NATIONAL BIOTECHNOLOGY ECOSYSTEM STUDY

Presentation of Results

SOFOFA HUB

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Chile has unique conditions to position biotechnology as a driving force of economic development and sustainability. This cross-cutting discipline can transform productive sectors, add value to natural resources, and respond to global challenges such as climate change, food safety, energy transition, and circular economy. In this context, biotechnology firms serve as catalysts of technology transfer, bringing knowledge from research to productive markets.

The goal of the study, developed by the Translational Biotechnology Center (Centro de Biotecnología Traslacional, CBT) of SOFOFA Hub (Society for the Promotion of Manufacturing, Sociedad de Fomento Fabril), with the support of the National Agency for Research and Development (Agencia Nacional de Investigación y Desarrollo, ANID), was to map, identify, and regionally characterize the main actors of the biotechnology ecosystem in Chile, considering both supply and demand in strategic sectors. This

was approached by applying the Sectoral Systems of Innovation (SSI) framework, which helps explain not only the presence of actors, but also the quality and density of their interactions.

The methodology combined secondary data collection, qualitative interviews, and regional analysis. Of the 202 biotechnology companies that were identified, 173 are firms dedicated exclusively to biotechnology (Dedicated Biotechnology Firms, DBFs) and 29 are firms in which biotechnology complements other activities (non-DBFs). Young startups and spin-offs predominate, focused on technology validation and first commercialization experiences, mainly with B2B models and a growing interest in internationalization. The most dynamic sectors of application are agriculture and livestock (51), human health (47), and industrial processing (30), although advances are also evident in new materials (19), animal health (18), and aquaculture (14).

Additionally, about 250 other actors were mapped, including universities, R&D centers, specialized laboratories, incubators, hubs, offices of technology transfer, investment funds, public agencies, among others. More than 50% of them are located in the Metropolitan Region (Región Metropolitana, RM), although emerging regional poles stand out in Biobío, Los Lagos and Valparaíso, which are linked to strategic productive sectors such as forestry, aquaculture and agroindustry.

The study highlights strengths such as an internationally competitive scientific base, enabling public policies, and early-stage funding instruments, in addition to a growing interest of the industry in biotechnological solutions. However, structural gaps persist which limit the consolidation of the ecosystem: insufficient infrastructure for pilot testing and scale-up, scarce human capital with hybrid profiles that integrate science, business and regulation, weak articulation between supply and demand, a regulatory framework that is fragmented and poorly adapted to the speed of innovation, and low participation of private capital, concomitant with a strong dependence on public funding.

Overall, the Chilean biotechnology ecosystem is in an early consolidation phase: dynamic and with expanding regional poles, yet still conditioned by structural gaps. The study provides a comprehensive diagnosis that combines quantitative and qualitative evidence, showing that the competitiveness of the sector cannot be explained solely by isolated capabilities but rather by its articulation in stable networks that generate effective transfer, scale-up and productive impact. In this scenario, the intermediary actors are decisive in connecting technological supply and demand, reducing risks, accelerating market entry, and positioning Chilean biotechnology internationally.

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Introduction

The CBT of SOFOFA Hub is an initiative supported by the ANID, which has the main purpose of promoting the development of the biotechnology industry in Chile. To that end, it seeks to strengthen the ties between the business sector, the national system of science, technology, knowledge and innovation, and the public sector, thereby accelerating the adoption of biotechnological solutions in key productive sectors.

CBT's core mission is to contribute to the country's sustainable growth through the integration of high-value biotechnological solutions, effectively transferring knowledge, and the creation of conditions that facilitate the articulation and expansion of this ecosystem. Biotechnology represents a strategic opportunity to move towards a more sophisticated economy, generate highly qualified jobs, and position Chile as a benchmark in science-based innovation.

In line with this mission, the CBT conducted this first study to map and characterize the key actors in the national biotechnology ecosystem. Who are they? How do they interact? What gaps constrain its development, and what opportunities could be leveraged? These are some of the questions that guided the investigation, with the goal of collecting strategic evidence that may help design more effective interventions, foster collaborations between actors, and guide public policies for a robust and sustainable biotechnological development.

The study combines a quantitative and qualitative exploratory analysis with a regional focus, considering factors such as investment in Research and Development (R&D), the availability of prototyping, business, academic, technological, and financial capabilities. It includes the evaluation of corporate firms, startups, investors, universities, research centers and public agencies.

Overall, more than 400 actors who are active in biotechnology were identified throughout Chile, grouped in the dimensions of knowledge, funding, commercialization, and biotechnology firms. This allowed for a detailed regional characterization of the biotechnology ecosystem and a preliminary appreciation of their dynamics.

The structure of the report begins with an overview of biotechnology in Chile, followed by the conceptual framework that guides the mapping of the ecosystem, and the methodological description of the study. Then, the results of the study are presented, characterizing the national ecosystem with a regional emphasis, its dynamics, trends, challenges and opportunities.



Study Objectives

GENERAL OBJECTIVE:

Map, identify, and regionally characterize the main actors related to the supply and demand of biotechnology in the scientific-technological ecosystem, the funding ecosystem, and the national industry.

SPECIFIC OBJECTIVES:

1. Assess the national biotechnological capabilities and identify, map, and characterize the actors that mobilize the biotechnology industry by region and industrial sector, disaggregating information according to type of actors.

2. Identify opportunities for the regional biotechnology ecosystem to develop territorially and contribute to the economic growth of the country.



Background

OVERVIEW OF BIOTECHNOLOGY IN CHILE

In the last few decades, biotechnology has emerged as a key driver of innovation and economic development worldwide. In this context, Chile has strategically identified biotechnology as a priority sector to advance towards a knowledge-based economy, integrating actively into this global trend.

As an initial approach, data from the R&D Survey of 2020 (Encuesta de I+D) on biotechnology and nanotechnology, classified according to their economic activity using data from the Servicio de Impuestos Internos (SII) -the Chilean Internal Revenue Service- (Table 1) were analyzed. It should be noted that the SII reports the business expenditures in R&D in biotechnology and nanotechnology jointly. Therefore it is not possible to disaggregate this information into separate categories.

Table 1: Number of firms that do R&D and have expenditures in biotechnology and nanotechnology, per economic activity (2020)

ECONOMIC SECTOR	R&D COMPANIES	R&D COMPANIES WITH EXPENDITURES IN BIO AND NANO TECHNOLOGY
1=A: Agriculture, livestock farming, forestry and fishing	35	9
2=B: Exploitation of mines and quarries	6	1
3=C: Manufacturing industries	167	34
4=D: Supply of electricity, gas, steam, and air conditioning	6	0
5=E: Supply of water, wastewater management, waste management and decontamination	7	0
6=F: Construction	7	3
7=G: Wholesale and retail commerce, repair of motor vehicles and motorcycles	53	19
8=H: Transport and storage	6	0
9=I: Accommodation activities and food service	2	0
10=J: Information and communications	77	4
11=K: Financial and insurance activities	8	1
12=L: Real estate activities	1	1
13= M: Professional, scientific and technical activities	209	58
14=N: Administrative and support service activities	15	1
15=O: Public administration and defense; social security affiliation plans	0	0
16=P: Teaching	4	0
17=Q: Human health care and social assistance activities	12	6
18=R: Arts, entertainment and recreational activities	1	0
19=S: Other service activities	4	0

Source: prepared by the authors based on the survey "Encuesta I+D 2020"

According to this information, the majority of firms that carry out R&D activities in biotechnology and nanotechnology belong to two economic sectors:

- Professional, scientific and technical activities, with 209 R&D companies, of which 58 (28%) invest specifically in biotechnology and nanotechnology.
- Manufacturing industry, with 167 R&D companies, of which 34 (20%) invest in these areas.

This shows that biotechnology is being driven mainly by sectors that are knowledge-intensive (scientific and technical), while the manufacturing sector also shows a progressive adaptation to emerging technologies, incorporating it in its productive processes.

From a territorial perspective (Table 2) the Metropolitan Region concentrates 65% of the R&D companies in the country (404 of a total of 620), which reaffirms its role as the core of the Chilean innovation ecosystem. The two macrozones that follow are Center South (69 businesses) and Center (60).

Table 2: Number of companies that carry out R&D and have expenses in biotechnology and nanotechnology, per macrozone (Encuesta I+D 2020).

MACROZONE	R&D COMPANIES	R&D COMPANIES WHICH HAD EXPENSES IN BIO AND NANO TECHNOLOGY	PROPORTION: R&D BIO AND NANO TECHNOLOGY COMPANIES/R&D COMPANIES
North	27	3	11%
Center	60	18	30%
Center South	69	25	36%
South	55	7	13%
Austral	5	0	0%
Metropolitan Region	404	84	21%
TOTAL	**620**	**137**	

Source: prepared by the authors based on the survey "Encuesta I+D 2020"

When the expenditure is analyzed specifically in R&D in biotechnology and nanotechnology, the Metropolitan Region leads with 84 companies, representing 61% of the national total. The Center South macrozone is second, with 25 companies, and the Center macrozone is third, with 18.

However, regarding the R&D companies that actually invest in biotechnology and nanotechnology, the Center South macrozone stands out with a rate of 36%, higher than the national average. When compared to other regions, this suggests a stronger specialization and focus on biotechnology.

On the other hand, biotechnology has acquired significant relevance in the ecosystem of Deep Tech startups, representing 24% of this sector in the country. In the region, biotechnology constitutes the majority (61%) of the Deep Tech startups in Latin America and the Caribbean (LAC), positioning Chile as one of the main actors regionally together with Argentina and Brazil. This leadership stems from a well-developed entrepreneurial ecosystem -that is, with availability of public and private investment funds and networks that support science-based startups-, and a high concentration of researchers specialized in fields related to Deep Tech.

The State has played a relevant role in this development. The Ministry of Science, Technology, Knowledge and Innovation (Ciencia, Tecnología, Conocimiento e Innovación, CTCI) actively promotes the creation and consolidation of Science- and Technology-Based Companies (Empresas de Base Científico Tecnológicas, EBCT), through programs that provide funding, technical support, strengthening of capabilities and promotion of collaboration between academia and industry. Initiatives such as Start Up Ciencia, Catálisis, and Semillero have been instrumental in enabling new technological companies. Likewise, along with the recent creation of the Division of Emerging Technologies, the Ministry of CTCI is promoting the creation of a National Policy on Biotechnology. The Chilean biotechnology ecosystem is configured as a complex network of interdependent actors—companies, universities, research centers, funding agencies, investors, and support platforms—who collaborate with each other to gain access to knowledge, complementary assets, and specialized infrastructure. This logic of network development, which promotes synergies and allows risk sharing is essential to understanding and strengthening the sector's growth in Chile.

In this context, biotechnology is not developed in isolation, but as a multi-actor network in which companies establish ties and strategic partnerships with various actors of the system, such as academic institutions, venture capital funds, public agencies and other support organizations. This collaborative dynamic facilitates access to critical resources –from commercialization capacities to funding– and requires an ecosystem perspective to understand it and strengthen it.

3.2. SECTORAL SYSTEMS OF INNOVATION (SSI)

Biotechnology, being an activity that is highly science-intensive, with high levels of uncertainty, long payback periods, and accelerated technological changes, drives companies to collaborate with multiple actors of the ecosystem. Although companies are the core, the development and commercialization of innovations depend on co-creation with universities, centers, regulatory entities and funders. Under this logic, the approach of Sectoral Systems of Innovation is especially useful to analyze the Chilean case, as it shows how knowledge, technologies, and productive, regulatory and financial capabilities are articulated in a dynamic network of interactions.

This approach emphasizes four key dimensions:

i. Biotechnological knowledge: the cognitive basis of the ecosystem under study.
ii. The actors who acquire, produce and use the knowledge.
iii. The interactions that facilitate its creation and transfer.
iv. The institutions—norms, regulations and routines—that frame these dynamics.

By considering the interaction between actors and how it takes place as the central element, the secto-

ral system undergoes processes of transformation driven by these actors. These processes result in the co-evolution of technologies and institutionalized forms of action and interaction, the emergent outcome of which is technological change in products, processes, and organizations.

Technological change, understood as the introduction and dissemination of new techniques, processes and products, constitutes the basis of the SSI approach. In this setting, companies compete using innovation as a strategic tool, which requires articulating knowledge from science, technology, the market and organizational experience.

Understanding technological change is crucial in the case of biotechnology, because companies compete through the introduction of innovations that can transform the logic and the competitiveness of entire industries. This dynamic is reflected in developments of high impact, such as vaccines, transgenic seeds, biological products, or gene editing techniques, which shorten development times, increase productivity and reduce costs.

Within the framework of the SSI, knowledge and innovation networks allow companies to access resources, coordinate activities, and generate learning beyond market transactions. These networks are based on relations of trust and non-hierarchical cooperation, where the interaction between companies, research centers, suppliers, clients and other organizations facilitates the creation and transfer of knowledge.

Their importance lies in the fact that they contribute to reducing technical and market uncertainty, facilitate access to complementary technological competencies, and allow identifying and evaluating new opportunities. Likewise, they stimulate collective learning, the establishment of norms and standards, and obtaining innovative solutions.

There are different types of networks: vertical networks, related to clients and suppliers within value chains, and horizontal networks, which include collaborations with other companies, research institutions, consultants, or technology transfer entities. The greater a company's knowledge base and absorptive capacity, the more benefits it can derive from these interactions.

3.3. WHAT DO WE UNDERSTAND BY BIOTECHNOLOGY AND BIOTECHNOLOGY COMPANIES?

3.3.1. Biotechnology

Since the first definition of the term «biotechnology», coined by the Hungarian Karl Ereky in 1919 ("all lines of work from which products based on raw materials are made with the help of living organisms"), various definitions of the term coexisted until 2005, when the OECD published the following definition, which was adopted throughout the world and guides the current elaboration of national statistics:

Biotechnology is «the application of science and technology to living organisms, as well as parts, products and models thereof, to alter living or non-living materials for the production of knowledge, goods and services» (OECD 2005).

The proposed definition is operationalized and interpreted by the following techniques of modern biotechnology:

- Recombinant DNA/RNA techniques: genomics, pharmacogenetics, sequencing, genetic engineering.
- Proteins and molecules: sequencing of peptides, synthesis of lipids, proteomics, hormones, growth factors.
- Cell and tissue culture: tissue engineering, embryos, cell fusion, stimulation of the immune system.
- Process biotechnology: bioreactors, fermentation, bioprocessing, bioleaching, bioremediation.
- Genetic vectors and RNA: gene therapy, viral vectors.
- Bioinformatics: computational analysis and modeling of biological data.

