconomy and circular economy strategy to lower emissions and tackle waste. This approach also creates new businesses and job opportunities and helps to "maintain economic competitiveness as global markets demand stronger environmental credentials across value chains."⁹

Costa Rica is a regional leader in the bioeconomy and launched its national strategy in 2020. It is actively implementing this strategy through its inter-ministerial Bioeconomy Committee made up of the Ministry of Science, Innovation, Technology and Telecommunications (MICITT), the Ministry of Environment and Energy (MINAE), the Ministry of Economy, Industry and Commerce (MEIC) and the Ministry of Agriculture and Livestock (MAG). Costa Rica has since set up a range of financing options for bioeconomy businesses through BIOFIN, which include a green bond, a Bioeconomy accelerator program, specific services for bio businesses, and an incubator program with seed capital. To date, five financial mechanisms and a bio-enterprise accelerator program, were established, of which two are for women.¹⁰

In 2020, Argentina created a National Directorate of Bioeconomy to promote and regulate bioeconomy products and their use in the economy. Through the Paris Agreement, Argentina committed to a sustainable, innovative, better-quality food sector; and these goals, in turn, support circular and local economies, and employment and regional development. To this end, The Directorate hosts innovation roundtables and programs to promote bioproducts, bioinputs, biomaterials, and R&D.

⁸ Thai Embassy to the United States (2023). <https://washingtondc.thaiembassy.org/en/page/bio-circular-green-economic-mode-bcg?menu=641d814bb2a0ec60c758d0a3>.

⁹ New Zealand Ministry of Business, Innovation & Employment (2024). <https://www.mbie.govt.nz/business-and-employment/economic-development/circular-economy-and-bioeconomy>.

¹⁰ BIOFIN (2024). <https://biofin.cr/en/>.

Colombia stands out as a country with an innovative bioeconomy strategy that leverages its biodiversity. In 2020, the Ministry of Science, Technology and Innovation (Minciencias), supported by the National Planning Department and the Presidential Council for Competitiveness and Public-Private Management, authored the Action Plan for Colombia's Bioeconomy Strategy.¹¹ The plan provides a national strategy for Colombia's bioeconomy, and aims to position the country as a leader in this field. Colombia aims to create 2.5 million jobs, develop 500 sustainable bioproducts, and contribute 10% to GDP through its bioeconomy by 2030. Regional plans have been developed that cascade and further adapt specific bioeconomy intervention and objectives to specific regions.

Colombia's strategy has worked, with a record for patent applications in 2022 and a number of benefits of state intervention. A key component of the Action Plan is the Sácale Jugo a tu Patente program, which supports commercialization and technology transfer for pending and realized patents, and trains inventors to negotiate with developers to birth new products. Up until 2022, the program had funded 22 projects, with 738 people trained and 115 initiatives supported.¹² In the same year, 1,020 patent applications were filed - a 19% increase over the previous year and a record.¹³ Other early results include 30 scientific expeditions and 132 new bioproducts. Minciencias invested over US\$246 million between 2020–2022. Additionally, 422 bioprospecting licenses have been granted, which will lead to R&D to commercialize native Colombian species for bioprospecting, industrial, or commercial purposes.¹⁴

Meanwhile, sustainable products are significantly driving global growth in consumer-packaged goods, offering opportunities for Paraguayan exports. A recent study by McKinsey and Nielsen IQ shows that 78% of consumers value sustainable lifestyles and 30% of these are more likely to shop accordingly.¹⁵ From 2013 to 2023, products marketed as sustainable contributed nearly a third of the growth in consumer-packaged goods, with their market share consistently rising each year. Currently, sustainable products hold an 18.5% market share, 1.2 percentage points up from the previous year.¹⁶

¹¹ Bioeconomy for a Living and Diverse Colombia - towards a Knowledge-Driven Society. Available at: https://minciencias.gov.co/sites/default/files/upload/paginas/bioeconomia_para_un_crecimiento_sostenible-qm_print.pdf.

¹² Minciencias (2022). Balance del Programa Colombia BIO y la Misión Nacional de Bioeconomía. Available at: https://minciencias.gov.co/sites/default/files/upload/paginas/balance_colombia_bio_mision_de_bioeconomia.pdf.

¹³ Superintendencia de Industria y Comercio (2024). Available at: <https://www.sic.gov.co/ruta-pi/noviembre-2022/propiedad-industrial/aumento-de-solicitudes-de-patentes%C2%A0colombia-gana-en-innovacion>.

¹⁴ Minciencias (2022). Balance del Programa Colombia BIO y la Misión Nacional de Bioeconomía. Available at: https://minciencias.gov.co/sites/default/files/upload/paginas/balance_colombia_bio_mision_de_bioeconomia.pdf.

¹⁵ Sustainability: the new consumer spending outlook; The latest environmental, social, and governance (ESG) developments that your business should know about. Nielsen Consumer LLC, 2022.

¹⁶ The 2023 Sustainable Market Share Index. NYU Stern Center for Sustainable Business 2023.

The market for bio-based food and feed, products, and energy is expected to grow from US\$10.3 trillion in 2018 to US\$12.8 trillion in 2030, a 1.8% annual growth. According to the same study, pharmaceuticals will have the highest potential, with US\$760 billion in 2030, followed by textile and apparel, and building material and construction with US\$700 billion each (Table 2). Another example is sustainable packaging and food, which have shown the highest market growth for sustainable products.¹⁷ These products have seen 21% growth from 2019–2022, while in September 2022, “plastic free” product claims, like those with biomaterials, increased by 157%.¹⁸

TABLE 2 Bioeconomy Sectors and Market Shares

SECTOR	BIOPRODUCT EXAMPLES	MARKET SIZE 2018 (BILLION US\$)	MARKET SIZE 2030 (BILLION US\$)	GROWTH PER ANNUM OF MARKET	BIO-BASED MARKET SHARE 2018	BIO-BASED MARKET SHARE 2030
Pharmaceuticals	Carrot cells to treat certain metabolic disorders. Chamomile, flax, peppermint, and buckthorn.	264	760	2%	21%	38%
Textile and apparel	Natural fibers include jute, flax, and hemp. Man-made cellulosic fibers such as viscose, modal, and lyocell	417	686	4%	46%	45%
Building materials	Laminated veneer lumber or cross laminated timber; wood fibers and lignin; wood cement composites	331	682	9%	3.5%	7%
Packaging	Bio-PET for drinking bottles or Bio-PE for food, cosmetics, and pharma packaging.	375	544	7%	43%	44%
Automotive	Hemp for specific boards and vehicle steel parts. Sisal fiber for floor mats. Tires made from dandelion or guayule. Silica derived from rice husk ash as an alternative source for silica.	255	526	7%	4.6%	5%
Other forest products	Recycled paper. microfibrillated cellulose. Bio-based aromas for fragrances and flavors, lubricants, natural fertilizers, or cleaners and solvents.	133	201	3%	27%	29%
Bioenergy	Biofuels, biogas	143	188	2%	9.7%	10.5%

Sources: Based on World Business Council for Sustainable Development 2020. Original source: European Commission; Oxford Economics; WBCSD; BCG analysis; Member companies. Based on rough estimations and rounded market sizes, sorted by substitutional potential in 2030.

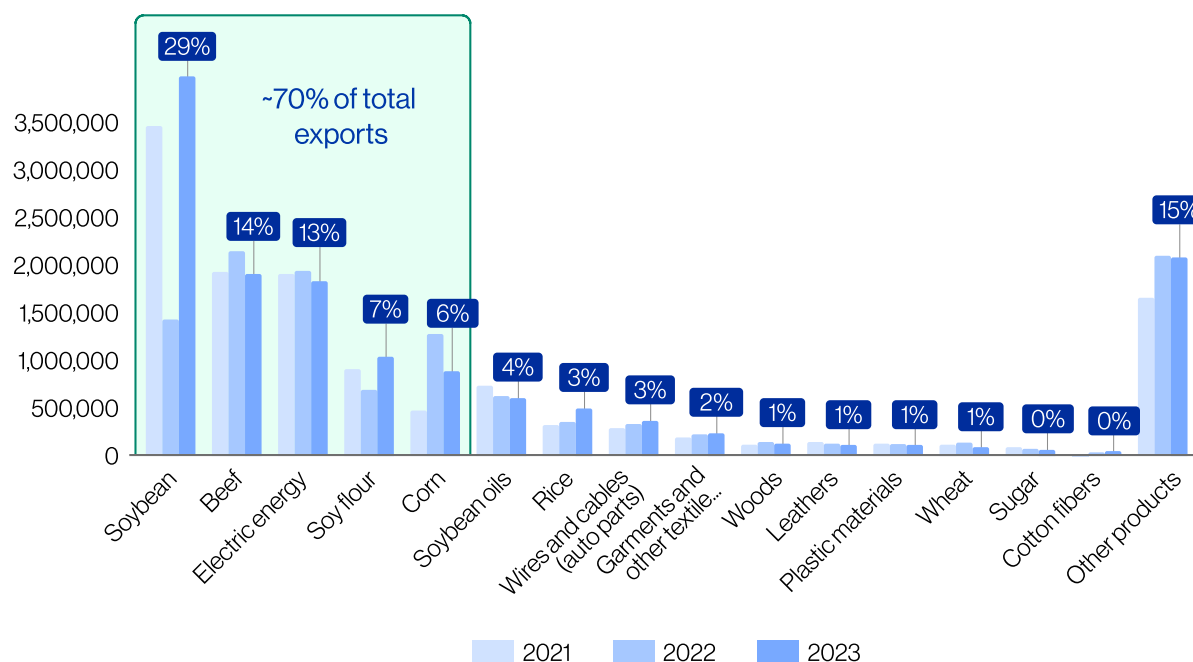
¹⁷ Consumers care about sustainability—and back it up with their wallets, McKinsey, February 6, 2023. <https://www.mckinsey.com/industries/consumer-packaged-goods/our-insights/consumers-care-about-sustainability-and-back-it-up-with-their-wallets#/>

¹⁸ Sustainability: the new consumer spending outlook; The latest environmental, social, and governance (ESG) developments that your business should know about. Nielsen Consumer LLC, 2022.

Paraguay can leverage its ongoing success in bioeconomy sectors to diversify its export basket.

In 2023, Paraguay's exports were worth US\$11.890 million, with imports of US\$15.680 million.¹⁹ The most exported products in 2023 were soybeans, with a value of US\$3.424 million (29% of exports); beef, with a value of US\$1.639 million (14%); electricity, US\$1.572 million (13%); and soy flour, US\$885 million (7%).²⁰

FIGURE 2 Main Exports in Million US\$, 2021–2024



Source: Banco Central del Paraguay – Anexo Estadístico del Informe Económico enero 2024.

Paraguay's merchandise exports are highly concentrated compared to regional peers, with the top nine trading partners accounting for 80% or more of exports (Figure 3).²¹ Most exports go to the Southern Common Market (Mercosur), followed by other groups of Latin American and Asian countries (Figure 4).²²

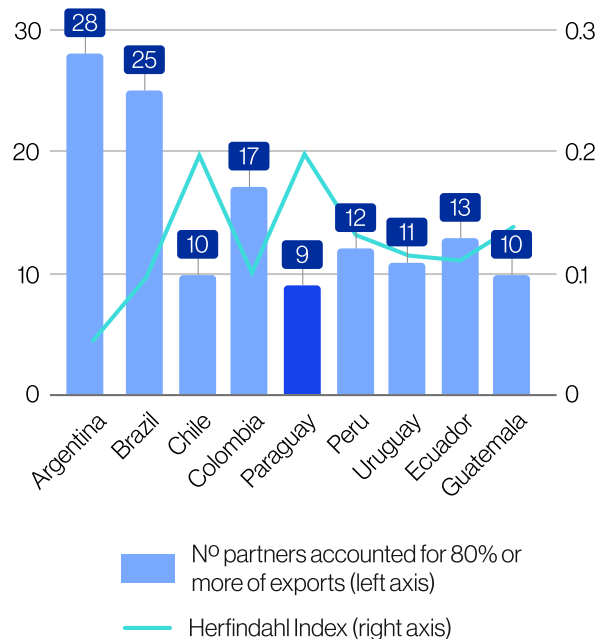
¹⁹ Re-exports are excluded.