3.3.2. Biotechnology firms

For a better understanding of the composition of the biotechnology ecosystem in Chile, the following typology is proposed in this study (Figure 1):

i. According to their dedication to biotechnology:

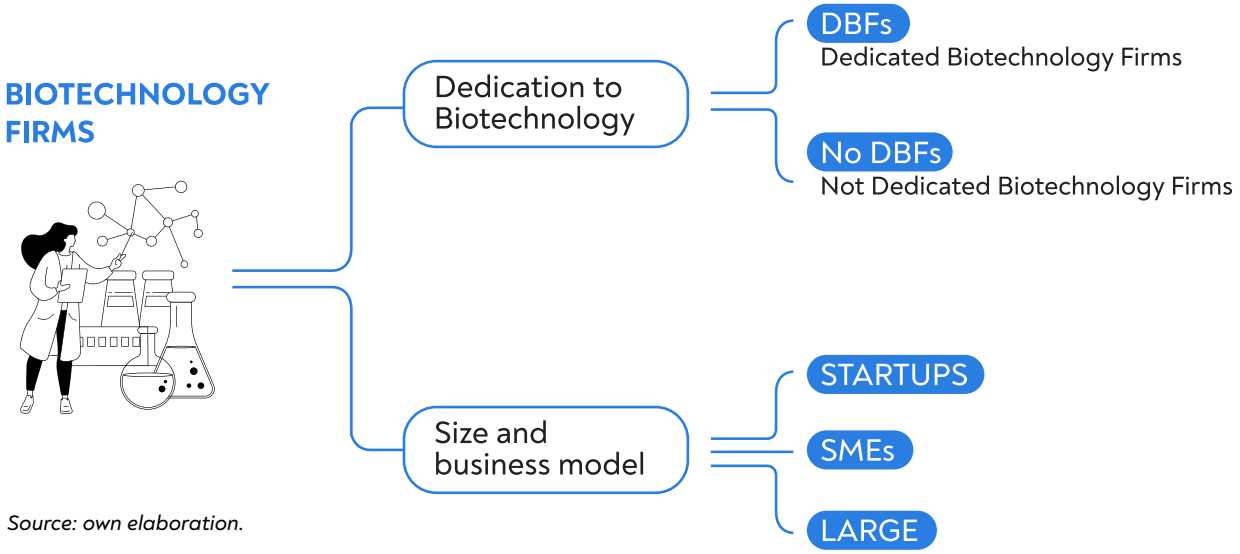
- Companies exclusively dedicated to biotechnology (DBFs, Dedicated Biotechnology Firms): whose main and sole activity is biotechnology.

- Companies not exclusively dedicated to biotechnology (non-DBFs): they use biotechnology to complement other activities. These firms typically have a knowledge base in disciplines such as chemistry, biology or agronomy, and incorporate biotechnology as a new technological platform to diversify their products, services or processes.

ii. According to their business model:

- Startups: firms created recently (up to 10 years), centered in the development of scalable biotechnological technologies with global innovation potential, financed mainly by venture capital.

- Established firms: all firms that apply biotechnological technologies or develop biotechnological products and/or services, either for international markets or exclusively for national markets. Firms within this group may be classified by size in small and medium-sized enterprises (SMEs) and large firms.



Source: own elaboration.

Figure 1: Types of biotechnology firms.

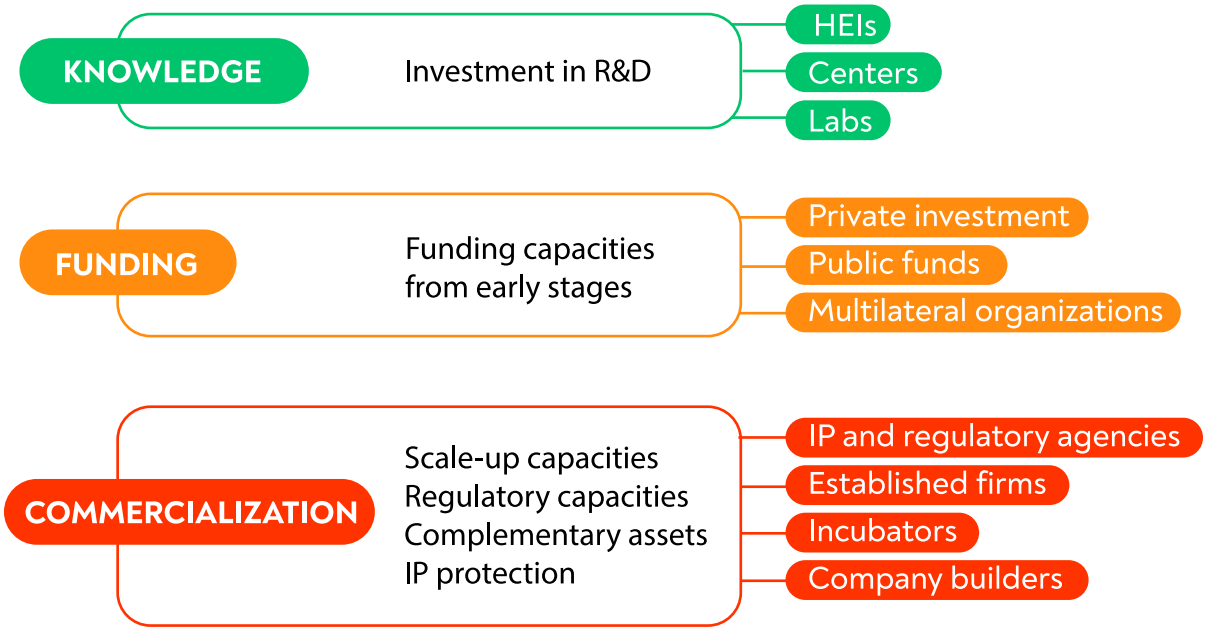
3.4. OTHER ECOSYSTEM ACTORS

In frontier industries, like biotechnology, the complexity of their developments, the high risk associated with the creation of new products and processes, and the accelerated pace of technological change drive firms to interact and exchange knowledge and resources with other actors, both within and beyond the industry.

Empirical evidence shows that the development of biotechnological activity is supported by a complex network of collaborations between various types of actors: companies, universities, public research institutes, laboratories, and venture capital funds.

In this sense, the actors who make up the biotechnology ecosystem may be classified according to the types of assets they provide or co-develop together with the biotechnology firms (Figure 2):

- Actors who provide knowledge: they invest in R&D in biotechnology. They are generally higher education institutions (HEIs), research centers and/or laboratories that generate scientific and technological knowledge.
- Actors who provide funding: these include investment funds, angel investors, multilateral organizations, and public funds.
- Actors who provide complementary assets to take technologies to market: intellectual property (IP) and regulatory agencies, incubators, company builders, technology parks, hubs, as well as non-biotechnology firms which offer production and/or commercialization capacity, among others.
- Trade associations: they articulate business demand and promote the adoption of biotechnological solutions.



Source: own elaboration

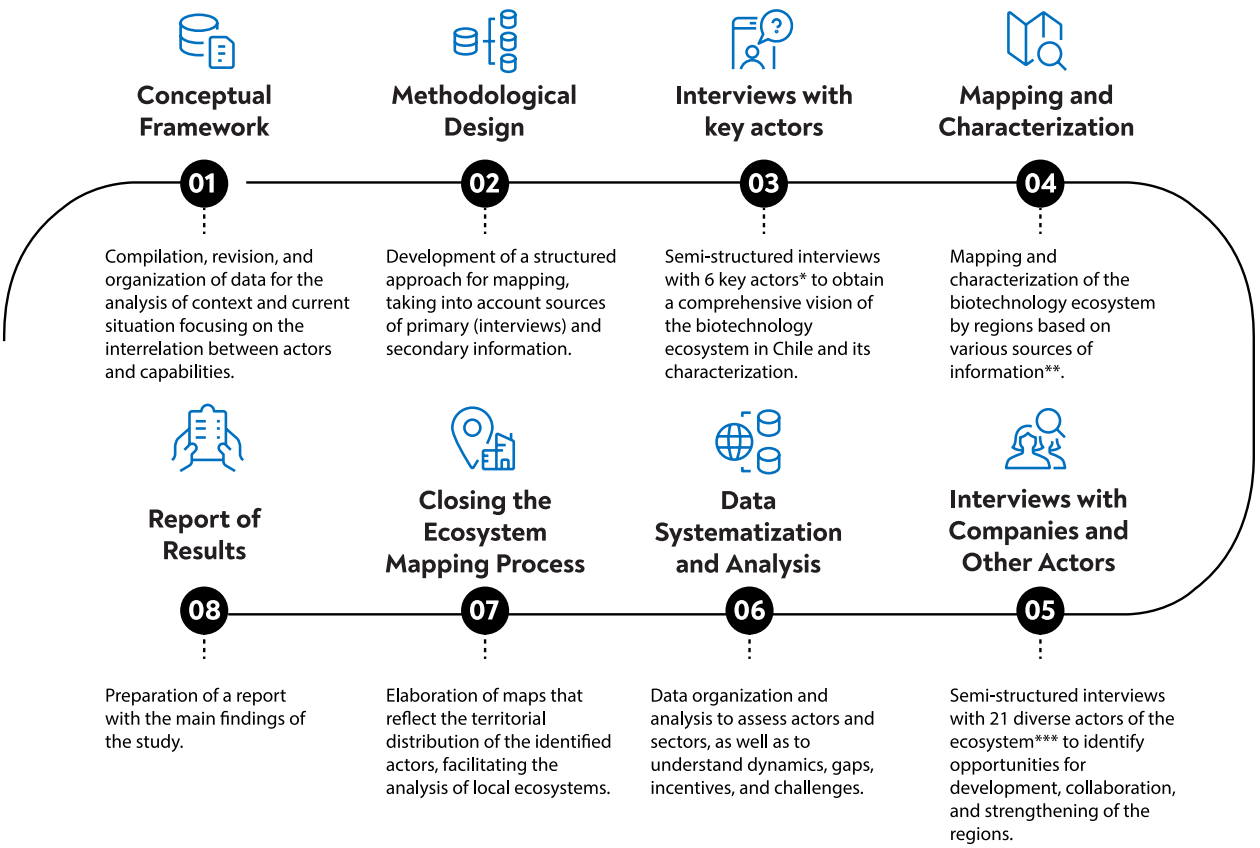
Figure 2: Map of biotechnology actors.

04

Methodological approach

The methodological approach of the study (Figure 3) adopts an ecosystem perspective, considering the actors, their capabilities, and the dynamics of regional interactions. This model seeks not only to characterize the biotechnology ecosystem in Chile but also to identify gaps from a multidimensional perspective as well as opportunities to strengthen this sector.

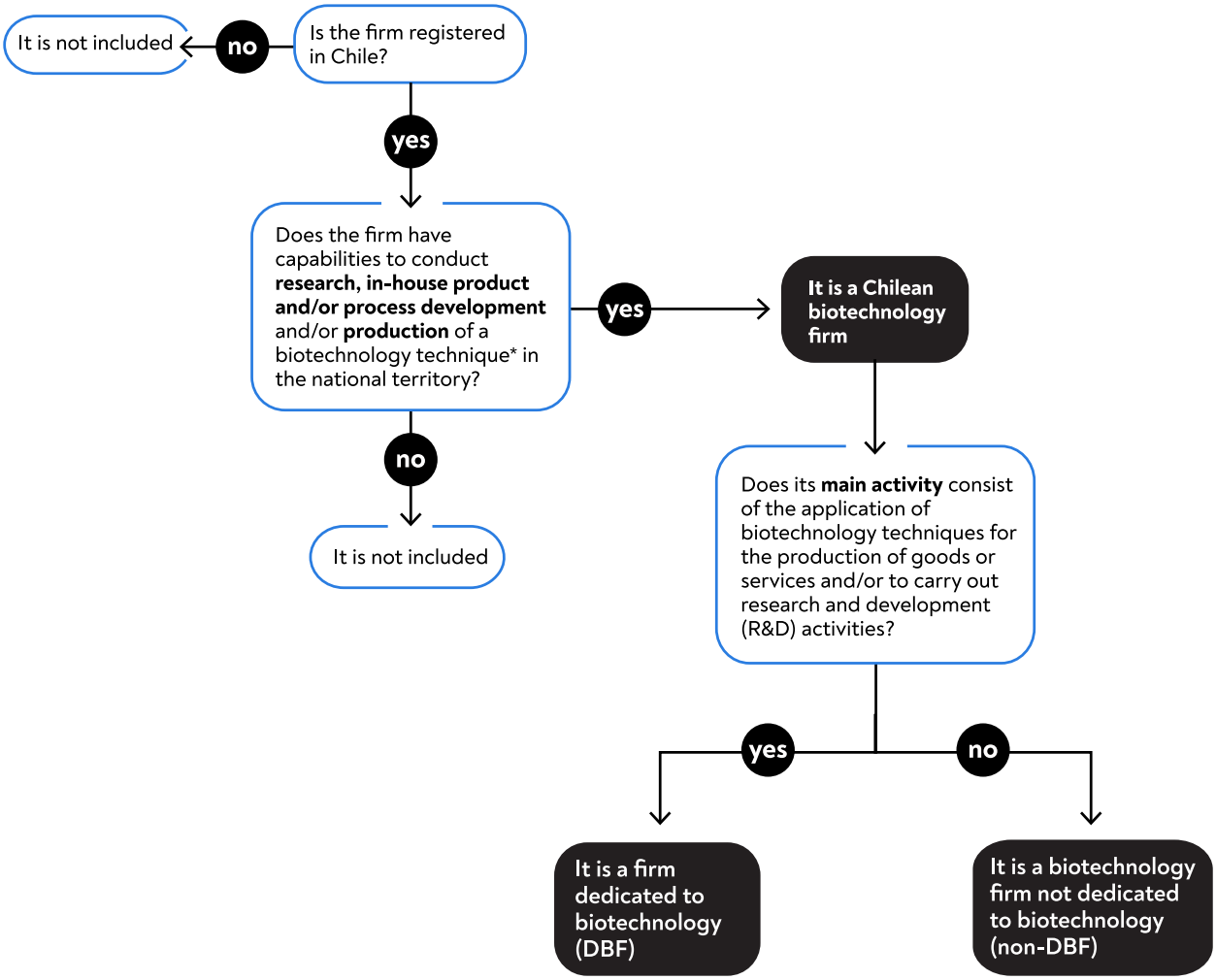
This approach will not only explain how the biotechnology ecosystem in Chile is structured, but will also provide information for designing strategies that foster the creation, scale-up, and sustainability of biotechnology firms and initiatives.



**Key Actors: Business leaders and experts of the biotechnology sector.*
***Sources of information used: databases provided by the CBT (event participants, data from previous studies, among others), traditional databases (Directorio de EBCTs MinCiencia, R&D Law, INAPI Patents, projects awarded by StartUp Ciencia and Innova CORFO) and non-traditional sources of information (technology portfolios of venture capital funds, incubators, accelerators, among others, LinkedIn, interviews).*
****Interviewed actors: They belong to biotechnology companies, large companies, knowledge, financing, commercialization, and other (trade associations) actors.*

Figure 3: Methodological approach.

Additionally, Figure 4 shows the logic used to classify the type of biotechnology firm according to its dedication.



(*) According to the OECD (2018) the biotechnology techniques include: rDNA, Proteins and Molecules, Cell and Tissue Culture, Process Biotechnologies, Gene Vectors and RNA, Bioinformatics, Synthetic Biology.

Source: own elaboration.

Figure 4: Decision tree for the definition of national biotechnology firms.



05 Characterization of the ecosystem

The characterization presented is based on an iterative process of identification and screening of the universe of firms and other actors of the biotechnology ecosystem. This process combined technical criteria of the conceptual framework, validation by the CBT team, and empirical evidence of the qualitative work.

5.1. CHARACTERIZATION OF BIOTECHNOLOGY FIRMS

As a result, 202 biotechnology firms were identified in Chile. The characterization was based initially on official records of the SII, which allowed the integration of variables such as size, age and location. Additional dimensions developed specifically for the study were incorporated into that database, being related to dedication to biotechnology, application sectors, capabilities, and business models.

In terms of their dedication to biotechnology, 173 firms (86% of the total) that use modern biotechnology techniques in their developments and have their own R&D capabilities were identified. In contrast, 29 firms (14% of the total) that integrate biotechnology as a complement to their business were identified, mainly in the agricultural, animal health, and industrial processing sectors.

The identified firms have an average age of between 7 and 10 years, which confirms the ecosystem is relatively young, with great potential for expansion and consolidation. This young age also implies challenges in terms of sustainability, scale-up, and attraction of venture capital.

Figure 5 shows that the Chilean biotechnology ecosystem has experienced an accelerated growth in recent years. Indeed, during the decade of 2013-2023, the number of firms increased more than three-fold, which is equivalent to a compound annual growth rate close to 11%. This dynamism reflects a process of consolidation which contrasts with the period prior to 2010, in which the creation of companies was sporadic and of low intensity.

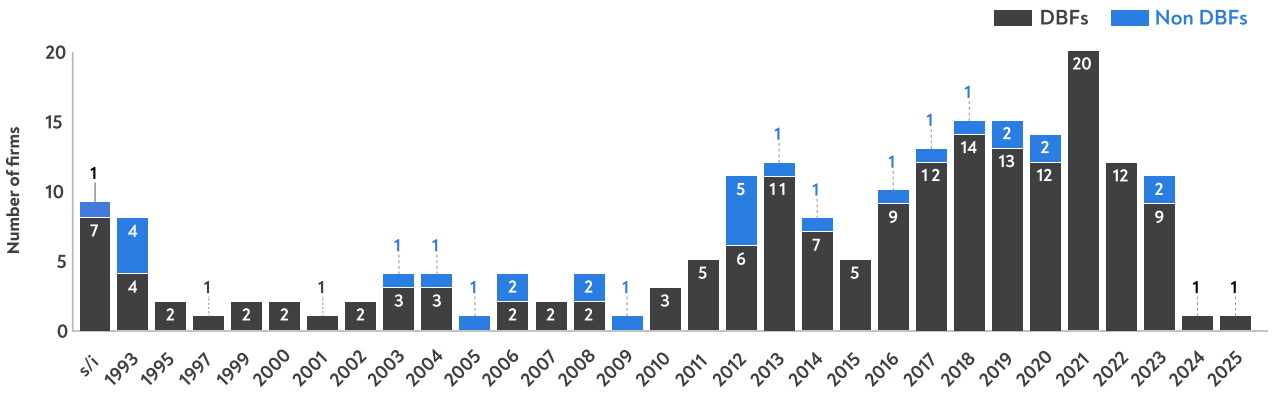


Figure 5: Historic evolution of biotechnology firms (DBFs and non-DBFs).

The creation of biotechnology firms has had several peaks during the last decade, reflecting the existence of favourable conditions for new entrepreneurial ventures, possibly related to the strengthening of public policies, greater access to funding and the expansion of support networks for the creation of science- and technology- based companies. In the case of 2021, the increase may be related to the context of the COVID-19 pandemic, which generated new opportunities and demands for the biotechnological sector, as well as to the Startup Ciencia program, launched in 2020 by the Ministry of Science, Technology, Knowledge and Innovation, which generated an additional stimulus for the creation of new companies in the sector.

The predominance of DBFs over non-DBFs reinforces the idea that biotechnology in Chile is mainly driven by initiatives whose central strategy is biotechnological, rather than as a diversification of traditional companies. Nevertheless, the presence of non-DBFs shows that biotechnology is also permeating existing productive sectors as a complementary way of innovating.

The territorial distribution of the 202 biotechnology firms identified (Figure 6) shows a strong concentration in the RM (54%), which reflects the centralization of scientific infrastructure, financing, and innovation networks in Santiago.

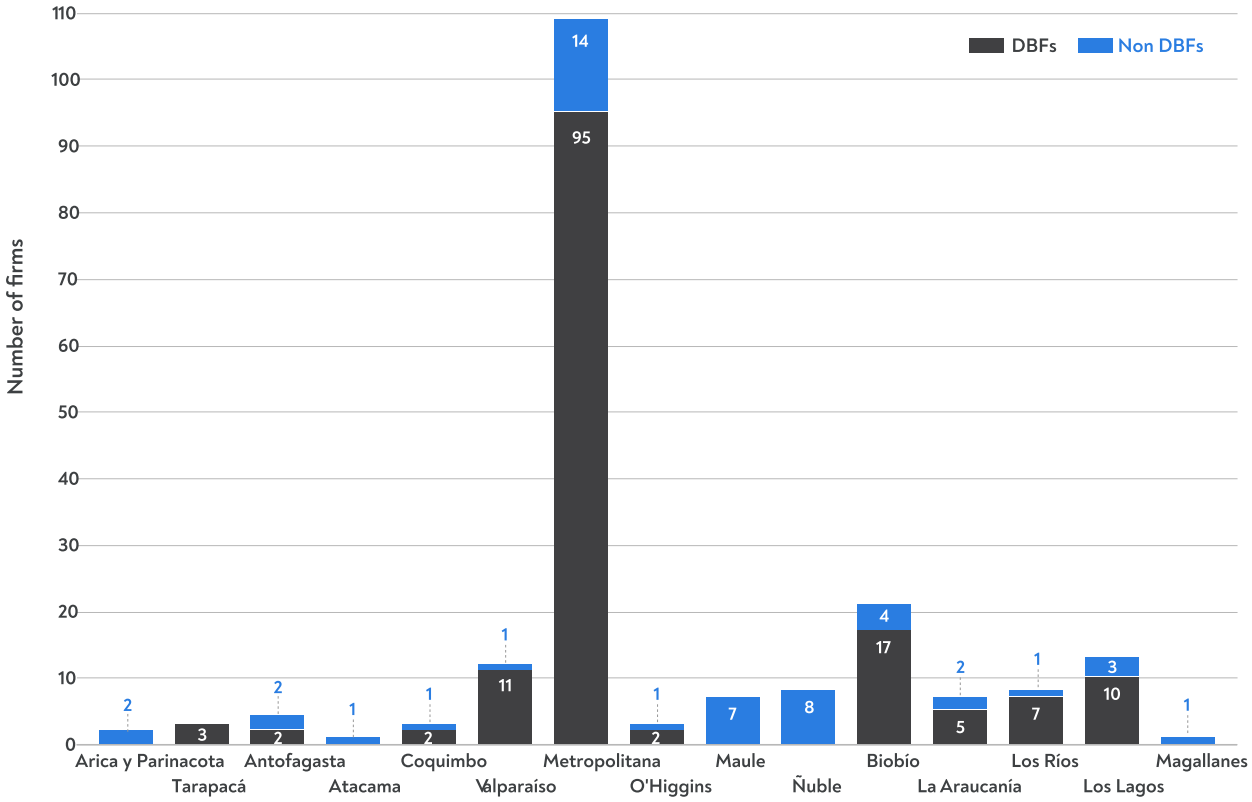


Figure 6: Geographic distribution of biotechnology firms (DBFs and non-DBFs).

The regions that stand out in second place are Biobío (10%), followed by Los Lagos (6%), and Valparaíso (6%), which constitute relevant regional poles associated with productive sectors such as aquaculture, agriculture, and the industry.

The rest of the regions show an incipient presence (less than 5% each), and in the case of Aysén, no companies were registered. This reflects significant territorial gaps, but also presents the opportunity to strengthen local capacities and diversify the national biotechnology ecosystem.

It is important to consider that this distribution may be conditioned by the source of information, based on records of the SII, which do not necessarily reflect where the firms actually operate.

Figure 7 presents the segmentation of firms by size according to their annual sales, according to parameters of the SII, commercial year 2023.

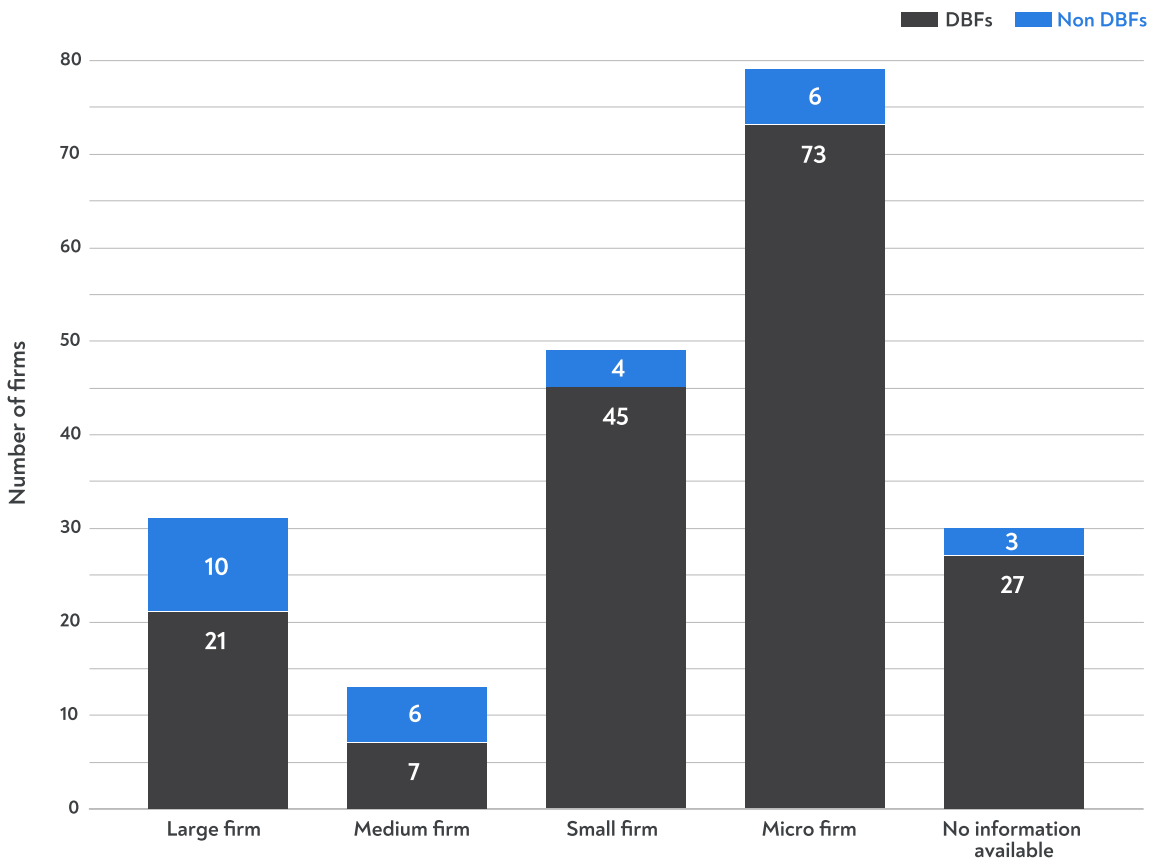


Figure 7: Size of biotechnology firms.

The distribution by size shows that the majority of the biotechnology firms in Chile are of a small scale, predominantly microenterprises (39 %) and small enterprises (24%), which confirms the entrepreneurial and emerging character of the ecosystem.

In contrast, medium-sized (6%) and large firms (15%) represent a smaller proportion, although they fulfill an important role in terms of investment capacity, scalability, and access to global markets.

Companies for which there is no information available on sales add up to 15% of cases, which limits a comprehensive analysis, but does not alter the main conclusion: the biotechnology sector in Chile is primarily driven by a network of startups and SMEs, with a small number of larger, established players.

Regarding the application sectors on which biotechnology firms are focusing, 9 classifications were used, as detailed below:

i. Aquaculture: Applications oriented to salmon farming and culture of marine and freshwater species. It includes nutrition, diagnostics, fish health, disease control, genetics and environmental sustainability.

ii. Agriculture and livestock: Innovations in agriculture and livestock, such as new breeding techniques, bioproducts, biological pest control, biofertilizers, and solutions to increase productivity and resilience to climate change.

iii. Environment, energy, and natural resources: Solutions focused on waste management, bioremediation, renewable energies (e.g., bioenergy) and sustainable use of natural resources in different territories.

iv. Mining: Applications for green and sustainable mining (e.g., bioleaching, bioremediation of mining waste) and processes that reduce the environmental impact and water consumption.

v. New materials: Advanced materials that include biopolymers and nanomaterials, as well as biocompatible materials for medical applications, such as scaffolds for tissue engineering.

vi. Industrial processing: Use of biotechnology in productive processes (food, beverages, chemistry), including enzymes, fermentation, biomass, and bioprocesses to add value or increase efficiency.

vii. Animal health: Products and services for the diagnosis, prevention and treatment of diseases in production animals (livestock and aquaculture), as well as vaccines and supplements.

viii. viii. Human health: Development of therapeutics, diagnostics, advanced therapies, medical biotechnology, and solutions oriented to human health.

ix. Other: Residual category that includes emerging or cross-cutting applications that do not fall in the above categories, such as digital technologies applied to biotechnology, support services, or enabling platforms.

As seen in Figure 8, biotechnology in Chile is mainly concentrated in the agricultural and livestock sector (25%) and the human health sector (23%), which together comprise almost half of the companies, showing both the importance of agriculture in the national economy as well as the dynamism of biomedicine and health.

In a second tier industrial processing (15%) and new materials (9%) stand out, followed by animal health (9%) and aquaculture (7%), which are related to strategic productive sectors such as livestock and salmon farming.

Sectors such as environment and energy (4%) or mining (2%) continue to have a low presence, but represent areas with great potential for development to diversify and strengthen the national biotechnology ecosystem.

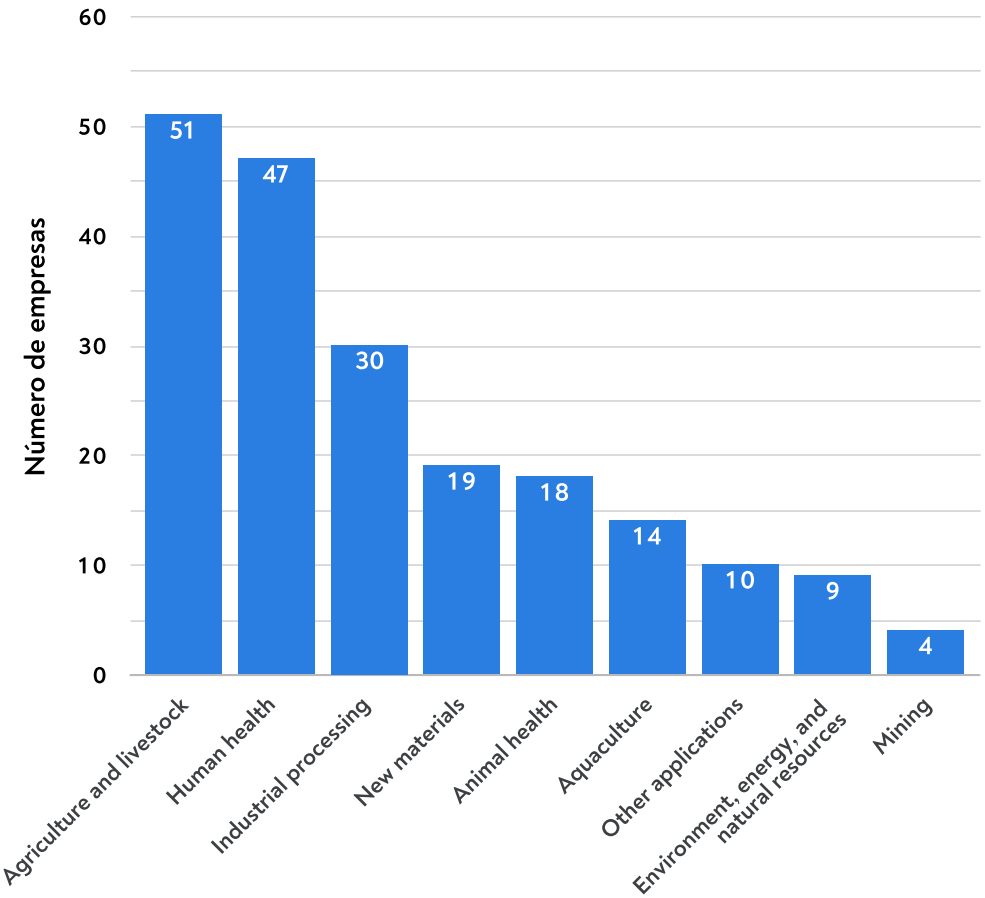


Figure 8: Main sector of application of biotechnology firms.