²⁰ Ministerio de Hacienda, Subsecretaría de Estado de Economía (2022). Perfil económico y comercial. Dirección de Integración, departamento de Convenios Comerciales. Available at: https://www.economia.gov.py/index.php/download_file/view_inline/648

²¹ United Nations (2023): 2022 International Trade Statistics. Yearbook. <https://comtradeapi.un.org/files/v1/app/publicationfiles/2022/Voll2022.pdf>.

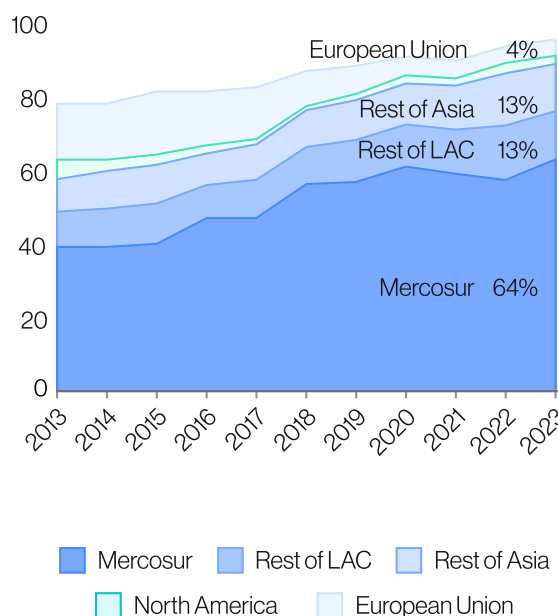
²² Banco Central del Paraguay – Anexo Estadístico del Informe Económico, enero 2024.

FIGURE 3 Concentration of Merchandise Trade - Partners and Comparators, 2022



Source: United Nations (2023): 2022 International Trade Statistics Yearbook.
<https://comtradeapi.un.org/files/v1/app/publicationfiles/2022/Voll2022.pdf>. Own elaboration.

FIGURE 4 Exports by Country Group, 2013 – 2023



Source: Banco Central del Paraguay – Anexo Estadístico del Informe Económico, enero 2024. Own elaboration.
 Note: 'Rest of LAC' accounts for Bolivia, Chile, Colombia, Cuba, Ecuador, Panama and Peru; 'North America' includes USA, Canada and Mexico; 'Rest of Asia' excludes China.

While innovative in its primary sector, Paraguay can further support its bioeconomy through more R&D spending. In 2020, Paraguay spent 0.16% of its GDP on R&D²³ – nearly four times less than most Latin American countries,²⁴ over three times less than the average R&D spending within Mercosur, and well below that of high-income countries (Figure 5). Over two-thirds of Paraguay's R&D funding comes from the public sector (Figure 6), with most investments directed toward basic and applied research (86%).²⁵ Only 14% is allocated to research to generate ideas for products or processes, or enhance existing ones.²⁶ In 2021, there were 1,832 researchers registered on Paraguay's Scientific and Technological Activities database. This is 0.48 researchers per thousand members of the economically active population, significantly lower than Latin American and Caribbean (1.3) or OECD (12.7) averages,²⁷ which suggests a shortage of education and training in science and technology.

23 World Bank (2022). Research and development expenditure (% of GDP). World Bank Databank.

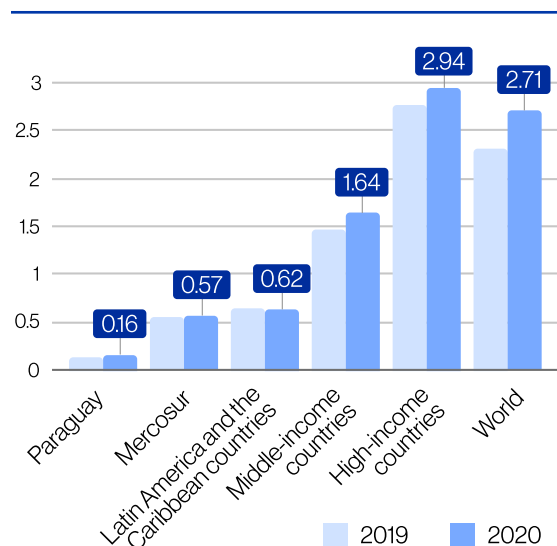
24 The estimation covers Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, Guatemala, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, St. Vincent and the Grenadines, Trinidad and Tobago, Uruguay, Venezuela, and the Virgin Islands.

25 Source: CONACYT (2022). https://www.conacyt.gov.py/sites/default/files/upload_editores/u489/Informe-final-ACT-2021.pdf.

26 Source: CONACYT (2022). https://www.conacyt.gov.py/sites/default/files/upload_editores/u274/Glosario-de-Terminos-y-Conceptos-ACT2021.pdf.

27 Source: CONACYT (2022). https://www.conacyt.gov.py/sites/default/files/upload_editores/u489/Informe-final-ACT-2021.pdf.

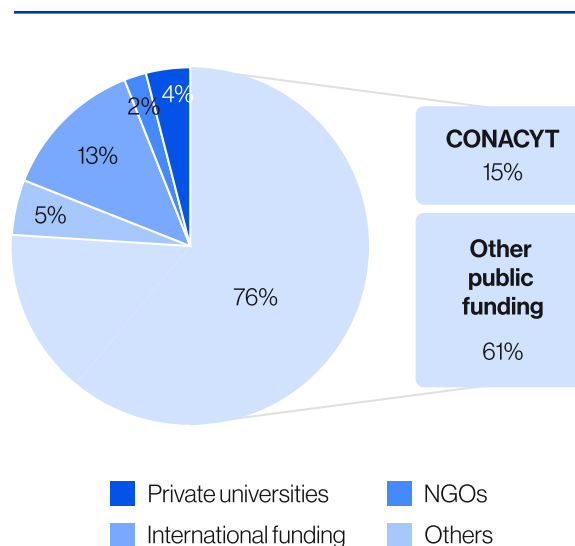
FIGURE 5 R&D Spending as % of GDP, 2019 – 2020



Source: World Bank (2020).

Note: 'Mercosur' excludes Venezuela from the average.

FIGURE 6 R&D Investment by Financing Sector in Paraguay, 2021



Source: CONACYT (2022). Own elaboration.

Note: CONACYT = National Council of Science and Technology

The country's rich biodiversity and cultural heritage can serve as a basis for the bioeconomy which can in turn help to preserve and restore these natural assets. Paraguay's forest includes 6,500–7,000 species of plants, 708 species of birds (including 79 endemic species, of which 23 are threatened), 63–75 species of amphibians, up to 150 species of reptiles, and as many as 167 mammal species.²⁸ This diversity underpins the bioeconomy and thus creates incentives to conserve these biodiversity assets. Paraguay's forests are part of regional biomes containing significant biodiversity and ecosystem value. The Paraguayan Chaco represents 25% of the Gran Chaco—the second largest forest biome in South America after the Amazon.²⁹ The Alto Paraná Forest in the eastern region is part of the Atlantic Forest – one of the world's most threatened forest ecosystems, which extends across Paraguay, Brazil, and Argentina. Both are important habitats for biodiversity. Even small patches of the Atlantic Forest contain important habitats for endemic and endangered species.³⁰ The Chaco similarly hosts many endemic and unique species and, until recently, contained large expanses of contiguous and undisturbed forests.³¹

Collaboration among bioeconomy sectors may offer a framework to coordinate efforts across agencies, academia and the private sector. This report uses intervention categories that are commonly used internationally in the bioeconomy. Among countries analyzed, there is no set methodology to prioritize bioeconomy interventions. Most strategies identify sectors that are relevant to their country conditions. Usually, these areas of intervention are broad, and commonly cover agriculture, energy and forestry, related policy interventions and funding mechanisms. However, these categories should be expanded to include policy objectives across environmental, social, and economic domains.

²⁸ Kernan, B.S., W. Cordero and A.M. Macedo Sienra (2010). *Report on Biodiversity and Tropical Forests in Paraguay*. USAID Tropical Forests and Biodiversity Assessment. Washington, D.C.: USAID.

²⁹ Sarsfield, R. & Veit, P. (2017). *Documenting rights, reducing risks: Platform for Indigenous claims to land and forests*. Washington, DC: USAID Tenure and Global Climate Change Program.

³⁰ Esquivel, A., Zarza, R., Tiffer-Sotomayor, R., Díaz, A., Pérez, D. & Velázquez, M. (2019). *Conservation Status and Challenges of the Atlantic Forest Birds of Paraguay*. *Diversity*, 11(12), 247. MDPI AG. Retrieved from <http://dx.doi.org/10.3390/d11120247>.

³¹ Potapov, P., Hansen, M. C., Laestadius, L., Turubanova, S., Yaroshenko, A., Thies, C., Smith, W., Zhuravleva, I., Komarova, A., Minnemeyer, S. & Espinova, E. (2017). *The last frontiers of wilderness: Tracking loss of intact forest landscapes from 2000 to 2013*. *Science Advances*, 3(1), e1600821. <https://doi.org/10.1126/sciadv.1600821>.

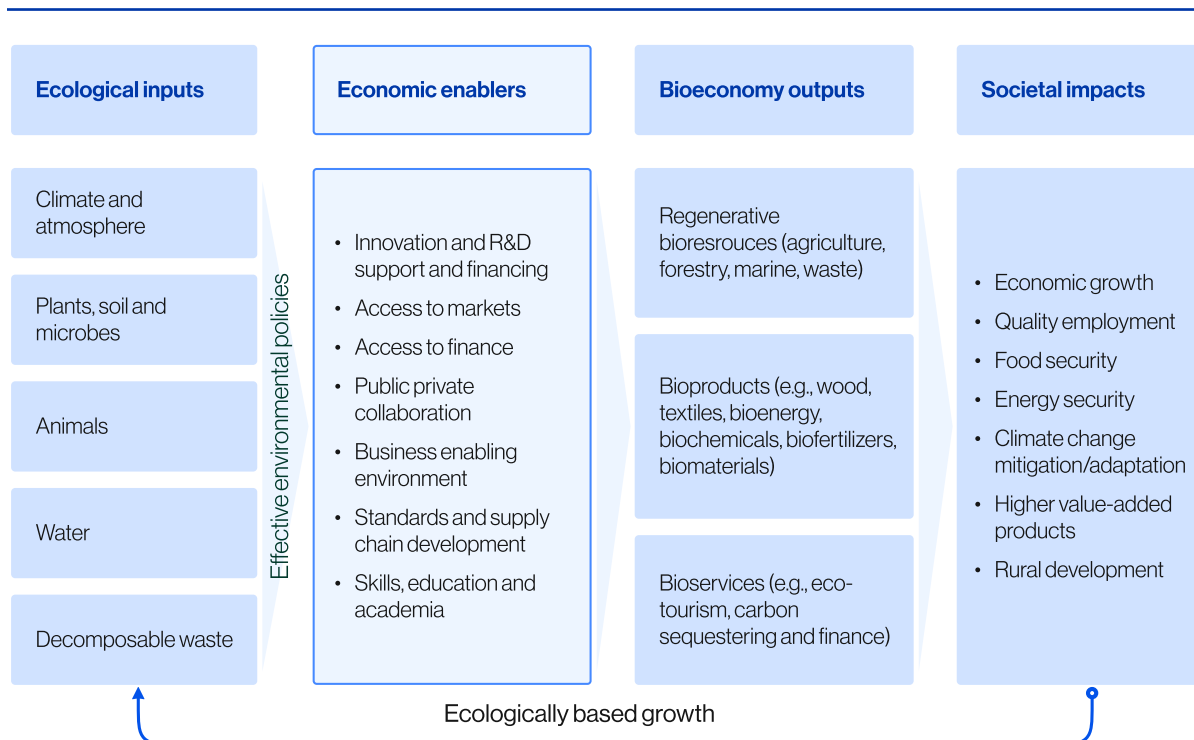
2

Bioeconomy Opportunities and Challenges

Given the role of the bioeconomy in economic diversification, innovation and sustainability, this chapter will provide examples of potential growth, challenges, and international successes. The core of the bioeconomy is its natural resources, including forestry, agriculture, marine and waste derivatives. Thus, it is important that these resources are sustainably used.

The bioeconomy is based on resources and molecular derivatives from agriculture, forestry, marine ecosystems, and waste. Effective environmental policies are needed to protect water, soils and nature from harm. The bioeconomy concept builds on economic enabling policies, which are needed to scale-up and mainstream bioproducts with desired societal impacts (Figure 7). This transformation requires innovative and entrepreneurial mindsets and cultures. More recent in the bioeconomy space is the concept of bioservices that may include ecotourism, carbon financing, or other services that help preserve the natural environment. Discussions with stakeholders and economic experts have led to the structuring of bioeconomy sectors as shown below. This selection was also influenced by 32 National Bioeconomy Strategies from countries including Brazil, Argentina, Colombia and Costa Rica.

FIGURE 7 Bioeconomy Inputs, Enablers and Impacts



Source: Authors

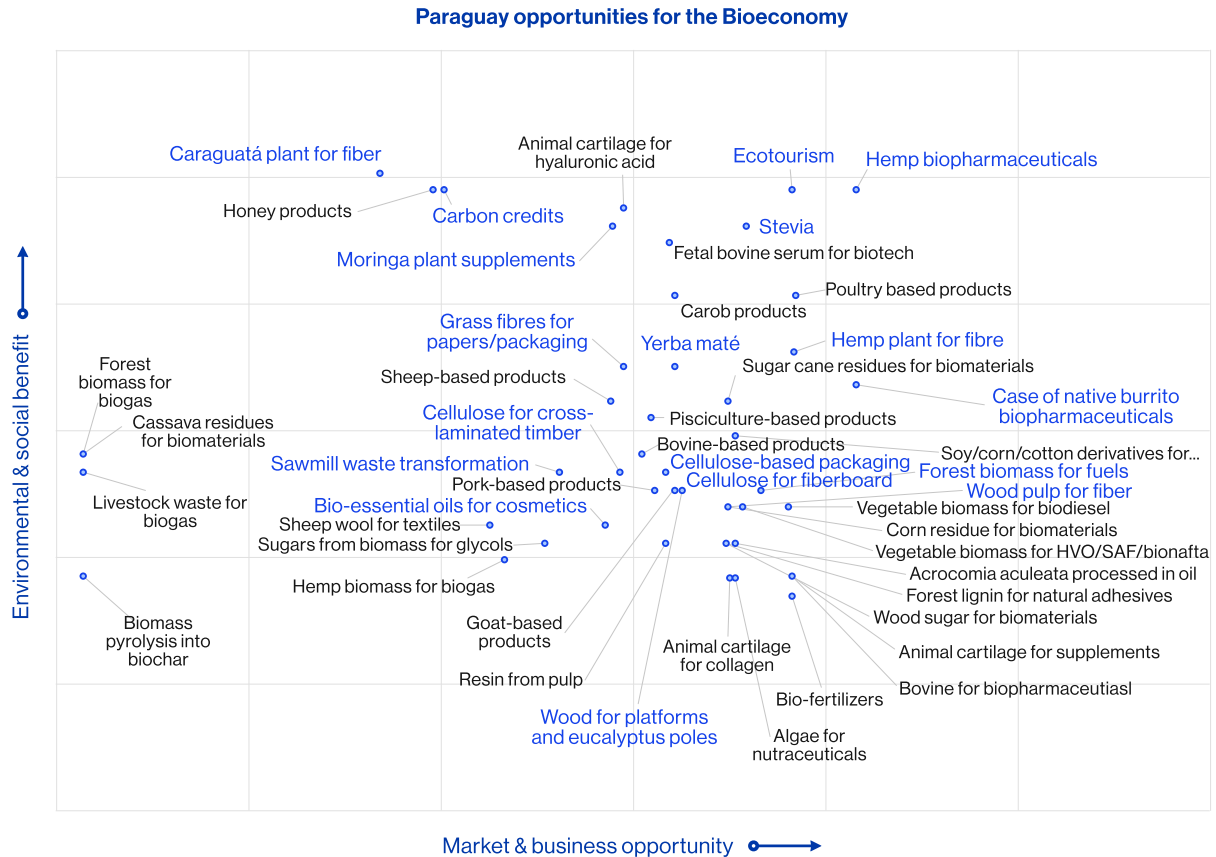
To structure this report, bioeconomy sectors are grouped into those that produce bioresources, products and services, as this allows us to differentiate between end products. Priority areas will need to be further developed, and include wood, food, biopharmaceuticals, bioplastics, textiles, bioenergy, ecotourism, and carbon finance (Table 3).

TABLE 3 Potential Bioeconomy Sectors

SECTOR	OPPORTUNITIES
Wood	<ul style="list-style-type: none"> • New products from wood, such as veneer • Engineered wood products for construction • Export revenue from pulp wood and derived products
Bioenergy	<ul style="list-style-type: none"> • Better use of residual biomass for industry and charcoal substitution • Biorefineries for waste fats and oils
Textiles	<ul style="list-style-type: none"> • Man-made cellulose fibers and new raw materials such as lyocell • Textile fibers from hemp and traditional plants
Biopharmaceuticals	<ul style="list-style-type: none"> • High value-added products • Leveraging traditional knowledge • Essential oils and hemp for biopharmaceuticals
Bioplastics	<ul style="list-style-type: none"> • Global market demand increasing due to sustainability commitments • Consumer demand in developed markets • Available raw materials inputs
Ecotourism	<ul style="list-style-type: none"> • Potential for niche based and high value-added ecotourism • Nature-based tourism, income in and around protected areas
Carbon finance	<ul style="list-style-type: none"> • Conservation of natural assets • Monetization of natural assets, that do not require intervention in natural ecosystems

A broad review of bioeconomy opportunities indicates that more innovation-oriented market segments remain nascent. However, products and market segments in Figure 8 indicate Paraguay's potential. These were assessed for market potential (x-Axis) and for environmental and social criteria (y-Axis), while Paraguay's competitiveness in these segments is subject to further market deep dives per individual product. Examples of market segments will be used to illustrate horizontal challenges to the bioeconomy in Paraguay.

FIGURE 8 Bioeconomy Market Segments with Economic, Environmental and Social Benefits*



*Blue indicates sub-segments covered under this chapter
Source: Author's evaluation

Availability, affordability, and access to sustainably sourced input materials are key success factors, yet one of the most important, wood from natural forests, becomes increasingly scarce. This led private industry and government to turn to forest plantations for supply. At present, plantation forestry is developing primarily in the eastern region where fuelwood and timber are in demand. Due to their good soils and rainfall, 80% of plantations are in the Departments of Caazapá, San Pedro, Itapúa, Alto Paraná, Caaguazú, Ñeembucú, and Guairá. Paraguay's National Forestry Institute (INFONA) estimates that Paraguay has around 5–6 million ha of land suitable for plantation forestry east of the Rio Paraguay. Rainfall regimes, soil conditions, physiography, and year-round subtropical temperatures in the east

provide highly favourable conditions for forestry plantations in Paraguay, which commonly have growth rates of around 35 m³ per ha per annum for eucalyptus. Compared with Chile and Uruguay, average rates are around 22 and 23 m³ annually per ha, respectively. Lower growth rates in Chile and Uruguay reflect slower growing pine plantations and lower latitudes. While the country's potential for plantation forestry has been recognized for decades, investment in the sector remains low, and there were only 203,000 ha of plantations in 2023,³² compared to Chile's 3.25 million ha and Uruguay's 950,664 ha.³³

BOX 1 Chile and Uruguay: Two Success Stories^{34, 35}

Chile's development is marked by afforestation policies which enabled it to maintain its forests and develop its forestry industry. Decree Law 701 of 1974 on Forest Development (DL 701) led to the rapid growth of forest plantations. The industry has recovered millions of hectares of degraded land by planting exotic, fast-growing trees with the help of the state and private entrepreneurs. The Decree established a legal framework for forest land—or land preferentially suitable for forestry—and an incentive scheme to boost the sector. Over the last 25 years, Chile's forest cover has expanded by more than 10%, driven by an investment of around US\$69 billion from private and public sources. The investment has also supported associated infrastructure, industrialization, transport, marketing, exports, innovation, and human capital development. Consequently, significant industrial clusters have emerged in the south-central region of the country.

In 2020, the forest and wood industry was a pillar of the Chilean economy, accounting for 2.1% of GDP. Domestic demand for timber and wood stands at approximately 48 million m³ each year, 99% of which comes from planted forests. In 2018, the sector created 113,769 jobs, 1.5% of the country's workforce. Additionally, the Forestry Sector creates approximately 300,000 indirect jobs and has diversified to provide 370 different products, of which NWFP have gained increasing importance in the economy, with significant benefits for rural communities. The Forestry Sector registered record exports of US\$6.8 billion in 2018, 9.1% of all exports. This performance ranked the sector as the third biggest export industry after mining, fishing and aquaculture. Chile has become a leader in Forestry Sector innovation and knowledge. Genetic improvement programs have increased the productivity of fast-growing species like Pine and Eucalyptus. The sector has also developed monitoring and evaluation systems which provide scientific data for forest management to public and private actors. These include the "Cadaster and Evaluation of Native Plant Resources Chile" administered by CONAF, and the "Continuous Inventory of Forest Ecosystems of Chile" administered by INFOR. INFOR also maintains statistical data and economic accounts for the sector.

³² INFONA (2024). <https://infona.gov.py/?s=plantacion>.

³³ World Bank Country Climate and Development Report Paraguay (2024, forthcoming).

³⁴ World Bank. 2020. "Chile Forest Note." Washington, DC: World Bank. <https://documents1.worldbank.org/curated/en/379851591243537122/pdf/Chile-s-Forests-A-Pillar-for-Inclusive-and-Sustainable-Development-Country-Forest-Note.pdf>.

³⁵ Burbano, L. (2020). The Uruguayan forestry miracle. UPM Pulp. <https://www.upmpulp.com/articles/pulp/20/forests-in-uruguay/>.