Figure 9 shows an analysis of the business model and type of offering of biotechnology firms. The majority of the biotechnology firms operate under a B2B model (73%), followed by those which combine B2B and B2C (25%). Only three companies in the sample operate exclusively under a B2C model.

Companies that only supply biotechnological products (102 cases) or a combination of products and services (79 cases) predominate. Purely service-based companies are less frequent, with a total of 19 firms.

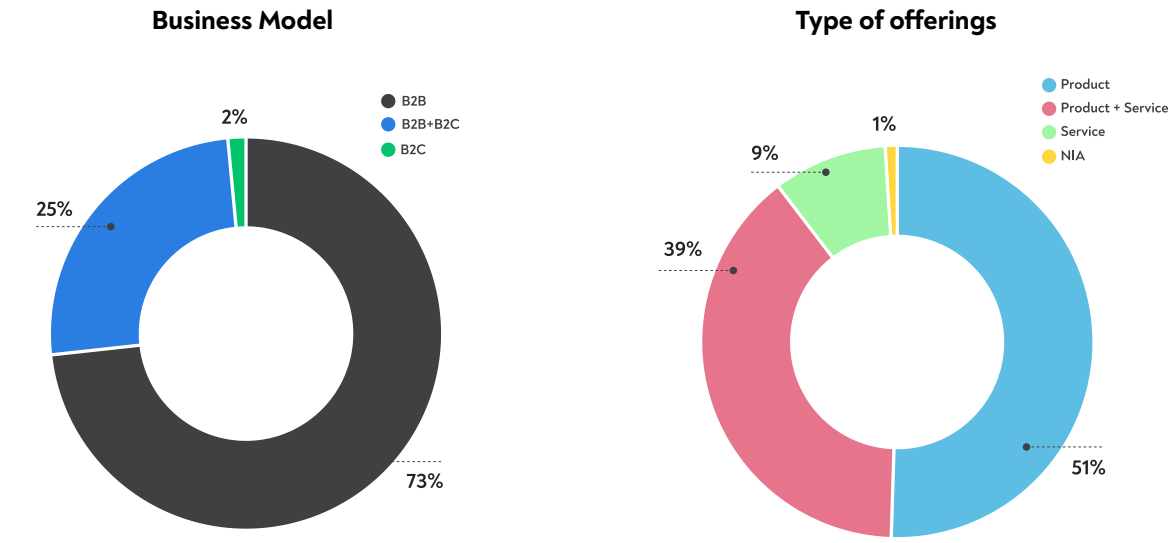


Figure 9: Business model and type of offering of biotechnology firms.

In terms of the nature of the business (Figure 10), 69% of the identified firms correspond to startups, while 32% were classified as spin-offs with recent ties to the institution they originated from.

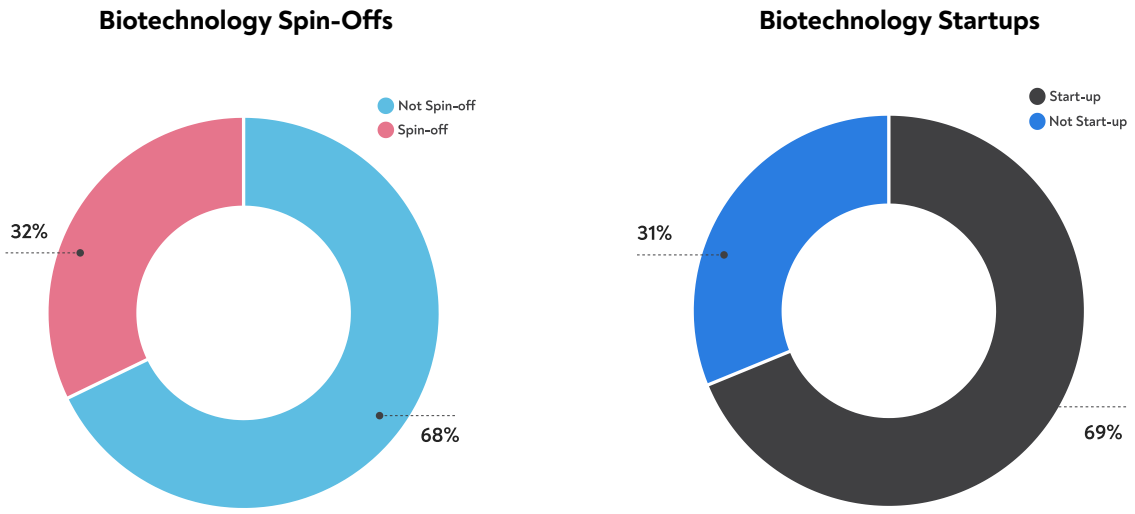


Figure 10: Classification of biotechnology firms as Startups and Spin-offs.

5.2. OTHER ECOSYSTEM ACTORS

As indicated at the beginning of this report, the Chilean biotechnology ecosystem is not composed solely of companies, but also of a network of institutions that play critical roles, such as universities, research centers, incubators, public agencies, and innovation hubs.

Adopting the SSI approach, and as previously defined in section 3.4, the actors of the biotechnology ecosystem were grouped according to their main functions in: knowledge, funding, commercialization, and trade associations.

This qualitative mapping, based on representative cases, is intended to illustrate the complexity and diversity of roles and interactions present in the ecosystem. It does not seek to achieve comprehensive coverage, but rather to highlight the main types of entities that constitute it. In this sense, the number of actors included in the characterization responds to the methodological approach applied, and should be interpreted as such.

A total of 247 institutions related to biotechnology were mapped according to the distribution shown in Figure 11. The analysis of these institutions allows the identification of gaps, overlaps and opportunities of articulation that may strengthen the national biotechnology ecosystem.

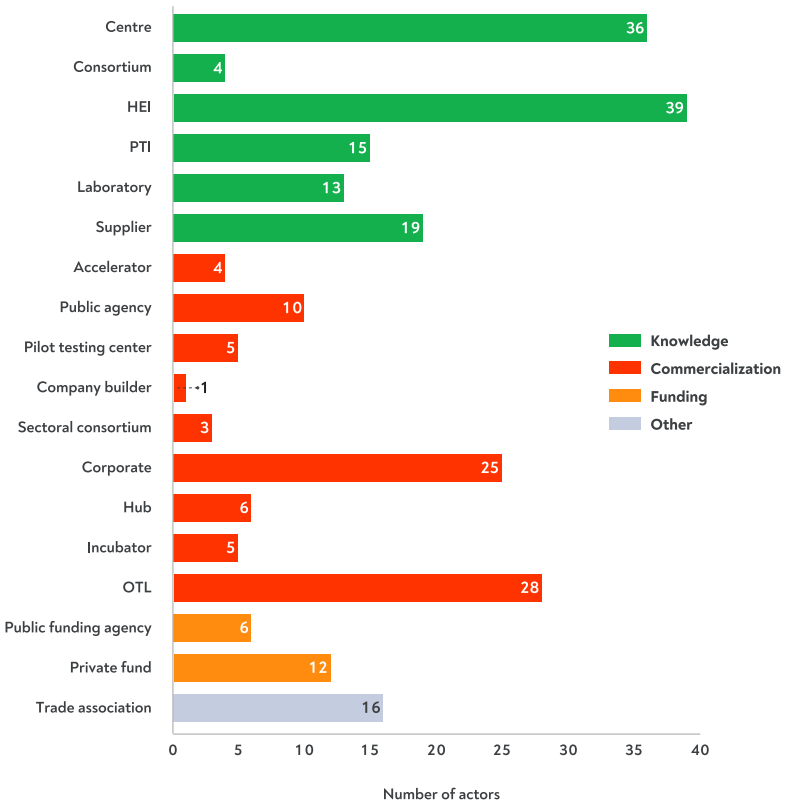


Figure 11: Distribution of actors according to dimension and subtype.

The 4 categories used to classify the actors of the biotechnology ecosystem are described below.

5.2.1. Knowledge

Knowledge actors are the central pillar in the creation of scientific capacities, talent development and technology transfer in biotechnology in Chile.

5.2.1.1. Institutions of Higher Education (HEIs)
The 39 HEIs linked to the biotechnology ecosystem have different degrees of development: universities with strong R&D capacity, technology transfer and generation of patents, institutions with intermediate capacities that combine academic training and significant scientific productivity, and those with a primarily teaching role and low technology transfer capacity, as well as universities whose connection is still incipient and have limited structures in biotechnology. Advanced capacities are concentrated in RM, Biobío, Valparaíso and La Araucanía.

5.2.1.2. Centers
The 36 centers identified in the study play a key role in strengthening scientific and technological capacities. Their profiles range from centers highly specialized in biotechnology, enabling infrastructure platforms for research, and centers that focus on health and biomedical applications, to those centers oriented toward productive sectors such as agroindustry, aquaculture and food, besides initiatives that integrate science, entrepreneurship, and technology transfer.

5.2.1.3. Public Technology Institutes (PTIs)
These institutes are fundamental in applied R&D and in technology transfer in strategic areas for the country, making contributions in technical standardization, public health, sectoral innovation, forestry and plant health, as well as contributing to connecting scientific research to national productive needs. A total of 15 PTIs were identified at the national level.

5.2.1.4. Suppliers
The 19 suppliers identified in the study contribute to the ecosystem by facilitating access to advanced technologies, specialized supplies, consultancies, and strategic services in areas such as molecular diagnostics, nanotechnology, certification, genetic conservation, environmental sustainability, and specialized distribution, acting as a critical support for research and development.

5.2.1.5. Laboratories
Laboratories offer advanced analytical and diagnostics services applicable to biotechnology, with capacities in molecular, microbiological and chemical analyses, and applications to human health, veterinary, aquaculture, precision oncology, environmental technologies and natural products, constituting a key infrastructure for the validation and scale-up of solutions. Of these, a total of 14 were identified in the study.

5.2.1.6. Consortia
Technological consortia manage collaborative R&D projects for the development of solutions for strategic sectors. Their purpose is to articulate scientific, technological, and productive capacities relative to common challenges, standing out in areas such as fruit growing, marine genomics, viticulture, traditional crops and territorial development, strengthening the articulation between science, industry and territory. In particular, 4 consortia were identified in this category.

5.2.2. Commercialization

The commercialization of biotechnology in Chile is articulated through multiple actors who facilitate the transition from research to market. Those that stand out among them are the centers for pilot testing and validation (5), which reduce the technical uncertainty and allow scale-up; university and regional incubators (5), which support early stage entrepreneurial activity; OTLs (28) and hubs (6), which serve as bridges between research and companies; and accelerators (4), and company builders (1), which provide strategic support and networks for internationalization. Additionally, there is a growing and noteworthy participation of corporate firms (25) and sectoral consortia (3) (in agroindustry, aquaculture, foods, forestry, mining, health, and circular economy) which validate and cofinance solutions, integrating science and production. Finally, a group of public institutions and regulatory agencies (10) fulfill critical functions in intellectual property, internationalization, certification, sanitary and environmental regulation, constituting a framework that enables the scale-up and adoption of biotechnological innovations.

5.2.3. Funding

Public agencies and services play a key role in early stages of biotechnological developments, promoting applied research, technology validation, and the connection with the market through subsidies and competitive instruments.

Noteworthy examples are the funds of ANID, CORFO, FIA and the decentralized funds of Regional Governments. On the other hand, funding of biotechnology in Chile has advanced towards a greater presence of private funds and venture capital, with 12 active funds that concentrate on the validation, scale-up and internationalization phases. There are three categories among them: funds specialized in biotechnology; funds from technological and scientific venture capital with a growing interest in biotechnological projects; and corporate and institutional funds that support open innovation and technology transfer.

5.2.4. Trade associations

The 16 trade associations are essential in the sectoral representation and in the articulation of productive interests, encouraging collaboration, technology transfer, and the public-private relationship. Their action covers different spheres closely related to biotechnology: in the agricultural and food industry sector they promote agricultural innovation, genetic improvement, and the adoption of bioproducts; in aquaculture they promote R&D and sustainability; in health and life sciences they strengthen the development of innovative drugs, biomedicine, and advanced diagnostics; in the sphere of research and technology transfer they facilitate the science-business connection; and in the industry and development of regions they articulate productive sectors with sustainable innovation and the circular economy.

06

Regional distribution and capabilities

A total of 449 actors were identified as part of the national biotechnology ecosystem, 250 (56%) of which are concentrated in the RM and 199 (44%) are distributed throughout the other regions.

In order to compare regions with different population sizes, the indicator Regional Density of Actors (RDA) was defined as the number of actors per 100,000 inhabitants. This indicator enables the assessment of the relative concentration of capabilities beyond absolute values: a high RDA suggests active networks and greater potential for coordination and articulation, whereas a low value reflects more fragile ecosystems. The analysis of RDA combined with regional policies and strategic sectors provides insights for identifying emerging poles and guide actions aimed at strengthening territorial development.

Table 3 summarizes the total number of actors identified, the regional populations (2024 Census), the RDA, and whether biotechnology has been recognized as an economic driver of development in the Regional Innovation Strategies (Estrategias de Innovación Regionales, EIR).

Table 3: Regional summary of total number of actors, population, regional density of actors, and recognition of biotechnology in the regional innovation strategies.

REGION	NUMBER OF ACTORS	REGIONAL POPULATION	REGIONAL DENSITY OF ACTORS	BIOTECHNOLOGY AS DRIVER OF DEVELOPMENT
Arica y Parinacota	5	244.569	2,04	Yes
Tarapacá	5	369.806	1,35	No
Antofagasta	10	635.416	1,57	Yes
Atacama	5	299.180	1,67	No
Coquimbo	7	832.864	0,84	No
Valparaíso	31	1.896.053	1,63	No
Metropolitana	250	7.400.741	3,38	No
O'Higgins	9	987.228	0,91	Yes
Maule	14	1.123.008	1,25	No
Ñuble	10	512.289	1,95	No
Biobío	39	1.613.059	2,42	Yes
La Araucanía	18	1.010.423	1,78	No
Los Ríos	12	398,230	3,01	No
Los Lagos	28	890.284	3,15	Yes
Aysén	1	100.745	0,99	No
Magallanes	5	166.537	3,00	Yes
NATIONAL TOTAL	**449**	**18.480.432**		

Figure 12 shows the regional distribution according to RDA, as well as the national average, equivalent to 1.93. Although the most populated regions are expected to concentrate more actors, some regions with less population have higher densities, indicating active and articulated ecosystems. Regions were organized in six groups according to this indicator: (i) hyperconnected hubs (RDA > 3.30); (ii) expanding poles (2.61 – 3.29); (iii) articulating hubs (2.27 – 2.60); (iv) emerging regions (1.60 – 2.26); (v) developing regions (1.26 – 1.50); and (vi) lagging regions (≤ 1.25).

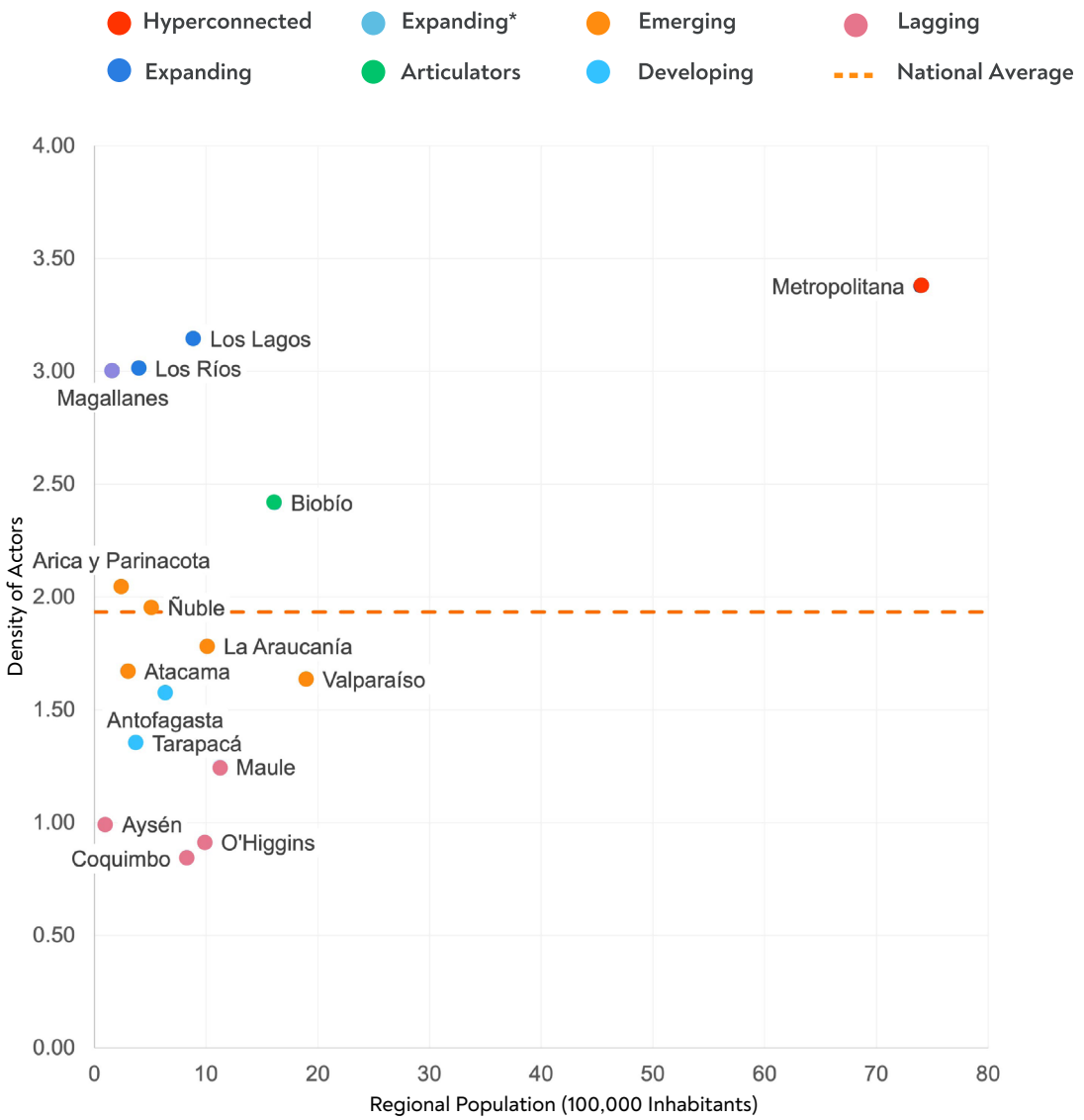


Figure 12: Regional distribution based on the Regional Density per Actor

The RM constitutes the only hyperconnected hub, with a RDA of 3.38, a value which is 75% higher than the national average. Thus, it is confirmed as the main hub of the ecosystem, both in absolute number and relative density, reflecting the historic centralization of the science and technology system. The challenge here is to avoid an excessive dependence on the capital Region while, at the same time, leveraging its role as an articulating platform to transfer capabilities to other regions.

Among the expanding poles, Los Lagos (3.15) and Los Ríos (3.01) stand out. In spite of their smaller population, they have developed active and specialized ecosystems. Los Lagos has consolidated its leadership in aquaculture, while Los Ríos leads in the agroforestry sector. Given their joint origins, both regions share similar productive bases. As a consequence of their complementarity and geographic proximity, the development of one also drives the other, strengthening the southern region as a strategic pole for national biotechnology.

Regarding Magallanes (3.00), its classification as an expanding pole is relative. Although it has a relatively small ecosystem, its high density facilitates articulation among local actors. As a remote southern region, it has fostered a tradition of collaboration across multiple sectors, both nationally and internationally, which represents an opportunity to further develop its role as a specialized node in Antarctic research and biotechnological applications derived from this unique environment.

The only articulating hub that was identified is the Biobío (2.42) which combines a high absolute number with a significant density. Its industrial background, the prominence of its universities and the proximity to forestry and manufacturing sectors reinforce its role as a strategic center in the center-south of the country, with the potential of interregional articulation.

The emerging regions are Arica y Parinacota (2.04), Ñuble (1.95), La Araucanía (1.78), Atacama (1.67), and Valparaíso (1.63), all with densities close to the national average. They are regions with growing ecosystems, still fragmented or with a low critical mass, but with strategic productive sectors, such as the agroindustry, agriculture, and mining sectors, which can propel their maturation. Two cases stand out in this group: Valparaíso, which, despite being the second most populated region in the country, has a density lower than average, reflecting the gap between its solid university base and its ties to industry; and Arica y Parinacota, which, despite its reduced number of actors, has a high relative density, positioning itself as an emerging region thanks to the desert agriculture and the development of climate resilient crops, with a global implications in food security.

The development regions are Antofagasta (1.57) and Tarapacá (1.35), which concentrate significant investments in technological innovation for mining, mainly in automation, digitalization and sustainability. However, biotechnology has been less present in these territories. Solutions like bioleaching, though recognized as a promising solution, have not yet reached large scale consolidation. Overcoming this gap would allow both regions to become an international reference for green and sustainable mining.

The last group of lagging regions encompasses Maule (1.25), Aysén (0.99), O'Higgins (0.91), and Coquimbo (0.84). These have critical densities and emerging ecosystems, still with low investment in innovation

and dependence on traditional agroproductive sectors. Part of this lag is due to recent developments in higher education and infrastructure, with milestones such as the creation of the public universities of O'Higgins and Aysén in 2015. Their main challenges are to reach critical mass, strengthen capacities, and consolidate ties to industry. Even so, there are opportunities in agroindustry (Maule and O'Higgins), aquaculture (Coquimbo), and sustainable production (Aysén).

On the other hand, only six regions have incorporated biotechnology into their development plans: Arica y Parinacota, Antofagasta, O'Higgins, Biobío, Los Lagos, and Magallanes. In some cases, policy and density are aligned (Los Lagos, Magallanes, and Biobío), whereas in others (O'Higgins and Antofagasta) it responds more to sectoral choices than to the maturity of the ecosystem. In contrast, regions with high densities, such as Los Ríos, lack explicit policies, which represents an opportunity to enhance their existing capacity. The recent CORFO call for proposals for the creation of the Technological Center of Biotechnology for Sustainability (Centro Tecnológico de Biotecnología para la Sostenibilidad) in Los Ríos points precisely in that direction. This center aims to equip the region with technological and research capabilities for the development of sustainable solutions of high added value.

This scenario reveals that the existence of regional policies does not always match the density of actors: in some territories they anticipate future ecosystem development whereas in others their absence limits taking advantage of local capacities.

Summarizing, a marked polarization is evident: a hyperconnected hub in the capital and southern expanding poles, together with intermediate regions with potential, and lagging regions with structural gaps. The challenge is to articulate interregional networks, diversify ties with productive sectors and strengthen the weaker regions with targeted policies. Taking advantage of these sectoral opportunities would make it possible to design differentiated and territorially pertinent strategies, accelerating the consolidation of the national biotechnology ecosystem.

6.1. THE ROLE OF THE DIVERSITY OF ACTORS IN THE EMERGENCE OF REGIONAL HUBS

In addition to examining the relative density of actors, it is essential to analyze the types of actors that constitute the regional ecosystems and how they interact with one another. It is not enough for a region to concentrate a significant number of institutions; what really determines its maturity is the diversity of roles present: knowledge actors (universities, research centers), transfer and commercialization institutions (OTLs, incubators, consortia), private capital, and biotechnology firms capable of taking science to the market.

Of the 449 actors identified in this study, 247 correspond to knowledge, commercialization, financing institutions, and trade associations. Of these, 77 (31%) are public. If this analysis is performed by region, it becomes apparent that the share of the public sector exceeds 40%, well above the RM (23%). These data suggest that, in regional areas, the public sector plays a proportionally more relevant role in sustaining biotechnological activity compared to the capital region, where the landscape is more balanced, with a strong presence of private actors. For the next regional analysis, public agencies (16)

and trade associations (16) that operate with a national scope were excluded, leaving a universe of 417 actors. Of these, 223 (54%) concentrate in the RM, whose composition is shown in Figure 13. This suggests that for every 10 biotechnology firms there are approximately 6 knowledge institutions, 4 linked to commercialization, and 1 dedicated to private financing. This diversity confirms that the RM constitutes a dynamic and attractive ecosystem, in which the interaction between the different types of actors drives business development in biotechnology.

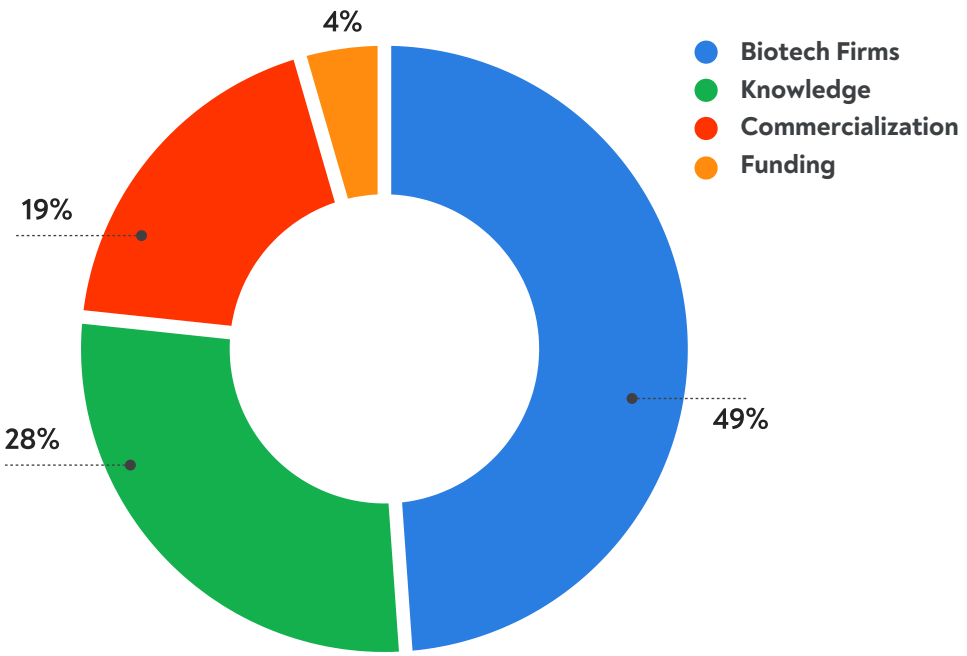


Figure 13: Distribution of actors in the RM.

The distribution of the 194 actors present in the 15 regions other than the RM (Figure 14) shows a positive relation between the number and diversity of actors and the number of biotechnology firms. That is, the greater the variety of institutions present in a territory, the greater the likelihood that new companies capable of transforming knowledge into products or services arise.

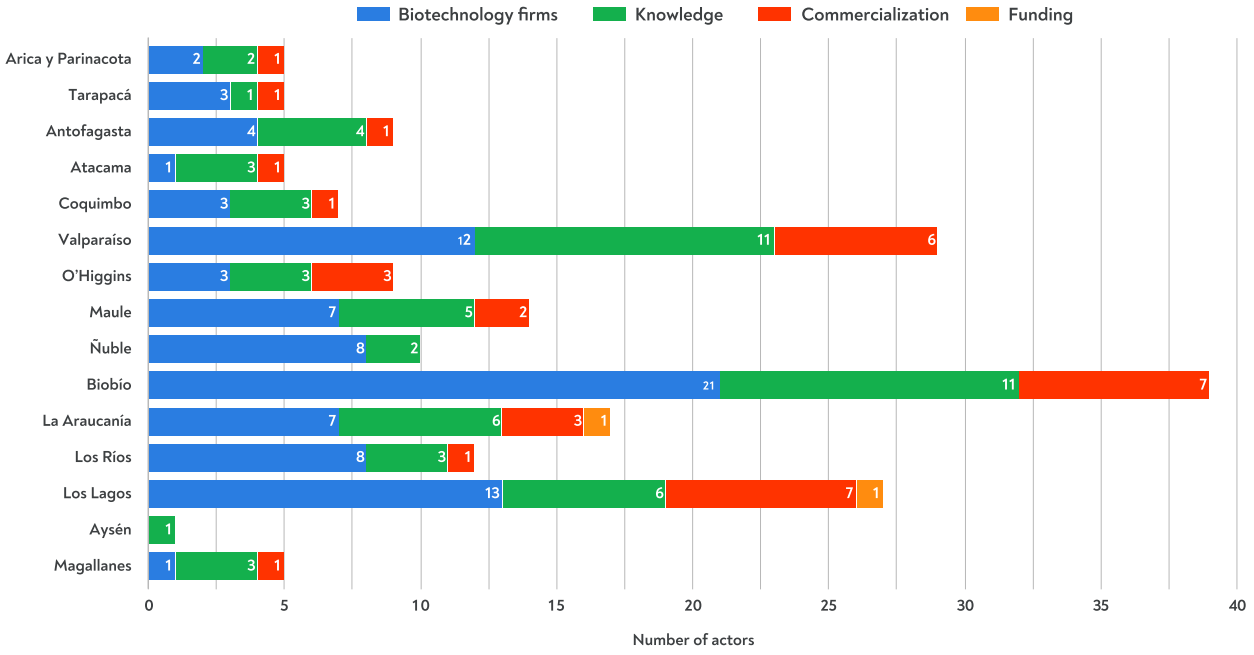


Figure 14: Regional distribution of actors.

In this intersection, Valparaíso, Biobío, and Los Lagos stand out as relevant poles, although with different profiles. From the point of view of the density (RDA), they fall under different categories (Valparaíso as an emerging region, Biobío as an articulating hub, and Los Lagos as an expanding pole), reflecting differences in their scale and level of consolidation. Nevertheless, regarding the diversity of actors, all three show that the interaction between knowledge institutions, commercialization mechanisms, and strategic productive environments creates favorable conditions for the emergence of regional ecosystems with growth potential.

This is in agreement with a prior study based on the quadruple helix, in which these regions had already been identified as emerging poles, precisely because of the convergence of academic capacities, ties to industry, and scenarios that are favorable for innovation. Thus, while the density explains the differences in scale among territories, the diversity of actors helps to understand why certain regions with intermediate densities such as Valparaíso, manage to project themselves as emerging poles, and why Biobío and Los Lagos have been able to move toward a more robust consolidation of the ecosystem.

Figures 15 and 16 confirm this interpretation by showing the regional diversity of actors of knowledge and commercialization, respectively. It can be seen that commercialization institutions, such as OTLs, consortia, or innovative corporate businesses, play a decisive role in ensuring that academic knowledge does not remain encapsulated in research, but rather translate into companies and applied solutions. In regions where these intermediaries are absent or are very weak, the ecosystem tends to be excessively academic, limiting its tech transfer capacity.