Uruguay shows a similar, positive development. The Uruguayan Forestry Law (Ley Forestal 15.939) was passed in 1987. Thirty years later, the sector accounts for 3.5% of the country's GDP (US\$56 billion in 2019) and generates US\$2,000 million in exports, according to the SPF. Prior to the law, man-made plantations covered around 50,000 ha – today, there are about one million ha, or 6% of the country's land. Forest plantations have also reversed unemployment in rural areas, improving the economic and working conditions of those living in the interior of the country. Currently, the forestry industry employs 25,000 people and 50% of those working in tree nurseries are women.

Along with plantations, Paraguay could further explore adding value from non-wood forestry products (NWFP) and better ranching practices, such as silvopasture. Silvopasture reintroduces trees to pastureland, increasing productivity per land area and storing carbon from the atmosphere. Selected cattle farmers in Paraguay are piloting this practice and a pilot program in Novo Campo in Brazil in 2016 increased profits by up to +US\$217/ha.³⁶ NWFP are biological products other than wood, such as food and food additives (e.g., edible nuts, mushrooms, fruits, berries, bushmeat, herbs, spices and condiments, aromatic plants, insects), fibres (e.g., bamboos and rattans), and medicines, cosmetics and cultural products (e.g., resins, gums and dyes, natural skin treatments).³⁷ NWFP can be produced from natural forests and plantations, improving value addition.

Yerba Mate is a successful and sustainable example of a non-wood forest product of Paraguay which benefits indigenous and local communities. According to estimates from the Paraguayan Yerba Mate association of producers, annual production in Paraguay is around 40,000 metric tons of processed yerba mate from 21,000 ha of plantations across the departments of Itapúa, Guairá, Alto Paraná, Caazapá, Canindeyú, and San Pedro. Approximately 18% of this produce is exported to nearly 30 destinations in the Americas, Europe, and Asia. Additionally, soluble yerba mate is exported for use in energy drinks and other products. The association estimates that 55,000 people are employed directly or indirectly along the value chain. An example is Guayaki Yerba Mate Paraguay SRL, which produces organic, Fair Trade-certified yerba mate through agroforestry practices. In 2021, the company was honored with the Green Recognition Award in the Biodiversity Protection Category by Global Compact Paraguay and WWF Paraguay. This initiative began over 15 years ago in the Ache Kuetuvy Indigenous Community to address biodiversity decline resulting from extensive deforestation of the Atlantic Forest, the natural habitat of yerba mate.³⁸

³⁶ World Resources Institute (2016). *The economic case for landscape restoration in Latin America*. https://files.wri.org/d8/s3fs-public/The_Economic_Case_for_Landscape_Restoration_in_Latin_America.pdf.

³⁷ FAO Sustainable Forestry Management Toolbox (<https://www.fao.org/sustainable-forest-management/toolbox/modules/management-of-non-wood-forest-products/basic-knowledge/en/#:~:text=Examples%20of%20NWFPs%20are%20foods,resins%2C%20gums%20and%20dyes>).

³⁸ La Nación. (2020). <https://www.lanacion.com.py/gran-diario-domingo/2020/07/19/la-esperanza-que-brota-en-los-verbales/> and Guayaki Yerba Mate (2023). <https://impactreport.guayaki.com/>

Another primary sector product is bananas, which comply with stringent international export standards. Paraguay's banana exports peaked in 2023, earning US\$36 million. Banana production covers 12,000 ha and employs 1,300 rural family farmers; 70% of their produce is exported to Argentina and Uruguay. In April 2024, a first shipment of 22 tons of bananas left for Chile in a breakthrough for Paraguay into another niche market.^{39,40}

Overall, Paraguay has the potential to further leverage its organic products to command higher market prices in growing international markets, especially for small and medium producers. The number of organic and agroecological farmers in the country accounts for only 8% of producers and 0.61% of production area. While global markets for organic products grew by 102% from 2012–2022, Paraguay's organic production only increased by 12.5% over the same period.⁴¹ Among the most important organic products for small-scale farming are sesame, sugarcane, citrus, medicinal herbs, peanuts, soy, vegetables, cassava, and indigenous handicrafts.⁴²

BIOPRODUCTS: Wood, Bioenergy, Textiles, Bioplastics, Biopharmaceuticals, Ecotourism and Carbon Finance

This section provides an overview of bio-products and services, their estimated global market potential, and challenges and market inefficiencies in Paraguay. It is a non-exhaustive list of potential downstream sectors that could contribute to the bioeconomy. As these are based on bioresources, their sustainability and contribution to biodiversity is also critical.

As a forestry bioproduct, wood has high potential because of its many value-added downstream sectors. Additionally, derived products such as textiles, bioplastics⁴³ and non-wood forestry products also have potential due to their rapid growth expectations in international markets. Bioenergy is also important, and its role needs to be clarified so that materials can be sustainably sourced.

Sustainably sourced wood products can benefit from the emerging commercial forestry industry in Paraguay, with potential spillovers to other sectors. The Paraguayan wood industry contributes significantly to the country's economy, with over 6,850 enterprises and 50,000 employees. Paraguay's roundwood production increased by 20% between 2002–2022, but only 35% of this produce was processed into higher value-added wood, while the remaining 65% was used for energy. The wood industry lacks sustainably sourced input materials due to the absence of long-term financing, and consequently, low investment. The industry has seen few innovations, mainly due to a lack of R&D, infrastructure, and skilled labor; and suffers high transport costs as a landlocked country, which reduces the competitiveness of lower value-added goods, especially commodities. The industry's

39 Freshplaza.es (2023). <https://www.freshplaza.es/article/9594157/las-exportaciones-de-banana-de-paraguay-registraron-un-nuevo-record/>.

40 Productivacm.com (2024). <https://www.productivacm.com/banana-paraguaya-ya-va-camino-a-chile/>.

41 <https://fundacionetea.org/en/2022/03/28/the-organic-sector-through-the-technical-committee-presents-the-national-organic-program-as-a-key-instrument-to-strengthen-family-agriculture-in-paraguay/>.

42 La Nación. (2022b, May 9). Paraguay cuenta con 187.383 hectáreas de producción orgánica y agroecológica. La Nación. <https://www.lanacion.com.py/negocios/2022/05/09/paraguay-cuenta-con-187383-hectareas-de-produccion-organica-y-agroecologica/>.

43 Bioplastics can be manufactured from different feedstocks including wood.

feedstock production suffers from a lack of official data, the perception of forests as undeveloped land, and unclear land cadasters and property rights. The rapid replacement of forests by agriculture has led to a shortage of sustainable raw materials. Despite these challenges, there are plans for a large pulp mill in 2024, which aims to create 4,000 direct jobs, potentially creating large export revenues from pulp wood production.

While commercial native/exotic plantations have high market and export potential, this needs to be balanced against biodiversity values, other uses (e.g., food), and environmental impacts (e.g., water availability and use). Plantations may protect native forests by providing fuel wood substitutes from their residues and thus reducing illegal harvesting. They can also remove carbon dioxide from the atmosphere if used in long lasting products. The main constraint to developing plantations has been a lack of affordable long-term financing. Along with increasing plantations of native species, eucalyptus and pine, market opportunities for veneer/plywood (+102% until 2050 in global consumption) and particle/fiberboard (+72% to 2050 in global consumption)⁴⁴ such as cross-laminated timber for construction emerge.

Biomass is an important source of bioenergy in Paraguay. The country produced 20,403 GWh in 2021, 58% was used by industry for process heat and the remaining 42% by households. However, the unsustainably high use of fuel wood from native forests in both residential (70% of native fuel wood consumption) and selected industrial sectors (e.g., brick and ceramics industry), and the lack of competition from cleaner energy sources, are important issues in the bioenergy sector.⁴⁵ In 2021, Paraguay's industry used biomass residues to generate 40% of its energy demand. 37% of the energy used by industries still came from fuel wood, of which only 43% came from plantations. The National Biomass Certification Program (PNCB) aims to certify, control and promote the use of bioenergy, but it has yet to be implemented. More biofuel production is planned, including processing used cooking oil and animal fat into diesel and aviation fuel. The goal is to improve distribution and affordability for industry and residential sectors in order to reduce fuel wood demand; to certify fuel wood and charcoal; and to pursue opportunities such as green hydrogen.

The textile industry added US\$737 million to Paraguay's economy in 2021, but faces falling productivity and competitiveness, especially in cotton production, although alternative feedstocks may help to redefine the sector. Paraguay produces textiles from cotton or the Bromeliad, caraguata. There are over 8,942 enterprises, of which 98% are SMEs that employ over 33,000 people, of which 83% are informally employed.⁴⁶ Issues in the textile sector date back to the "picudo" plague in the 1970s, and due to lack of modern technology, low innovation, and insufficient investment, competitiveness further decreased.⁴⁷ Given Paraguay's experience with textiles at most stages of the value chain, alternative feedstocks may redefine the industry. R&D partnerships and innovations are needed to develop hemp fiber or lyocell, and fiber from wood pulp as feedstock.

44 FAO (2022). *World Forest Sector Outlook 2050*. <https://www.fao.org/3/cc2265en/cc2265en.pdf>

45 Ministerio de Obras Públicas y Comunicaciones/BID. (2019). *Viceministerio de Minas y Energía - Producción y consumo de biomasa forestal con fines energéticos en el Paraguay [Production and consumption of forest biomass for energy purposes in Paraguay]*.

46 UNDP (2022). *Data to drive the development of the garment sector*. Available at: <https://www.undp.org/es/paraguay/blog/LessonsYaguaronCensus2022>.

47 Quintana, E., Valls, E. & Roncero, M. B. (2024). *Dissolving-grade pulp: a sustainable source for fiber production*. Available at: <https://link.springer.com/article/10.1007/s00226-023-01519-w>.

The global bioplastics market is expected to grow between 35–45% through 2027 as large buyers commit to these products despite a price premium. Paraguay is exploring bioplastics from cassava starch, and some pilot projects have begun. However, challenges remain, and there is only one enterprise selling bioplastics in the country. This company lacks the technology to produce the polymer, which it imports from Europe, highlighting the need for R&D, investment in technology, and recognition of domestic feedstocks. Sector stakeholders have appealed for testing of new packaging and R&D to develop new products. While bioplastics remain expensive, their uptake is fostered by environmental concerns and related corporate commitments from global companies like Toyota and Nestle.

The country's pharmaceutical sector has 26 registered enterprises and 4,693 employees, and the potential to leverage its biobased ethno-botanical resources and traditional medicine practices. On average, the pharmaceutical industry offers higher wages compared to textiles (5x), beverages (1.6x), and telecommunications (1.2x).⁴⁸ Several opportunities relate to the expiry of patents over the next five years, and Paraguay is already a global leader in less complex products, such as petitgrain essence, with around 10,000 small-scale producers. There is much potential to produce hemp for biopharmaceuticals, with over 2,000 ha registered for cultivation. However, the pharmaceutical industry in Paraguay needs to improve patent processing, innovation, technology, and product differentiation. Despite these challenges, Paraguay could produce high value-added pharmaceuticals with its rich aromatic and medicinal plant resources.

The economic importance of the services sector in Paraguay rose from about 52 to 61% from 1992–2022, while ecotourism and carbon finance are the most prominent forms of value addition from ecosystem services. Located in a remote area and lacking well-defined tourism products, Paraguay's potential for international tourism is limited in the short-term. However, its tourism potential can be developed through regional niche markets and domestic markets to create inclusive jobs and protect natural areas. This would require changes to legislation and regulations such as concessions for tourism within protected areas, coordination across ministries, investments in human capital and infrastructure, and data-driven marketing and planning. In addition, ecotourism can be a driver of greener growth, forest conservation, and local community involvement in conservation. Another opportunity is carbon markets, which can increase the value of native forests without having to make large investments. Given its novelty, carbon finance faces several challenges such as carbon accounting, proof of impact in reducing emissions, its regulatory frameworks, and a lack of successful international examples.

⁴⁸ Countries considered: Brazil, México, Colombia, Costa Rica, Ecuador y Chile.

These are examples of downstream bioeconomy sectors that could increase in value added in Paraguay. This mix of industries, if based on a sustainable supply of input materials (e.g., from certified sustainable forestry or preserved eco-systems) could diversify Paraguay’s economy and provide more value-added goods. Critical challenges keep them from growing. According to stakeholder workshops and interviews, some of these may be sector specific (e.g., Table 4), while others would need to be tackled across bioeconomy sectors, as proposed in the following chapter.

TABLE 4 Challenges for Bioeconomy Sectors

SECTOR	CRITICAL SECTOR CHALLENGES
Wood	<ul style="list-style-type: none"> • Unclear property rights and indigenous land claims, land invasions in forestry • Need for certified sustainable sourcing • Lack of wholistic sector strategy, land development strategy • Complicated and expensive transport, price-disadvantage, and slow delivery • Gap in long-term financing for plantations and manufacturers
Bioenergy	<ul style="list-style-type: none"> • Lack of sustainable sourcing and certification of input resources • Rural residential consumption of fuel wood/charcoal • Higher cost to transition away from illegally sourced biomass due to its low prices • Innovation for alternative energy sourcing from biomass
Textiles	<ul style="list-style-type: none"> • Weak innovation, R&D on wood pulp to higher value-added textiles • Lack of sector strategy for textile industry • Need for technology upgrade and financing
Biopharmaceuticals	<ul style="list-style-type: none"> • Weak innovation • Slow patent approvals • Compliance with industry standards due to lack of R&D infrastructure/ financing
Bioplastics	<ul style="list-style-type: none"> • Standards to test bioplastics and materials • National support/funding for innovation/ R&D for sustainable packaging • Lack of environmental awareness
Ecotourism	<ul style="list-style-type: none"> • Accessibility and desirability • Lack of qualified human resources and skills in the hospitality sector • Lack of tourism infrastructure (airports, etc.) • Lack of positioning and country brand
Carbon finance	<ul style="list-style-type: none"> • Regulatory environment internationally on GHG-accounting • Credibility and verification of certificates: Green claims vs actual GHG-emission reduction

Source: Based on stakeholder discussions and interviews

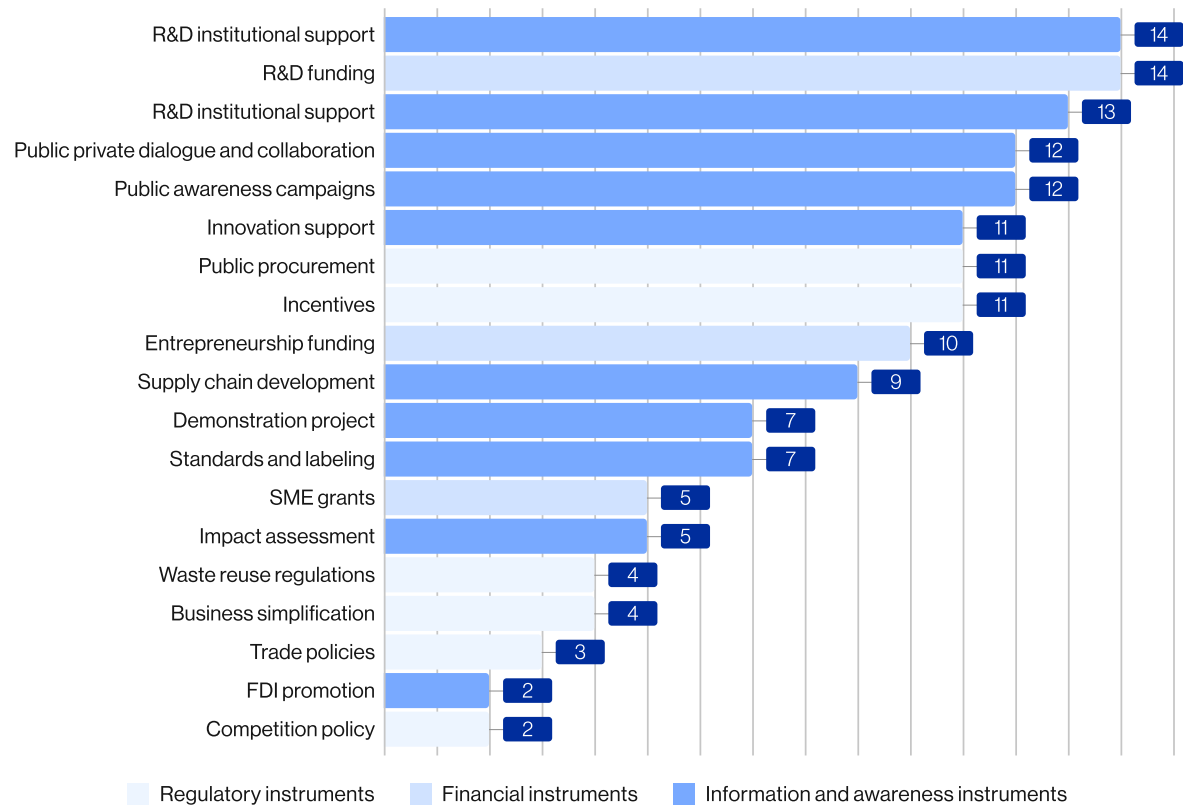
3

Recommendations to Grow the Bioeconomy

Identifying sectoral challenges helps clarify the conditions needed to grow the bioeconomy. Using areas of intervention identified by 32 countries, this section will suggest horizontal policies to benefit the Paraguayan bioeconomy. These are based on stakeholder views, sector round tables and surveys.

While there is no single policy for the success of bioeconomy sectors, most countries have national or sectoral bioeconomy strategies to define their priority areas. Based on a desk review of 32 action plans or strategies, these can be broken down into three broad public interventions that governments use to promote the bioeconomy: regulatory, financial, and information-based instruments. Based on this analysis, Figure 9 provides a policy framework for regulatory interventions in the bioeconomy.

FIGURE 9 Global Policy Instruments in Bioeconomy Strategies



Source: Authors

The analysis will use areas highlighted in other strategies to review the performance of Paraguay in these categories. Organizing analysis and discussions around these areas, and market and government inefficiencies allows for an informed discussion of policies. Policy interventions need to stimulate: public and private research and collaboration, training of scientists, capital markets, appropriate intellectual property rights, competitive product markets, regulation to reduce risk, and a

dialogue with the public on the benefits of biotechnology.⁴⁹ The most common instrument referenced in bioeconomy strategies was information and financial support for R&D, followed by public private dialogue and collaboration, public procurement, public awareness, innovation support and publicly supported demonstration projects.⁵⁰

The private sector highlighted the lack of a government bioeconomy strategy, poor market information on opportunities, and weak R&D as major constraints. As intervention areas cover a cross-section of bioeconomy related industries, a perception survey and stakeholder discussions were used to analyze market and government inefficiencies, where 158 private firms responded. (Table 5).⁵¹

TABLE 5 Perceived Challenges by Bioeconomy Private Sector Stakeholders

CONSTRAINTS	RANKING 1 (COUNT)	RANKING 2 (SCORING)
Lack of government bioeconomy strategy	1	1
Poor market information on bioeconomy opportunities	2	2
Lack of support from innovation and research institutions	3	6
Availability of skilled labor	4	3
Cost of importing raw materials	5	5
Lack of government support to tackle climate change	6	4
Cost of skilled labor	7	9
Weak local markets	8	7
Unfair local competition	9	11
Availability of good quality local inputs	10	8
Difficulties to register new businesses	11	10
Cost of exporting	12	12
Unfair regional competition	13	13
Poor patent system	14	14
Weak bankruptcy laws	15	15
Lack of support from universities	16	16

Source: Authors

49 *The Bioeconomy to 2030: Designing a Policy Agenda*. OECD, 2009.

50 This is based on analysis of the bioeconomy strategy or government documents of 25 economies. The list is non-exhaustive but provides a snapshot of trends of instruments used by governments. It is important to note that EU member countries also fall under EU regulations on bioeconomy and have extensive access to innovation and R&D funds, in addition to other community-wide instruments.

51 In the analysis of binding constraints, there are two distinct ranking methodologies. The first approach, "Ranking 1", counts how often participants identified a factor as a binding constraint. The second approach, "Ranking 2", incorporates a scoring mechanism. Specifically, if a participant selected "Lack of government bioeconomy strategy" as their primary binding constraint, it was assigned a score of 5; the subsequent constraint received a score of 4, and so forth, in descending order.

Follow up discussions stressed the general weakness of government agencies to coordinate around strategic priority areas. It was evident that labs and research centers were not receiving enough public support, and needed upgrades. The main research institutions were poorly coordinated with private sector actors. Private stakeholders flagged a lack of transparency in their public sector counterparts, with low levels of trust and collaboration.

Four policy areas need improvement: the sustainable sourcing of inputs; science, technology and innovation needs; finance and proactive public awareness. These are fundamental constraints to the bioeconomy, all of which influence competitiveness. Based on our analysis, Table 6 maps by importance each policy in the framework. The recommendations are in line with these categories, but try to highlight links between elements (e.g., Importance of public procurement to scale innovative approaches or promote input markets).

TABLE 6 Sector Sensitive Enabling Factors*

TYPE	ENABLING FACTOR	WOOD	BIO-ENERGY	BIO-PLASTICS	BIO-PHARMA	TEXTILE	TOURISM	CARBON FINANCE
Regulatory	Business environment							
	Patent system							
	Public procurement							
	Trade policies							
	Competition policies							
	Waste regulations							
Financial	Entrepreneurship and R&D funds							
	Access to long-term financing (esp. SMEs)							
Information	Standards and labeling							
	Public awareness							
	R&D and innovation							
	Skills and education							
	Demonstration projects							
	FDI promotion							
	Public private collaboration							

Source: Authors

* Importance of horizontal category based on survey results and stakeholder consultations. Performance of Paraguay in enabling factors indicated by color. Dark grey indicates most important constraint/area for improvement.

Based on the review of the market environment and enabling conditions, the following recommendations for the government of Paraguay have been formulated.

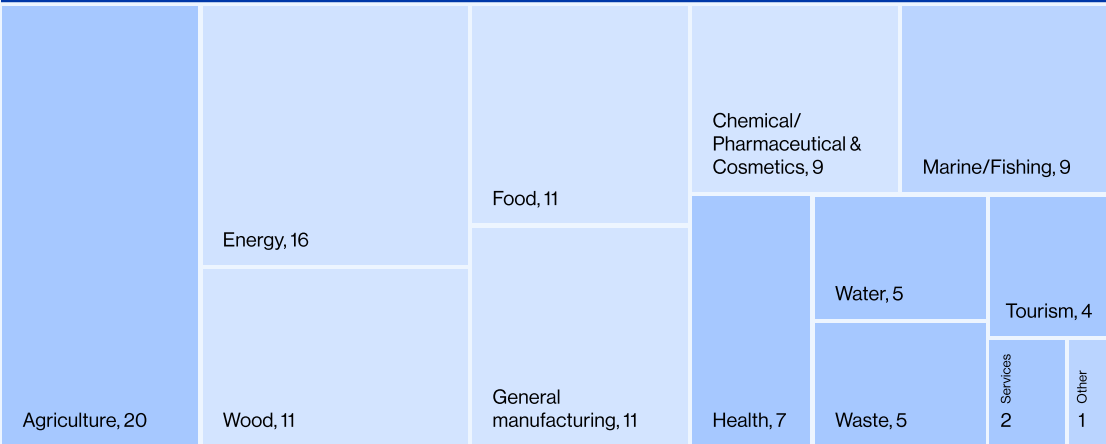
RECOMMENDATION: Improve information, coordination and monitoring for the bioeconomy

Stakeholders note the absence of a unified and coherent bioeconomy strategy. The international landscape reveals that over 45 countries have a bioeconomy strategy to pursue competitiveness, innovation, and climate change goals, among others. These strategies typically prioritize sectors like agriculture, manufacturing, and energy.