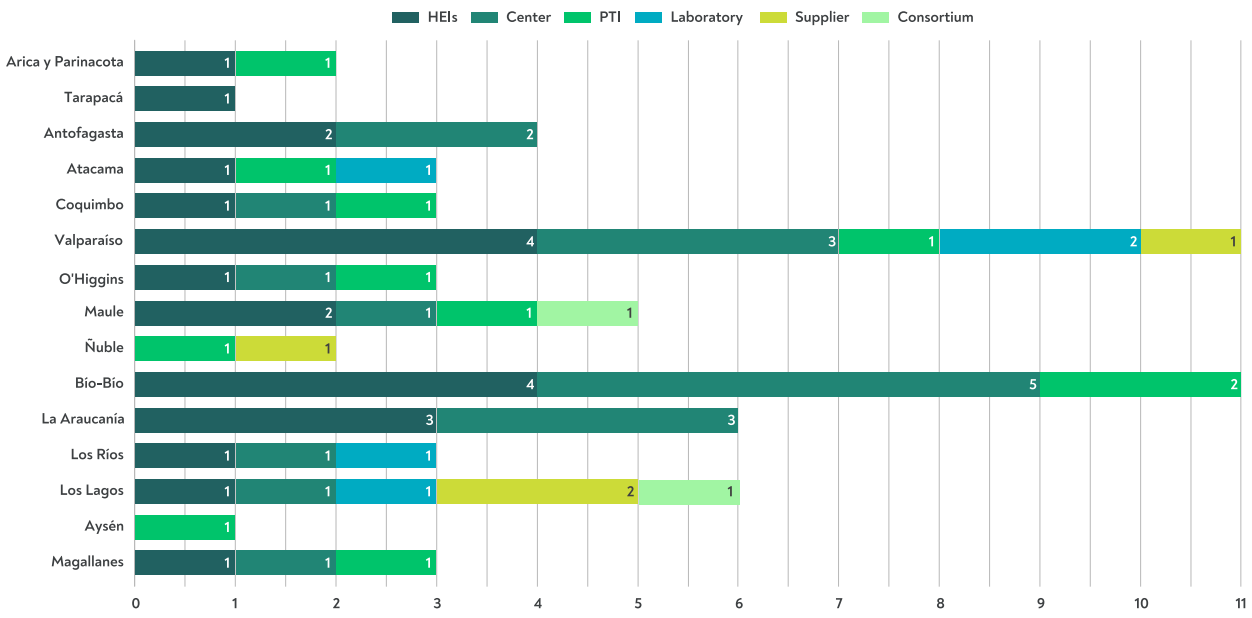


Figure 15: Regional breakdown of the types of actors identified in the knowledge group.

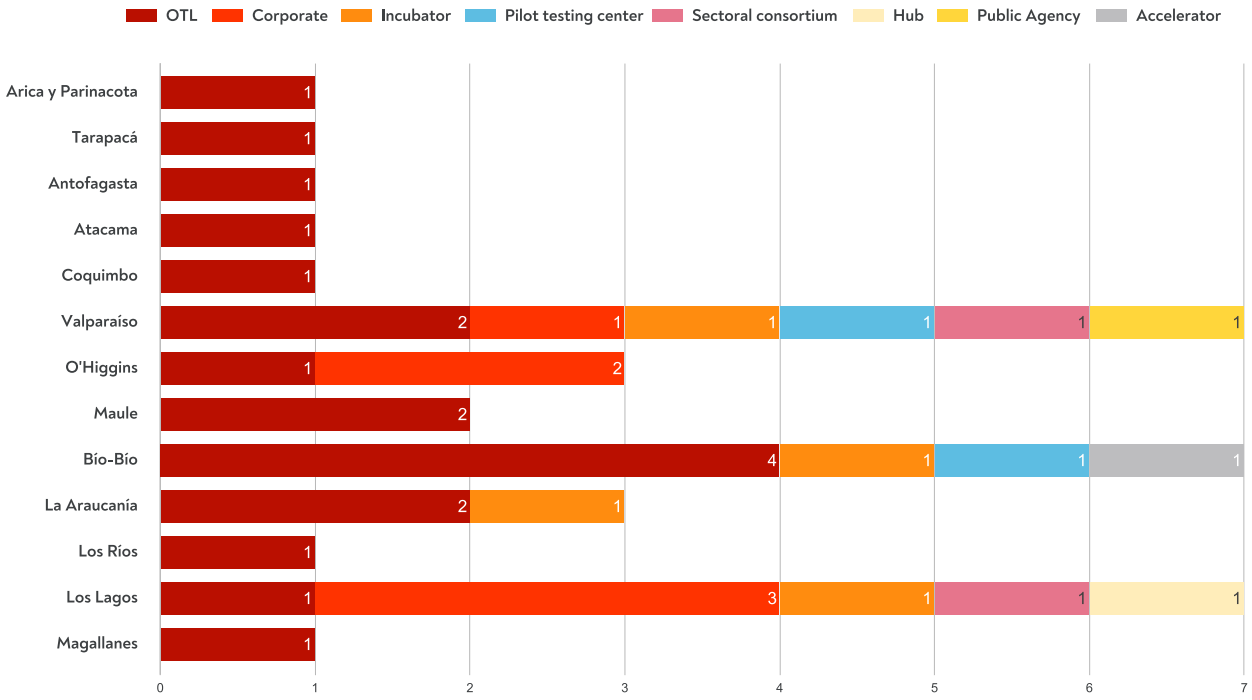


Figure 16: Regional breakdown of the types of actors identified in the commercialization group. The regions of Ñuble and Aysén do not appear as no actors of this group were identified.

Figures 17 and 18 are presented to reinforce the observation above. The graphs show the regional distribution of the number of biotechnology firms or private financing actors, respectively, indicating the proportions of knowledge and commercialization support actors that exist in each one.

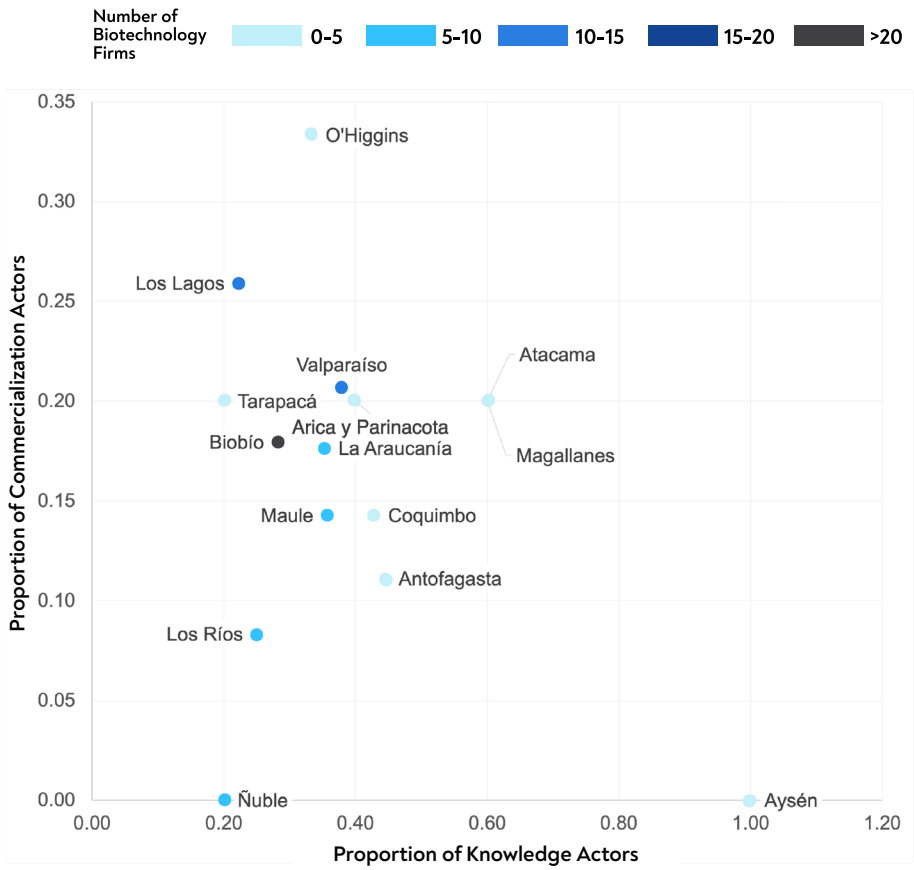


Figure 17: Regional distribution based on the proportion of knowledge and commercialization actors identifying the volume of biotechnology firms.

Figure 17 shows that, in general, when more than 40% of the actors are knowledge institutions, regions tend to be configured as "predominantly academic" ecosystems, with little connection to industry. On the other hand, when the proportion of commercialization actors increases, the number of biotechnology firms also grows. Examples such as Los Ríos and Maule which, in spite of having less than 15% of transfer actors have between 5 and 10 firms, show that even small groups of specialized intermediaries can generate significant impact on the creation of companies.

There are notable exceptions. In Ñuble, the presence of eight biotechnology firms is better explained by its proximity to Biobío and the emergence of university spin-offs (at least three identified) than by its own density or diversity. This shows that interregional articulation can compensate for local gaps and serve as a catalyst for growth. In contrast, O'Higgins is home to major corporations, but it also has a young university, and therefore less experienced technology transfer actors, which slows the maturation of the ecosystem. This is further compounded by its proximity to the RM, which may lead companies to prefer establishing their operations in the capital rather than in the region.

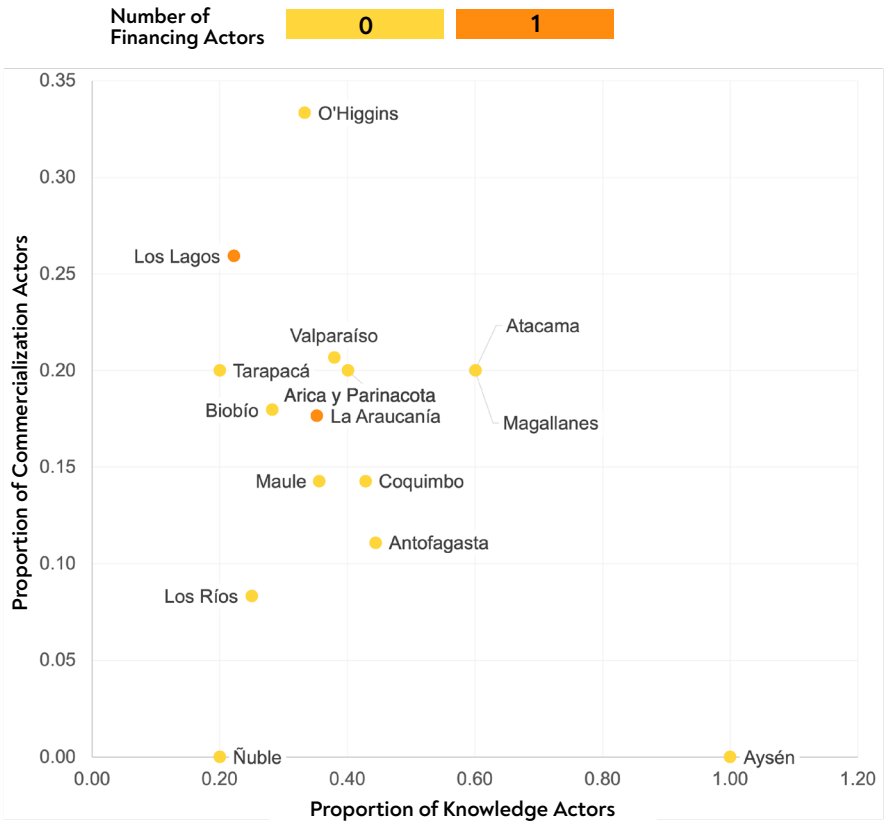


Figure 18: Regional distribution based on the proportion of knowledge and commercialization actors identifying the volume of financing actors.

The importance of private funding as a driver of development is shown in Figure 18. The case of Los Lagos is illustrative, as the presence of private capital has accelerated the growth of the ecosystem. In La Araucanía, there is the DevLabs Ventures venture capital fund, which, although mainly focused on software, shows the potential of this type of capital to support Deep Tech companies. Overall, while pu-

blic funding remains crucial for research and early stage development, it is private capital that enables progress in validation, scaling-up, and market entry, thereby reducing time and risk.

In terms of macrozones, in the north of the country the development of biotechnology is mostly lagging behind or at incipient stages, while from the central zone to the south, it shows greater progress. The sectoral analysis conducted with data of the Central Bank (Banco Central) regarding the contribution to GDP during 2024 by sectors potentially demanding biotechnology (Figure 19) helps to connect the diversity of actors with the economic sectors that provide application opportunities. In the north, mining remains the primary economic activity, although biotechnology has yet to gain a significant foothold. In contrast, from Valparaíso southward the agriculture and livestock, forestry, aquaculture, waste management, and manufacturing sectors predominate, where biotechnology finds a more fertile ground to develop.

This aligns with the application sectors in which biotechnology firms are focusing on (Figure 20), with those related to the agricultural, manufacturing, and aquaculture industries -along with a growing prominence of animal health in the south- being the ones that prevail. Thus, sectoral diversity acts as a resilience factor of the ecosystem, as it opens up multiple niches for application and innovation that support business growth across different productive environments.

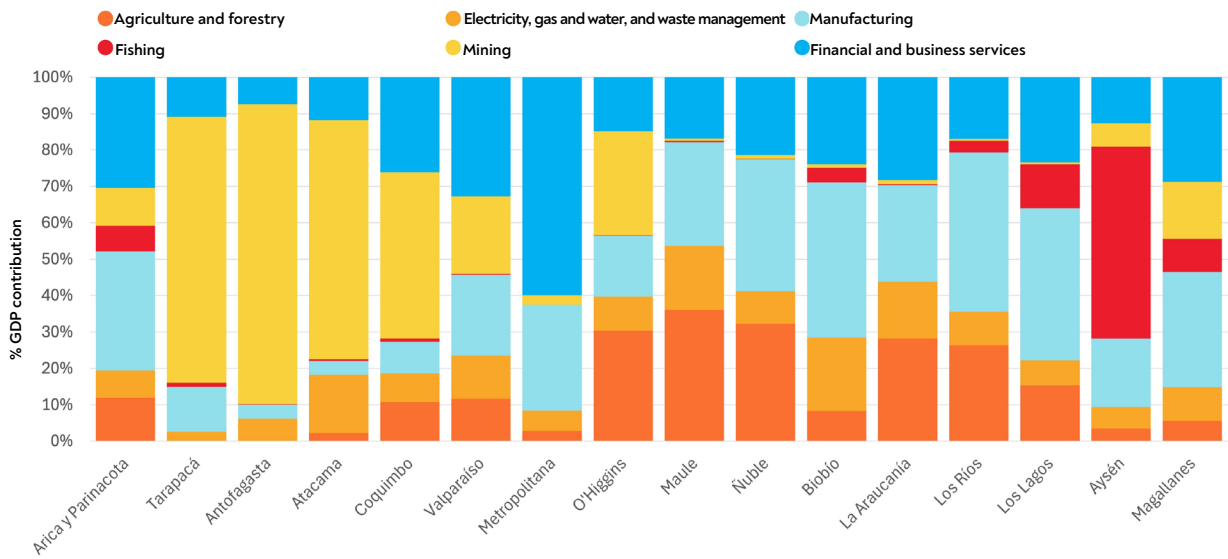


Figure 19: Contribution to the regional GDP of productive sectors in which biotechnology has potential.

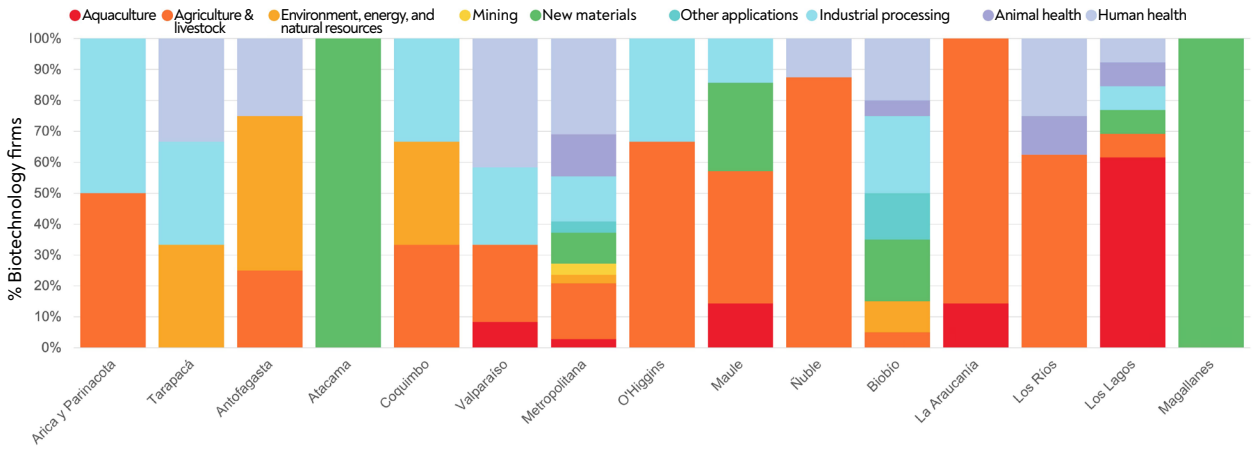


Figure 20: Regional application sectors for biotechnology firms. The region of Aysén does not appear as no biotechnology firms were identified in it.

Consequently, the regional analysis reveals three factors that explain the maturity of biotechnology ecosystems:

i. Density of actors, which reflects the critical mass and articulation capacity.
ii. Diversity of actors, which determines the potential for the creation of biotech firms and technology transfer.
iii. Regional policies, which enable or limit the use of local capacities.

The combination of these factors explains the polarization observed: a hyperconnected hub in the RM and expanding poles in southern Chile, in contrast to intermediate regions with potential and lagging territories with structural gaps. However, there are potential poles linked to sectors that have comparative advantages: desert agriculture in Arica y Parinacota, aquaculture in the south, agroindustry in the center-south, and green mining in the north. To capitalize on this potential, it is necessary to align regional and national policies, attract private financing, and strengthen technology transfer mechanisms.

The cases of Valparaíso, Biobío, and Los Lagos show that the convergence of academic capacities, transfer institutions, and private capital, can accelerate the consolidation of regional ecosystems. Instead, regions with a predominantly academic profile and poor connection to industry show that knowledge is unlikely to translate into productive impact when adequate mechanisms of transfer are lacking.

Biotechnology, given its collaborative nature, requires highly interdependent environments where science, businesses, funding, and regulation interact continuously. The strategic challenge is to transform this interdependency into solid and sustainable networks, capable of articulating regional capacities with productive sectors. It is only in this way that Chile may consolidate a competitive and resilient biotechnology ecosystem with global reach.



Dynamics and trends in the biotechnology ecosystem

The characterization presented above provides a quantitative view of the composition and distribution of the ecosystem, but understanding how it works requires an analysis of the interactions between actors. This is why a qualitative analysis based on in-depth interviews was carried out, which made it possible to examine how the actors of the ecosystem relate to each other and establish networks of collaboration, financing, and scale-up, and how they shape routes of innovation and technology transfer. Thus, there is a transition from a static snapshot to a dynamic set of links which define the evolution of biotechnology in Chile.

Table 4 summarizes the main dynamics and trends identified by actors, which are discussed in depth below.

Table 4: Dynamics, trends and gaps identified by type of actor in the national biotechnology ecosystem.

TYPE OF ACTOR	CRITICAL ASPECT	OBSERVED DYNAMICS	EMERGING TRENDS	GAPS
Biotechnology firms	Market strategies	• Intensive in internal or collaborative R&D. • Focused on solving problems of national strategic sectors (agro, health, aquaculture). • Coexistence of DBFs and non-DBFs.	• Growing number of biotechnology startups with B2B focus. • Rise of science-based solutions with export potential. • Growing interest in scale-up technologies in productive sectors.	• Difficulties to access infrastructure for pilot testing and/or production. • Scarce ties to companies with traction.
	Infrastructure and scale-up	• Outsourcing of production and validation abroad. • International expansion to attract specialized investment. • Early internationalization as a way to scale up.	• Growing demand for pilot testing and certified facilities. • Greater focus on scale-up in public policies (StartupLabs, Centro Tecnológico de Biotecnología).	• Insufficient infrastructure certified for production, more so outside of the RM. • High costs of access to installations and strong dependence on imported materials. • Difficulty to validate technologies in real or industrial environments.
	Relation with industry	• Limited interaction with companies that demand technology. • Emerging collaborations and alliances in chains having comparative advantages.	• Preference of the industry for previously validated technologies. • Greater interest in open innovation by established firms. • Gradual progress in the adoption of biotechnological solutions in key productive sectors. • Emerging access to environments of industrial validation.	• Difficulties to identify and access technology demand of the productive sector. • Lack of mechanisms and incentives for joint pilot testing. • Resistance to adopt emerging technologies in traditional sectors due to a poor culture of innovation and aversion to risk.

TYPE OF ACTOR	CRITICAL ASPECT	OBSERVED DYNAMICS	EMERGING TRENDS	GAPS
Knowledge	Knowledge and scientific capabilities	• Solid and advanced knowledge in basic research. • Key articulating role in technology transfer.	• Strategic development of emerging technologies. • Growing interest in connecting with productive challenges.	• Misaligned timelines and differing priorities with industry partners. • Limited access to specialized infrastructure due to administrative and operational difficulties. • Conflicts over IP.
	Training of talent	• Active role in providing solid technical and scientific training. • Uncoupling of academic training from needs of the industry.	• Interest in innovation, entrepreneurship and technology transfer training programs.	• Gap between academic training and needs of the industry. • Little experience in scaling up and in managing R&D.
Comercialització	Science-industry ties	• Predominance of specific relationships or those based on projects. • Cases of consortia and other articulating intermediaries. • Growing participation of OTLs, but with unequal capacities.	• Greater interest in open innovation and intersectoral collaboration. • Appreciation of the role of technological articulators. • Increase in the industrial perspective in young researchers.	• Shortage of platforms connecting supply and demand for technology. • Mistrust and misalignment among actors. • Difficulties in establishing sustainable science-industry agreements.
	Entrepreneurial support services	• Keys to validate business models and strengthen entrepreneurial capabilities. • Emerging programs of open innovation and venture capital for technology validation.	• Interest in specializing services for biotechnology. • Greater connection with funds and investors. • Growing appreciation of models such as venture client to validate technologies in real environments.	• Uneven and centralized supply that does not cover all stages of the development. • Low articulation with scale-up and validation instruments. • Weak training and counseling in IP. • Corporate programs not in line with the entrepreneurial ecosystem.
	Regulation and institutionality	• Key for commercial viability and access to financing. • Its interpretation requires technical support or specialized counseling. • Regulatory uncertainty that discourages investment.	• Acknowledgement of the topic in public agendas. • Emerging initiatives to modernize regulatory frameworks. • Interest in establishing instances for dialog between multiple actors.	• Fragmented regulatory frameworks, outdated and scattered across multiple entities. • Long and costly processes. • Lack of regulatory knowledge among entrepreneurs and scarce offer in specialized training.

TYPE OF ACTOR	CRITICAL ASPECT	OBSERVED DYNAMICS	EMERGING TRENDS	GAPS
Funding	Diversification of private actors	• Predominance of public funds in early stages. • Limited funding alternatives in intermediate phases. • Difficulties to raise private investment, while preference for technologies with fast returns persist.	• Emerging interest in specialized venture capital. • Greater participation of angel investors. • Emerging initiatives of corporate venture capital, although still very limited.	• Funding gap for validation and scale-up. • Few instruments adapted to technologies of high uncertainty. • Scarce articulation between funding sources. • Lack of capacities to assess Deep Tech (biotech) projects.
Regional ecosystems	Diversity and density of the ecosystem	• High concentration in the RM. • Greater diversity and number of actors reveal regions with greater development. • Ecosystems advance where knowledge, funding and ties to industry coexist. • High specialization in certain regions (e.g. aquaculture in Los Lagos).	• Recognition of regional ecosystems as drivers of development. • Regional nodes act as territorial catalysts, spreading capacities to adjacent regions. • Increase in regional interactions (e.g. Los Lagos, Biobío, and Maule). • Consolidation of regional nodes with critical capacities.	• Ecosystems continue to be fragmented. • Low number of articulating actors. • Lack of systemic vision that takes advantage of local capacities.

7.1. THE EMERGING CONSOLIDATION OF BIOTECHNOLOGY FIRMS IN AN ECOSYSTEM UNDERGOING TRANSFORMATION

7.1.1. Dedication to biotechnology and market strategies

In the analyzed cases, Chilean biotechnology firms are highly intensive in knowledge and innovative. These firms base their business strategy on the development of internal R&D activities (in some cases in collaboration with or with ties to local science and technology organizations), based on the constitution of teams having high academic training and oriented to the development of technologies that are globally novel.

Table 5 below presents a characterization of both biotechnology firms dedicated entirely to biotechnological activities (DBFs) and of those that conduct biotechnological activities as part of other activities (non-DBFs).

Table 5: Characterization of DBF and non-DBF companies

CATEGORY	DBF	NON-DBF
Focus of activity	Exclusively biotechnology.	Biotechnology as a tool or line of work within a broader portfolio.
Origin	Researchers with scientific developments (supply) or by professionals with sectoral experience (demand).	Established firms that incorporate biotechnology responding to specific opportunities.
Business model	Biotechnology startup.	Development of products in established markets.
Age and size	Generally young and small.	Larger in age and size, with greater capacity installed.
Funding	Initially public funds, then venture capital.	Self funding (internal cash flow or reinvestment).
Maturity	In early stages, validating technologies or starting commercialization.	Established firms with proven track record.
Initial infrastructure	Shared space (co-work space, university incubators).	Developed own infrastructure.
Intellectual property (IP)	High appropriability through patents or industrial secrets, key part of the business.	Less emphasis in formal IP, centered in operational capacity and practical solutions.
Competitive advantage	Technological innovation, solving global problems, intellectual property.	Flexibility, customization, knowledge of the local client.
Ties to academia	Frequently originated in academic environments, although not always as formal spin-offs.	Fewer direct ties to universities.
Examples	Neocrop Technologies	Veterquímica

7.1.2. Access and barriers to critical assets of infrastructure and equipment

One of the main barriers for the scale-up of biotechnology firms in Chile is the limited availability of adequate and certified infrastructure for validation, and production. This scarcity has forced many startups to externalize their production abroad, mainly in the United States and Europe, which, in spite of accelerating validation processes, increases costs and generates external dependency.

Faced with this scenario, some companies have chosen to establish a presence in international markets as a growth strategy, taking advantage of the access to specialized investors and better production conditions. Another option that has proved to be effective is the incorporation of strategic investors, who provide not only financing but also knowledge of the sector and networks, thus enabling the construction of their own facilities and the advancement of certification processes.

These strategies, although effective in certain cases, make evident the need to generate local conditions that are more favorable for the development of productive capacities, especially outside the RM, where new regional dynamics of innovation and scale-up could be implemented. In June 2025, CORFO launched a call for proposals for the Regional StartupLabs initiative (StartupLabs Regionales), which will fund a collaborative physical or digital space with technologies and programs specialized in advancing growth and scale-up of science- and technology-based firms, connecting them with stakeholders in the national and international innovation ecosystem. Results are expected to be announced in October of this year, when it will be known if any initiatives focused on biotechnology will receive funding.

7.1.3. The opportunity to innovate in activities of natural resources

A fundamental aspect in the development of biotechnology in Chile is its ties to consolidated productive sectors, particularly those in which the country has comparative advantages: aquaculture, agriculture, food, livestock, and mining. Biotechnology companies, both DBFs and non-DBFs, have started to insert themselves in these chains as providers of technological solutions oriented to sustainability, efficiency and health, generating innovative products and services which have global scale-up potential.

This insertion represents a concrete opportunity to accelerate applied innovation from the national biotechnology ecosystem. Solutions such as agricultural bioproducts, high-throughput sequencing for salmon diagnostics or insect proteins for animal nutrition respond not only to local challenges, but also enable production methods that are more sustainable, healthier and with high potential for global scale-up. In this context, the proximity to world-class corporate firms that operate in Chile becomes a strategic advantage, because it allows validating, adapting and showcasing these technologies in real environments before their internationalization.

However, this relationship is not without difficulties. In the first place, many biotechnology firms face barriers to identifying concrete opportunities for collaboration due to the low visibility of technological needs of corporate firms. This disconnection deepens in the case of entrepreneurial initiatives originated in the academic world which often lack networks or knowledge of the productive environment.

Secondly, there is a low innovation culture in several corporate sectors where traditional operating models and strong aversion to risk predominate. This translates into preference for technologies that are already validated, and reluctance to experiment with emerging solutions, which limits the space for testing and learning together with local startups.

Despite this, there are positive experiences in supply chains, such as in the agri-food sector where some corporate firms have begun to facilitate validation spaces such as laboratories, experimental fields, or pilot lines, which allow testing technologies in real-world conditions. These collaborations, often mediated by open innovation programs, incubators or public funds, represent opportunities that are valuable to iterate, adapt solutions to specific needs, and diminish the technical and commercial uncertainty. Overall, they contribute to strengthening the relationship between the supply of technology and the industry, and to accelerate the adoption of new solutions.

7.2. THE ROLE OF UNIVERSITIES AND RESEARCH CENTERS IN THE BIOTECHNOLOGY ECOSYSTEM

7.2.1. Advanced scientific capabilities with potential for industrial impact

Universities and research centers play a strategic role in the Chilean biotechnology ecosystem, contributing both in training specialized talent and in the comprehensive development of scientific, technological, and business capabilities.

Their main activity focuses on basic research, aimed at expanding scientific knowledge in highly specialized areas such as advanced microbiology, molecular genetics, cell biology, bioinformatics, among others. Although initially these investigations do not seek immediate commercial applications, they establish a solid foundation for the development of emerging technologies that allow organizations to strategically anticipate future demands that have not yet been clearly defined by the market.

Despite this fundamental contribution, there is a relevant disconnection between the academic timing and approaches and the immediate needs of the industrial sector, which usually seeks fast, specific, and concrete solutions. Even so, there are successful collaborations in specific sectors such as animal health, in the joint development of vaccines, or in agricultural biotechnology through the creation and validation of microbial biostimulants. In these instances of collaboration, specialized researchers and private companies interact directly to solve specific problems. Nevertheless, important barriers persist, such as administrative restrictions, limited access to specialized technological infrastructure and problems of maintenance of equipment, as well as recurring conflicts related to intellectual property. These factors hinder effective collaboration, leading biotechnology firms to develop their own internal capacities and intellectual property strategies. This preference for autonomous mechanisms responds to the need to safeguard developments in times and conditions more in accordance with the demands of the productive environment.