BOX 2 Global Bioeconomy Strategies

For many countries, the balance between preservation and economic growth is best pursued when bioeconomy strategies complement sectoral or horizontal strategies. To this effect, over 32 countries evaluated in this report have a dedicated bioeconomy strategy to improve competitiveness (e.g., Italy), innovation (e.g., Colombia, Latvia), climate change mitigation (e.g., Austria), employment (e.g., Brazil, Türkiye), food security (e.g., France), energy security (e.g., Germany), and rural development (e.g., Ireland). Nearly all these approaches have a strategic sector focus (Figure 10), with dominant sectors of agriculture (green), manufacturing (yellow) and energy (blue). Countries with bioeconomy strategies also have innovation, circular economy, decarbonization and green economy strategies to support their agenda. A focus on the bioeconomy does not deprioritize other areas of green growth (e.g., EU, UK, Netherlands).

FIGURE 10 Sector Focus of Country Bioeconomy Strategies



Source: Authors

FIGURE 11 Strategic Objectives of Global Bioeconomy Strategies

Climate change, 11	Higher value added products, 10	Sustainable development, 8	Rural development, 5	Other, 5
			Biodiversity conservation, 4	Energy security, 4
Economic growth, 10	Innovation and technology, 9	Employment, 6	Competitiveness, 4	Food security, 4

Source: Authors

A core theme of these strategies is that of innovation, value added, conservation, and new areas of growth. Public and private sector support for innovation is critical to create new materials and products from existing biological raw materials, and forms the cornerstone of the bioeconomy.⁵² In the State of Para, Brazil, where it is estimated that the bioeconomy could generate over US\$35 billion by 2040, policies have prioritized innovation, certification, fiscal and financial instruments and efficient land-use planning.⁵³

A clear definition, objectives and a wholistic performance evaluation framework could help Paraguay to track progress and measure success. Currently, Paraguay lacks a monitoring and evaluation system for bioeconomy initiatives. Some countries have established monitoring systems within specific bioeconomy sectors. For instance, Colombia has developed a definition, overall strategic objectives, and a monitoring and evaluation system that lays out milestones and targets that are measurable. Indicators include the number of applications for patents, the number of spin-offs and start-ups in the bioeconomy, and the value of public procurement for bioeconomy technologies. Target values and corresponding actions are defined for each objective.⁵⁴

Paraguay could also review current policies on sustainability in agriculture, forestry, and waste management. Building on these policies, the goal is to establish conditions which foster new products through entrepreneurship and R&D funding. This may involve expenditure reviews for private and public science, technology and innovation; and evaluating regulations and financial and informational tools in emerging bioeconomy sectors. Such actions, commonly undertaken in countries with bioeconomy strategies, should engage diverse stakeholders and actors to define a shared vision and roadmap.

Potential areas of improvement:

- **Establish a national working committee to develop a national strategy for bioeconomy,** including definitions, sectors and objectives.
- **Develop a framework** for monitoring and evaluation.

52 Philp, J. and D. Winickoff (2019). "Innovation ecosystems in the bioeconomy", OECD Science, Technology and Industry Policy Papers, No. 76, OECD Publishing, Paris, <https://doi.org/10.1787/e2e3d8a1-en>.

53 The bioeconomy of Pará state's socio-biodiversity: Results and public policy recommendations, IDB, The Nature Conservancy Brazil, Natura, 2022 https://www.nature.org/content/dam/tnc/nature/en/documents/TNC_ParaBrazil_SocioBioeconomy_PolicyBrief.pdf.

54 Departamento Nacional de Planeación, DNP.

- **Establish an online information platform for the bioeconomy** covering government initiatives, funding, and R&D.
- **Adopt a cascading approach towards biological resources**⁵⁵ and provide regulatory frameworks.
- **Prepare action plans and work with agencies and partners** (MIC, Ministry of Finance, CONACYT, DINAPI, MAG, etc.) to implement the strategy. Foreign investors could be approached, and the annual budget should be reviewed.
- **Expand the implementation of regional bioeconomy action plans.** This should begin with the Chaco regional pilot project, and expand to other territories. Encourage all actors to participate, and identify regional needs and potential for clusters.

RECOMMENDATION: Increase support for national science, technology and innovation systems

Paraguay lags behind other countries in the region, and could improve its R&D investment.⁵⁶ In 2019, Paraguay's gross expenditure on R&D was equal to 0.1% of GDP, ranking it 99th globally.⁵⁷ With only 155 researchers per million people, Paraguay's R&D capacity is low in comparison to other middle-income countries such as South Africa, Senegal, and Vietnam, which boast 518, 564, and 708 researchers per million people, respectively.

Another area in need of improvement is the patent system – shorter patent processing times, improved digitalization of DINAPI, and better patent enforcement are required. Paraguay's research output shows moderate quality, limited volume, and weak alignment between industry and academia. In 2022, according to the h-index of publication productivity and citation impact, Paraguay ranked 18th out of 51 Latin American countries and 134th out of 243 countries globally in scientific quality. Medicine accounted for the largest share of research output, but it does not rank highly in quality.⁵⁸ Research outputs do not drive innovation, as evidenced by the low number of patent applications. Between 2015 and 2022, the number of patent applications was relatively constant, and lower than those for regional peers (Figure 12). Aside from R&D, the Business Innovation Survey 2021⁵⁹ revealed that company innovations are largely confined to acquiring machinery and equipment, software, and hardware.

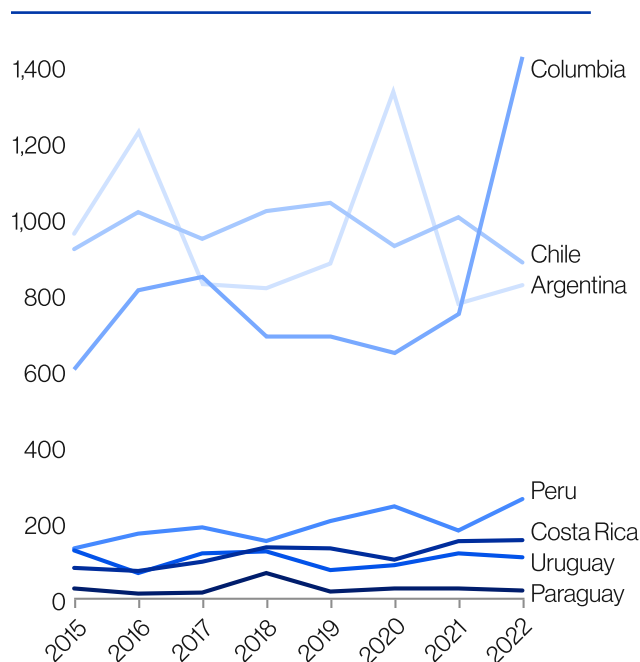
55 The cascading use of biological resources refers to maximizing their value by efficiently utilizing them in multiple stages of production and consumption, prioritizing higher-value applications before recycling or disposal. Campell-Johnston et al. (2020). <https://doi.org/10.1016/j.rcrx.2020.100038>.

56 Note: The data for Colombia, Mexico and Peru are from 2020, Costa Rica are from 2018, Honduras and Panama are from 2017, Ecuador is from 2014 and the data for the remaining countries is from 2019.

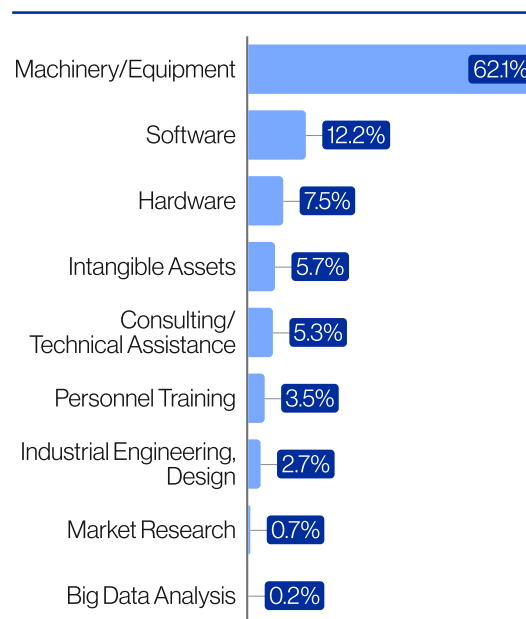
57 Paraguay. Global Index Innovation 2022. Available at: https://www.wipo.int/edocs/pubdocs/en/wipo_pub_2000_2022/py.pdf.

58 SCIMAGO Journal and country rank (2022). <https://www.scimagojr.com/countryrank.php?area=2700&order=h&ord=desc®ion=Latin%20America>.

59 CONACYT (2021). Business Innovation Survey 2021. Own elaboration. https://www.conacyt.gov.py/sites/default/files/upload_editores/u489/ENCUESTA-INNOVACION-EMPRESARIAL-INFORME-FINAL.pdf.

FIGURE 12 Patent Applications (residents and abroad) by Country, 2015–2022

Source: WIPO (2023). Own elaboration.

FIGURE 13 Distribution of Innovation Expenditure* 2018–2020

Source: CONACYT (2021). Business Innovation Survey 2021. Own elaboration.
*- excluding R&D

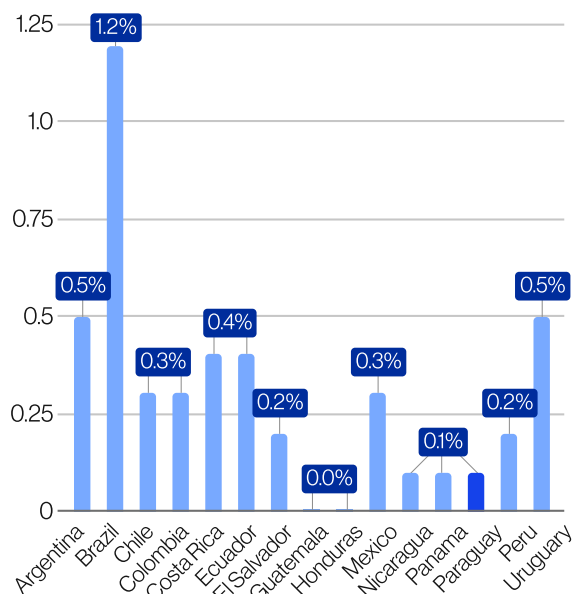
Patents are important in the bioeconomy as they allow inventors to profit from their products. DINAPI manages public policies on intellectual property, but has few resources and staff; in some cases its technology is dated, and it provides weak protection to patent holders. Patent applications are few (14 applications in 2020), and where they require the involvement of other quality assurance institutions such as DINAVISA or SENA, then processing takes even longer due to lack of cross-institutional collaboration.

According to an OECD analysis of bioeconomy strategies, investing in R&D is the most important area for public sector support in bioeconomy development.⁶⁰ While linking private sector capital to commercially viable innovations is important, the public sector has a role through public or public-private research institutions such as universities and research institutes. Collaboration with the private sector, venture capitalists, private equity providers and other investors remains a challenge, and is very limited in Paraguay.

There is a diverse approach to R&D partnerships across sectors and institutions in Paraguay, which aligns with international practices. Of the 158 companies surveyed for their R&D practices, 62 reported no R&D investment. Among those that do invest, collaboration is diverse: 33 partner with government or public entities, 30 with universities, 25 with local firms, 31 with international firms, and 39 with business associations.

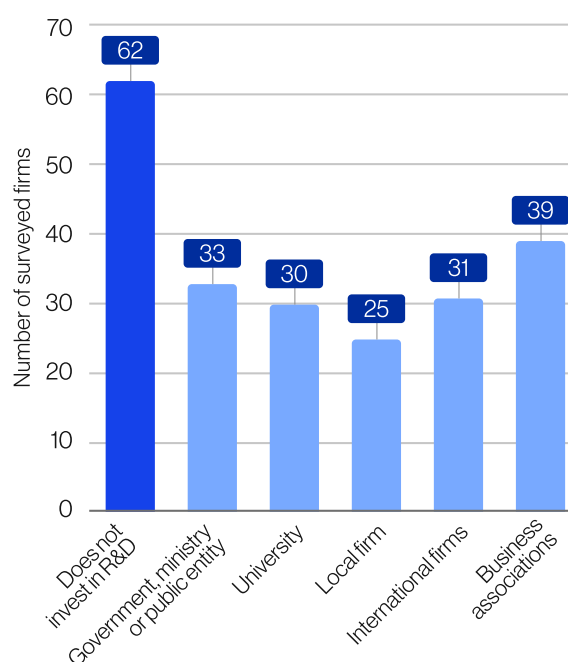
60 OECD (2009), *The Bioeconomy to 2030: Designing a Policy Agenda*, OECD Publishing, Paris, <https://doi.org/10.1787/9789264056886-en>.

FIGURE 14 Gross R&D Expenditure in Latin America (% GDP)



Source: Global Innovation Index (2022).

FIGURE 15 R&D Partnerships



Source: Own elaboration.

CONACYT, an important research institution supporting innovation in Paraguay, faces several challenges. CONACYT oversees public policies for scientific and technological development. Through the PROCENCIA Program, CONACYT funds Master's degrees in food biotechnology at the National University of Itapúa, and a Master of Science in Biotechnology at the University of Asunción, which also conducts ethnopharmacological research. Despite these initiatives, local researchers desire more influence in CONACYT's Council, which lacks organizations involved in science and technology.⁶¹ Paraguay also began to monitor scientific activities and R&D expenditure relatively late compared to other regional countries and the existing metrics are inadequate to measure results of public spending on scientific activities and R&D investments.⁶² While new start-ups are funded by CONACYT, their impacts are unknown, and metrics are required to track CONACYT-funded incubators.

Additionally, as given in the Green Paper on Paraguay's Science, Technology, and Innovation Policy,⁶³ scientific and technological output does not meet national development needs. This is attributed to several factors: universities have limited research capacity and struggle to meet the needs of social and productive sectors; promotion of research is poor, as are working conditions, and incentives are few; there is poor collaboration within-and-between universities, research institutions domestically and internationally, and academia and the productive sectors. In addition, Parque

61 Esquivel, D. (2019). Cubilla: Conacyt debe ser reformado, priorizando a los científicos. Available at: <https://cienciasdelsur.com/2019/08/24/cubilla-conacyt-debe-ser-reformado-priorizando-a-los-investigadores/>.

62 Insurralde, M. (2019). 5 ideas para fortalecer I+D+I en Paraguay. Available at: <https://medium.com/@matiasbaruch/5-ideas-para-fortalecer-i-d-i-en-paraguay-9fa2a38661a7>.

63 Caballero Merlo, J. N. and Almadall, I. C. (2015). Guidelines and Programs for Paraguay's Scientific Policy as from CONACYT. Its Agreement, and Disagreements, with Praxis from Universities. Processes, Data and Contributions. Rev. Cubana Edu. Superior vol.34 no.1 La Habana. Available at: http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S0257-43142015000100010.

Tecnológico Itaipú, the country's only technology park, contributes little to public policies on science, technology, and innovation.⁶⁴

Currently, expertise in science, technology, and innovation do not meet innovation demands.

According to the World Bank's Human Capital Index (2020), Paraguay ranks 12th among the 18 economies in Latin America and the Caribbean. Despite increased university enrollment, high school alumni often lack necessary knowledge, particularly in languages and mathematics at basic and secondary levels. University education, especially in science and technology, lacks quality, and many graduate programs fail to meet international standards for researchers and educators. Finance to specialize in science, technology, and innovation is also insufficient. The sector offers poor working conditions, facilities, opportunities, and incentives, leading to underemployment and emigration.

The Government of Paraguay should adopt a comprehensive policy framework to address research, development, and innovation. This framework should address fragmented agencies and lack of common agendas. It also should align with the National Innovation Strategy, and focus on sectoral priorities for economic, social, and environmental development. Five national innovation challenges have been identified: 1. Paraguay, protected and resilient; 2. Water and energy for the future; 3. Paraguay, a creative and cultural nation; 4. Sustainable cities of Paraguay; 5. Paraguay, world producer of green foods.

Potential areas of improvement:

- **Set up a common agenda for national research and innovation**, providing leadership in basic and applied research, and training.
- **Create an impartial and interdisciplinary council** to approve research projects and secure CONACYT's transparency. Review CONACYT's funding to promote R&D and their findings. Incorporate CONACYT's budget into the country's general budget.
- **Promote technology and innovation clusters**, exchanges, and good practices through networking platforms and round tables for policy makers, researchers, and market players; support start-ups and early stage entrepreneurs through accelerator programs and incubators.
- **Enhance R&D collaboration between universities and companies** through an innovation hub. The consortium of companies, universities, and research centres should steadily expand each year, and showcase projects to inspire stakeholders, investors, students, and citizens.
- **Consolidate and coordinate innovation funding**, and include education on the bioeconomy, and universities.
- **Support DINAPI** to examine patents, train their staff, and strengthen patent enforcement to encourage innovation. Exchange on best practices with international organizations.
- **Offer scholarships and training** to outstanding students in applied science and engineering, and include them in innovation hub projects. Provide innovation training through extension services to CONACYT, IPTA and potentially other institutions.
- **Standardize metrics** to monitor public spending and the outcomes of scientific activities and R&D investments.

⁶⁴ La [UKSPA](#) (United Kingdom Park Association) define Technology Parks as business and technology transfer initiatives are aimed at promoting entrepreneurship and the creation of knowledge. Countries such as Mexico, Brazil, Colombia, Sweden, and especially China have been taking advantage of this model for several decades.

RECOMMENDATION: Improve sustainability and quality assurance of input markets and facilitate market entry through public procurement

Though bioeconomy resources comprise 22.9% of Paraguay’s value added, the majority are not produced under any international green standard or label. This jeopardizes the viability of a sustainable bioeconomy and complicates procurement of sustainable local inputs for subsequent value-added products for export. Given that agriculture and forestry provide the raw materials for the bioeconomy, sustainability of sources is vital for national business continuity and in order to access international markets.

A bioeconomy built on natural resource depletion can’t be sustainable. A shift towards more sustainable practices is inevitable, also in order to build resilience against climate change. International climate commitments are gaining importance in exporting countries, shaping trade policies such as the “EU Deforestation-free Regulation 2023/1115”, which states that the “operator or trader who places these commodities on the EU market, or exports from it, must be able to prove that the products do not originate from recently deforested land or have contributed to forest degradation.”⁶⁵ This affects also Paraguay’s primary sector, such as grain traders, who reportedly blend Paraguayan soy in the terminals of Rio de la Plata for re-export, potentially exposing them to the EU deforestation-free regulation 2023/1115. The Cámara Paraguaya de Procesadores de Oleaginosas y Cereales (CAPPRO) estimates that, with 90% of soy being shipped to Argentina for re-export as beans, soy-cake or -oil, US\$2.5 billion of revenue could be affected, amounting to roughly a quarter of total Paraguayan soy exports.⁶⁶ Furthermore, international buyers and downstream consumer brand owners increasingly require sustainability certification for the materials they source. For example, Procter and Gamble, HP, L’Oreal and Nestle all have commitments to procure certified wood input materials largely or exclusively.⁶⁷

TABLE 7 International Certifications for Forestry and Agricultural Products

INTERNATIONAL CERTIFICATIONS - FORESTRY	
Forest Stewardship Council (FSC) Certification	FSC certification promotes responsible forest management, including sustainable harvesting, protection of biodiversity, and respect for indigenous rights. FSC certification can be applied to timber and non-timber forest products, and certification bodies such as the Paraguayan Forest Certification System (SPF) can guide compliance. FSC covers approximately 220 million ha of forests globally, with over 50,000 FSC-certified forest management units and more than 34,000 chain-of-custody certificates. ⁶⁸
Program for the Endorsement of Forest Certification (PEFC)	PEFC is an international non-profit that promotes sustainable forest management through certification. PEFC certification provides assurance that forests are managed according to environmentally, socially, and economically sustainable practices. PEFC certification is recognized for its inclusiveness, the consensus of its standards, its implementation, and the credibility of its national governing body. 280 million ha are certified under PEFC-endorsed schemes and over 20,000 companies benefit from the PEFC Chain of Custody certification. ⁶⁹

65 European Commission (2024). https://environment.ec.europa.eu/topics/forests/deforestation/regulation-deforestation-free-products_en

66 ABC News (2024) <https://www.abc.com.py/nacionales/2024/02/14/perder-certificacion-ue-afectaria-en-us-2500-millones-a-la-soja-paraguaya/>.

67 Triple Pundit (2021). <https://www.triplepundit.com/story/2021/scale-sustainable-forests-us/724316>.

68 FSC (2022). <https://open.fsc.org/server/api/core/bitstreams/e73b356c-5a98-4cae-be05-ebcf65b65b54/content>.

69 PEFC (2024). <https://www.pefc.org/>.

INTERNATIONAL CERTIFICATIONS - AGRICULTURE

Organic Certification	Organic certification standards recognize agricultural products that are produced using environmentally friendly practices, such as avoiding synthetic pesticides and fertilizers, promoting biodiversity, and maintaining soil health. Certification bodies such as Paraguay's IPTA, international labels like the USDA organic label, or the EU's Organic label can provide guidance on criteria and quality control mechanisms for organic certification.
Fair Trade Certification	Fair Trade certification indicates that agricultural products are produced under fair labor conditions and promote social and economic development for smallholder farmers and workers. Fair Trade standards cover various agricultural products, including coffee, cocoa, and sugar, but also soy for small-scale producers, and certification is typically provided by organizations like Fair Trade International. ⁷⁰
GlobalGAP (Good Agricultural Practices) Certification	Sets voluntary standards for agricultural production, covering aspects such as food safety, environmental sustainability, and worker health and safety. Can be applied to a wide range of crops, including fruits, vegetables, and ornamentals.
Roundtable on Responsible Soy (RTRS) Certification	RTRS certification sets standards for responsible soy production, addressing legal compliance, conservation of natural ecosystems, and social responsibility. RTRS certification aims to promote sustainable soy production while considering the needs of producers, consumers, and other stakeholders.
ProTerra Certification	Focuses on sustainable agriculture and food production, including soy. ProTerra standards cover environmental protection, biodiversity conservation, and human rights. ProTerra certification supports sustainable farming and promotes transparency throughout the supply chain.

INTERNATIONAL QUALITY STANDARDS

ISO 14001 Environmental Management System	An international standard for environmental management systems (EMS) which provides a framework for organizations to identify and manage their environmental impacts. ISO 14001 can help agricultural and forestry enterprises improve their environmental performance and comply with regulatory requirements.
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Besides sustainability certification, standards on quality assurance and traceability of products are important to assure high quality inputs and outputs in a bioeconomy. In Paraguay, conformity assessment bodies monitor compliance with mandatory and voluntary standards. The government organization which develops Paraguay's standards regime is The National Institute of Technology, Standardization and Measurement (INTN).

A conformity assessment covers all actions needed to comply with a technical regulation or voluntary standard. Conformity assessments can include test and calibration laboratories, product certification bodies, accreditation bodies, inspection and verification units, quality system registrars, and others. The following are the main national testing organization(s) and conformity assessment bodies:

- National Institute of Technology, Standardization and Measurement (INTN)
- Paraguayan Institute of Agricultural and Livestock Technology (IPTA)
- National Animal Quality and Health Service (SENACSA)
- National Seed and Vegetable Quality and Sanitation Service (SENAVE)
- National Food and Nutrition Institute (INAN)
- Ministry of Industry and Commerce, Consumer Protection Directorate (SEDECO)
- National Health Vigilance Directorate (DINAVISIA)

⁷⁰ Fairtrade (2024). <https://www.fairtrade.net/>.

Product certification is regulated by the ISO standards. The local accreditation body is the National Accreditation Organization (ONA) under CONACYT. The National System of Information and Notifications (Sistema Nacional de Informacion y Notificacion Sobre Reglamentos Tecnicos, Normas y Procedimientos de Evaluacion de la Conformidad - SNIN), under the Ministry of Industry and Commerce, acts as a database for all standards-related matters (e.g., proposals, comments/input, approvals). Final regulations are published in the government's Official Gazette (<http://www.gacetaoficial.gov.py/>). Each organization submits final regulations to the Ministry of Foreign Relations, which submits them to the World Trade Organization.⁷¹

Given that many bioproducts are new, market entry is a barrier that standards and certifications do not fully address. Public procurement has a strong pull-factor and shows political will to support firms in the bioeconomy. Public procurement has taken on an important role in Paraguay, and from 2021–2022 its value in the general budget of the nation (PGN) and the GDP increased from 21.1% of the PGN and 7.2% of the GDP to 25.6% and 8.6%, respectively.⁷² This makes the state one of the largest buyers, so the new Sustainable Public Procurement Policy will have a strong influence on the bioeconomy.

Paraguay has undertaken the first steps to promote “green” public procurement through its policy to integrate SMEs into the procurement process. The new law (N°7021/2022) establishes sustainable purchasing as a criterion in public procurement. The subsequent Action Plan for public procurement highlights ways to promote and track sustainable purchases by public agencies. This includes bioeconomy products from local SMEs.⁷³

Potential areas of improvement:

- **Adopt international certifications for forestry products** such as FSC. Identify agriculture value chains in which certification may create a niche market for Paraguayan products.
- **Capacity building for INTN, IPTA, SENAVE, SENACSA and DINAVISA** for increased credibility and enforcement through standards and certifications.
- **Promote markets for bioeconomy products** through public procurement:
 - **Develop a Public Procurement Manual for a sustainable bioeconomy**,⁷⁴ emulating the Manual for Sustainable Infrastructure, which aligns public procurement with the bioeconomy.
 - **Level the playing field between local and foreign applicants** through clear regulations.
 - **Improve monitoring and evaluation of impacts** from green public procurement.
 - **Prioritize sustainable biobased products** with low ecological footprints.

71 International Trade Administration (2022). Paraguay – Country Commercial Guide. Available at: <https://www.trade.gov/country-commercial-guides/paraguay-standards-trade>.

72 Dirección Nacional de Contrataciones Públicas (DNCP). (2023). Comportamiento de las Compras Públicas del Paraguay 2022.

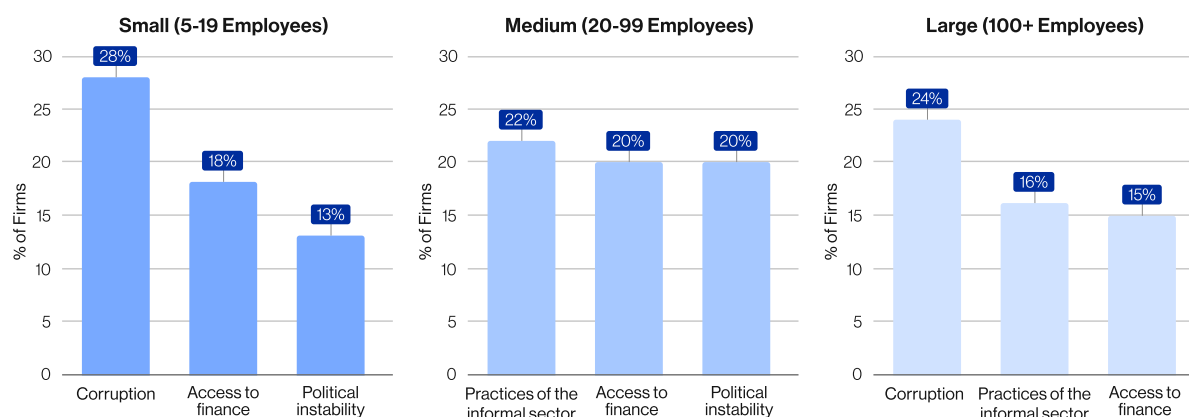
73 Lasagabaster, Esperanza; Signoret, Jose E.; Aranda Larrey, Yago; Carreras Schabauer, Noelia; Argolo Checcucci Filho, Ermani; Dauda, Seidu; Alejandro Espinosa-Wong; Miralles Murciego, Graciela; Vijil, Mariana; Patino Pena, Fausto Andres; Ramirez Robles, Edna Del Carmen; Rojas, Shunko. Accelerating Paraguay's International Integration Through Enhanced Trade, Investment and Competition Policies, Washington, D.C.: World Bank Group, 2021. <http://documents.worldbank.org/curated/en/099000103042241955/P1754520ee49cf00e0a88d020e0a14bf242>.

74 Ministerio de Urbanismo, Vivienda y Hábitat (MUVH). (2022). Manual de Compras Públicas Sostenibles en Obras Públicas de Paraguay Con Especial Referencia a Vivienda y Urbanismo. <https://www.muvh.gov.py/sitio/wp-content/uploads/2022/04/MANUAL-CPS.pdf>.

RECOMMENDATION: Enhance financial mechanisms to support input markets and entrepreneurs

Across all sizes of businesses in Paraguay, access to finance is among the top three constraints according to the World Bank Enterprise Survey 2023. For small and large companies, corruption was the main issue, while medium-sized companies struggled most with practices in the informal sector. The lack of long-term financing is a constraint, for example, in Paraguay's growing forestry industry, and prevents financing for plantations due to their long start-up periods without cash-flow before debt-repayments can begin.⁷⁵

FIGURE 16 Business Environment Constraints by Size⁷⁶



Only 60% of small firms have bank loans, and 71% of MSMEs cannot get loans. The estimated finance shortfall for MSMEs is approximately US\$4 billion.⁷⁷ The bioeconomy requires specialized funds for innovative startups and new business models that may have higher investment risks. Some funds in Paraguay could be improved to address bioeconomy sectors.

Existing mechanisms such as FONTAGRO could be leveraged to provide early help to Paraguay's bioeconomy. FONTAGRO⁷⁸ is a regional platform for institutions in Latin America, the Caribbean and Spain; it promotes cooperative research and innovation in family farming, finance for agricultural technology, and a forum for issues in technological innovation. Working in 33 countries, it has mobilized US\$137.8 million. Paraguay was a founding member of FONTAGRO in 1998 and contributed US\$2 million. During its 22 year membership Paraguay has participated in 19 consortia worth US\$18.2 million, of which US\$5.4 million was contributed by FONTAGRO and other agencies. Projects included R&D in wheat, cassava and organic production; information and monitoring for risk management in agricultural production, and strategies to address climate change, among others. FONTAGRO increasingly finances projects to enable bioeconomy approaches, and is well-positioned as a funder, particularly in the agriculture and food sectors. In December 2023, a Paraguayan scientist won an international prize at the FONTAGRO-organized "Contest for Successful Innovations in the Bioeconomy" (Concurso de Casos Exitosos de Innovaciones en Bioeconomía) for a new technology to green fertilizers.⁷⁹

⁷⁵ World Bank Paraguay Enterprise Survey (2023). <https://www.enterprisesurveys.org/en/data/exploreeconomies/2023/paraguay>.

⁷⁶ World Bank Paraguay Enterprise Survey (2023). <https://www.enterprisesurveys.org/en/data/exploreeconomies/2023/paraguay>.

⁷⁷ World Bank PAFI 2021.

⁷⁸ Fontagro (2023). Available at: <https://www.fontagro.org/new/proyectos/>.

⁷⁹ ABC News (31 Dec 2023). <https://www.abc.com.py/economia/2023/12/31/paraguay-gana-por-primera-vez-un-premio-internacional-de-innovaciones-en-bioeconomia/>.

The rise of green bonds offers opportunities to fund the bioeconomy. In search of sustainability, investors are expected to focus on greening and decarbonizing. Innovation-led growth models, such as the bioeconomy, offer opportunities for direct global economic impacts of up to US\$4 trillion a year over the next ten to 20 years.⁸⁰ While not yet specifically for the bioeconomy, Paraguay recently launched initiatives to support green bonds, green credits and sustainability bonds. Since 2020, a Framework Agreement between WWF and the National Securities Commission has developed green bonds, credit ratings and guidelines. In 2021, Paraguay's Sudameris Bank, with credit from the German, Netherlands and French Development banks, offered a Green Credit Line for sustainable financial products. In 2021, Banco Continental del Paraguay issued the country's first Sustainability Bond of US\$300 million, winning the Environmental Finance Bond Awards 2021. Paraguay is the first Latin American country to incorporate guidelines to achieve Sustainable Development Goals (SDGs) in its national regulation. In December 2023, the AFD (Agencia Financiera de Desarrollo), a second-tier public bank, issued its first sustainability bond with the Global Green Growth Institute (GGGI). The bond is only for projects with social and/or environmental benefits, and which fall under eligible green categories.⁸¹ The national bioeconomy strategy should specify the role of green finance to scale up the bioeconomy.

Potential areas for improvement:

- **Align financing mechanisms with bioeconomy objectives and scope**, and clarify the role of green financing.
- **Improve grant mechanisms for SMEs** to export bioeconomy and green products.
- **Increase specialized funds for R&D** to develop bioeconomy products.
- **Fund CONACYT to develop novel products** with the private sector.
- **Finance entrepreneurs in novel sectors of the bio- and circular economies**, and crowd-in private investment such as angel investors, venture capital and private equity.
- **Improve long-term financing for R&D** into sustainable, certified critical input industries.

⁸⁰ McKinsey (2020). <https://www.mckinsey.com/industries/life-sciences/our-insights/the-bio-revolution-innovations-transforming-economies-societies-and-our-lives>.

⁸¹ Global Green Growth Institute (2023). <https://ggi.org/first-sustainable-bond-issued-in-paraguay/>.