7.2.2. New training approaches to promote market impact

In the field of human capital development, these institutions are fundamental in preparing advanced students and researchers who actively participate

in strategic projects in collaboration with industry, validating technological solutions in real-world contexts. However, a significant gap identified in the current dynamics of the ecosystem is the limited integration of innovation, entrepreneurial, and technology transfer capacities early on in educational programs. This shortcoming negatively affects the ability of scientific and technological talent to develop sustainable and competitive business initiatives in the long term. To overcome this situation, it is essential to implement educational programs that integrate scientific and technological skills with practical knowledge on business and management from initial stages, facilitating a more agile and effective transfer from academia to the market.

To consolidate the academic role within the national biotechnology ecosystem, it is vital to ensure a strategic and balanced integration of academic, scientific, and business perspectives. This requires advancing institutional and cultural frameworks that maintain a dynamic balance between strong basic knowledge generation and the agile development of partnerships aligned with evolving market needs.

7.3. APPROACHING THE MARKET AS A CRITICAL LINK IN THE BIOTECHNOLOGY ECOSYSTEM

7.3.1. From applied research to the productive market

One of the critical aspects of the Chilean biotechnology ecosystem is the still emerging link between the scientific world and the productive sector, particularly in regards to the transfer and commercialization of R&D results. Although the country has universities and research centers that generate high-level knowledge and international recognition, a great part of these developments fail to translate into concrete solutions for the market.

The dominant dynamic has been that of isolated relationships between researchers and companies, often linked to grant-based projects or specific collaborations. Although valuable, these interactions have not yet consolidated into stable platforms or institutional mechanisms that scale up towards systematic processes of technological codevelopment, licensing or validation.

However, there is an emerging shift towards more structured models of interaction, where different actors start to recognize the strategic value of having specialized technological intermediaries. In this context, the Offices of Transfer and Licensing (OTLs) have been taking center stage in the identification, protection and valorization of IP, and in supporting researchers to transform scientific results into commercial opportunities. In addition, entities such as the CBT have started to play an articulating role between scientific supply and productive demand, facilitating access to validation networks, infrastructure, and services that support scale-up.

A concrete example of this type of collaboration is the Biofrutales Technology Consortium (Consorcio Tecnológico Biofrutales), which has managed to link universities, research centers, and companies of the fruit sector in the development of new varieties applying biotechnology tools, combining scientific capacities with clear productive goals and with international commercialization potential.

Despite these advances, there still are structural gaps that limit the impact of these initiatives. Althou-

gh there is a growing interest of young researchers to steer their developments towards challenges of the productive environment, they often lack the adequate tools, training and support required for it. The OTLs, key in this process, continue to face limitations in technical specialization in biotechnology, a discipline that demands deep knowledge, technological risk management and long maturation times. Furthermore, the misalignment of timelines, language and goals of universities and corporate firms persist, which makes it difficult to form lasting partnerships. Added to this is the scarcity of sustainable platforms that continuously connect technological offerings with the real demands of industry.

It is essential to overcome these gaps to strengthen the commercialization of biotechnological technologies, especially in a scenario where startups with a scientific base need to validate their developments, protect their IP and connect with strategic partners. A more robust and systemic science-industry link will not only allow to accelerate the time it takes for solutions to reach the market, but also promote the creation of new innovative startups, facilitate entry into regulated markets and amplify the economic and social impact of the knowledge generated in Chile.

7.3.2. The challenges of growing without the support of a fully articulated ecosystem

The development of biotechnology startups in Chile has been strongly influenced by the access to services that support entrepreneurship, such as incubators, accelerators and mentoring programs. These instances have been key to facilitate initial funding, networks, specialized mentoring, and opportunities for internationalization. These experiences have allowed to validate business models, adjust strategies and strengthen management capacities. However, there is a perception that the current initiatives are uneven and do not always respond to the different stages of the projects.

Training also appears as a recurring theme. Many entrepreneurs acknowledge that they face complex challenges that require expertise in areas such as financing, commercial strategy, product development and team management. Although training instances exist, they do not always respond to the actual needs of the ecosystem nor do they adapt to the different maturity phases of the enterprise.

Laboratories and pilot testing spaces are fundamental resources for scale-up and technology validation, but their availability is limited, especially outside of the RM. This forces regional businesses to look for alternatives outside of their territories, generating additional costs and logistical barriers that may affect their development. Likewise, many of these spaces are oriented to academic research, which makes their use for commercial purposes difficult. This lack of adequate infrastructure, together with poor coordination with accelerators and financing funds, generates gaps in the development chain. Entrepreneurs often manage to have access to funds for prototyping but then do not find where to validate those developments.

Regarding the relationship with corporate firms, an ambivalent dynamic is observed. On the one hand, these relationships can provide access to markets, technology validation in real-world conditions and direct feedback from relevant users. However, in practice, many startups face structural barriers that hinder collaboration. As previously indicated, the differences in timing, priorities and contractual con-

ditions generate complex dynamics. Although some companies support open innovation programs, they are not always designed with a thorough understanding of the needs and limitations of entrepreneurs. This is why some prefer agreements that allow them to maintain their autonomy. Nevertheless, models such as the venture client, in which startups do pilot testing directly in corporate operations, are valued when commitments and incentives are clear.

Finally, the protection of IP continues to be a weak and often neglected area. In spite of the highly innovative component of the products and services developed, many entrepreneurs lack information, support or resources to protect their developments, being exposed to competitive risks and this affects the sustainability of their innovations.

7.3.3. Regulation as a brake or driver of biotechnological development in strategic sectors

In the field of biotechnology, regulation plays a decisive role for the commercial viability and access to funding. In sectors such as biomedicine, agricultural bioproducts or animal health, the regulatory requirements can become a significant barrier. Obtaining certifications, preclinical assessments or field tests is essential, but it also implies high costs and complex processes. In biomedicine for instance, studies can last years, delaying products from reaching the market.

Regulatory uncertainty also discourages investment. The lack of predictability, frequent changes in regulations and the absence of policies that articulate regulation and innovation increase the risk for investors and make access to funding difficult. In turn, the lack of incentives to comply with regulations reduces profitability and limits business growth.

Given this scenario, different actors of the ecosystem propose measures to facilitate regulatory compliance. One of the most recurrent is the creation of mechanisms of early consultation that would allow entrepreneurs to receive guidance in regulatory matters before they finalize their developments, preventing investments in non-approvable solutions. It is also suggested setting up working groups involving startups, regulators, and industry stakeholders to anticipate potential barriers and streamline processes without compromising regulatory standards.

Another critical problem is the dispersion of regulatory information across multiple agencies and documents, which makes its understanding and access difficult, especially for those having no prior experience. It is for this reason that the need to consolidate and systematize regulatory information is presented, in addition to implementing training programs for startups facing certification or approval processes.

Finally, strengthening collaboration networks among startups, regulators and academia is proposed as a way to integrate regulation into innovation processes. This approach would build an environment that is more predictable, accessible and aligned with the development of new technologies, closing the gap between science, regulation and market.

7.4. FUNDING BIOTECHNOLOGY IN CHILE: RELEVANCE OF PUBLIC FUNDS AND THE VENTURE CAPITAL INDUSTRY

The development of biotechnology startups in Chile has been driven mainly by public funds, especially in early stages of applied research and validation of concepts. Instruments such as Startup Ciencia, FONDEF

(both from ANID) and Crea y Valida (from CORFO) have been key to financing prototypes, scientific tests and talent recruitment. Although poles have emerged outside of the RM—such as Los Ríos, Maule, Antofagasta, and Los Lagos—a gap persists in the access to instruments and capacities for technological scale-up in regions.

Additionally, it is noted that the current funds are designed to support the R&D stage, facilitating the validation of scientific hypotheses and progress in proof-of-concept tests; however, they do not always adjust to the particularities of biotechnology and its market application, which involve long, costly development cycles and require specialized infrastructure. This is especially critical in areas such as precision fermentation or synthetic biology, where the lack of networks and equipment forces many startups to seek international support.

Regarding private funding, even though the interest of the venture capital industry in biotechnology has grown, barriers remain due to long payback periods and the need for robust validations. Some venture capital funds have begun exploring investments in Deep Tech, but they are still the exception. To access capital, several Chilean startups have resorted to international accelerators and programs specialized in biotechnology; some have participated in accelerators such as The Ganesha Lab, Rockstart (Denmark), and other programs in the US.

On the other hand, there has been an increase in corporate investment, with established firms investing in startups to accelerate technology adoption, providing not only funding but also commercial validation. Nevertheless, the availability of funds specialized in biotechnology remains limited, and many startups must compete with other technological sectors for resources. Some actors have started to explore internal models of corporate venture capital, although these initiatives are still emerging. Overall, the challenges to attract private investment are still high, and the lack of local experience in biotechnology represents a significant barrier to the sector's growth.

7.5. ACTIVATION OF REGIONAL ECOSYSTEMS

The development of the biotechnology ecosystem in Chile, beyond the historical concentration in RM, opens up opportunities for the creation of regional hubs capable of mobilizing local resources and generating their own innovation routes. In this setting, the concept of innovation milieu, understood as a socioeconomic environment in which the geographic proximity favors constant interactions between universities, enterprises, technological centers, governments and communities, becomes useful. These environments, upon promoting collaboration, trust, and shared learning, facilitate the transformation of knowledge into technological solutions and new businesses.

Currently, the biotechnology ecosystem has a heterogeneous configuration, marked by the strong concentration in the RM. This centralization has allowed the consolidation of scientific, financial and articulation capacities, but at the same time it generates dependency and limits the maturation of regional ecosystems which lack their own critical mass.

However, a tendency to recognize regional ecosystems as drivers of development has become apparent in recent years. There has been an increase in the creation of biotechnology firms and collaborative projects where ties between universities, businesses, and articulators have strengthened. This greater

density of relationships has allowed the consolidation of hubs with critical capacities, capable of energizing their own territories and diffusing learning and opportunities to less developed neighboring regions.

The cases of Los Lagos, Biobío and Valparaíso are illustrative. Los Lagos has started to consolidate a milieu around aquaculture, based on a critical mass of private companies. Biobío combines a robust academic network with a diversified industrial base in sectors such as forestry and agroindustry, although it still needs to strengthen the interaction between them in order to fully consolidate. As for Valparaíso, it has relevant scientific capacities, but faces the challenge of connecting its research more effectively with the local industry. These experiences show that the specialization of sectors linked to natural resources can become a strategic advantage if they are upgraded through biotechnology.

Nevertheless, structural gaps that limit the full activation of these ecosystems persist. In several territories fragmentation is still high and the critical mass of actors is insufficient to sustain innovation processes continuously. Added to this is the scarcity of specialized intermediaries, which weakens the connection between knowledge and industry. Finally, a shared systemic vision that aligns regional and national efforts under a strategy that is coherent with the particularities of each territory is still lacking.



Challenges and opportunities for scaling up and articulating the ecosystem

A summary of the main challenges and opportunities drawn from interviews and secondary information is presented below (Table 6). The analysis is organized in terms of the key actors that make up the ecosystem—biotechnology firms, institutions that generate knowledge, financing agents, and entities involved in commercialization and articulation—with the purpose of visualizing the factors that limit the scaling up of biotechnology in the country, as well as the strategic opportunities that currently exist and which could be used to strengthen its development.

This diagnosis seeks to contribute concrete inputs for the design of policies, programs, and mechanisms that promote an agenda of biotechnological innovation that is more integrated, sustainable, and impact-oriented.

Table 6: Current challenges and opportunities for the scaling up and articulation of the ecosystem.

TYPE OF ACTOR	CHALLENGES	OPPORTUNITIES
Biotechnology firms	• Limitations of access to infrastructure and equipment for pilot testing or production, particularly in regions. • Low availability of certified centers (GMP or other), limiting international competitiveness. • High cost of setting up own laboratories and dependency on imported materials due to lack of local suppliers. • Limited continuity in relationships with large companies: fragile ties and asymmetrical negotiations. • nsufficient dissemination of industrial challenges makes it difficult to align the technology supply with specific and relevant demands. • Lack of an industrial culture of technological collaboration and incentives for joint pilot testing limit the validation of biotechnological solutions in real-world environments.	• Growing demand for biotechnological solutions in sectors such as food, agriculture, and health, driven by the need for sustainability and the pressure to innovate in competitive markets. • Strategic value of Chile as a natural laboratory for validation under real-world conditions with diverse climates. • Existence of public instruments for early funding that have facilitated the development of prototypes and products.
Knowledge	• Disarticulation with productive demand. • Limited talent with practical experience in production, scale-up, or regulatory compliance. • Low orientation towards effective technology transfer and poor response to market needs.	• Accumulation of academic capabilities in key areas. • Availability to articulate regional ecosystems based on knowledge nodes in local productive sectors. • Growing interest among researchers in generating solutions with market impact.

TYPE OF ACTOR	CHALLENGES	OPPORTUNITIES
Commercialization	• Lack of effective and sustained mechanisms to connect technology supply with productive demand. • Absence of formal structures that facilitate pilot testing and closing collaborative agreements. • Corporate programs misaligned with the entrepreneurial ecosystem. • Low integration between scale-up and validation instruments that limit the continuity of developments from the laboratory to the production environment. • Weak training and limited specialized counseling in IP management affecting competitiveness and international projection. • Slow, unclear regulatory procedures that are not in line with the pace of innovation. • Obsolete, confusing, or non-existent regulations for new technologies generate legal and commercial uncertainty.	• Chile as an attractive pilot market for scalable innovation. • Increasing emergence of intermediaries that connect science, industry, and the market. • Potential to consolidate regional and international networks that attract investment and collaboration. • Willingness to create instances of dialogue between multiple actors that enable the updating and the establishment of regulatory frameworks in biotechnology.
Funding	• Little sophistication in the use of public funding, centered more in technological development than in business sustainability. • Limited private capital available for scale-up. • Weak supply of suitable instruments and lack of technical capabilities to assess highly uncertain biotechnology projects.	• Public instruments such as Startup Ciencia or doctoral scholarships have revitalized the ecosystem. • Emerging interest among investors in biotechnology applied to strategic sectors.

8.1. GEOGRAPHIC RELEVANCE: THE CREATION OF REGIONAL HUBS

The future of biotechnology in Chile depends largely on its ability to create and consolidate regional hubs that transcend the historical centralization in the RM. These hubs would not only decentralize capabilities but also activate innovation poles with their own distinct identities, capable of further developing strategic sectors based on natural resources and integrating them into national and international value chains.

One of the main challenges resides in technological scale-up and pilot testing, which is limited outside of the RM because of lack of infrastructure, elevated costs, and restricted access to validation networks. This situation has caused internal migration to the capital region and even emigration abroad, generating talent exodus and weakening regional potential. Hence, it is necessary to generate enabling conditions in the territories: critical infrastructure, access to private funding, differentiated policies, and stable institutional environments that diminish the uncertainty of entrepreneurs.

In parallel, there are clear opportunities to confer sophistication to sectors that are intensive in natural resources, which can become biotechnological innovation platforms. The experience collected from

surveys highlights the potential of emerging regions. In Maule, opportunities are identified that are related to regenerative agriculture and sustainable animal nutrition, provided a fluid interaction between companies, universities and technological centers is fostered. In La Araucanía, agricultural biotechnology appears as a route of specialization if the collaboration networks that allow adapting solutions to local needs are strengthened. Los Lagos has already taken steps towards an innovation milieu in aquaculture, with the Patagonia Biotech Hub as an example of how infrastructure and the concentration of actors can catalyze technology transfer and product scale-up for this and other industries.

The remote regions of the country pose a paradox. Magallanes, Aysén, Atacama, and Arica y Parinacota lack biotechnology firms due to distance, logistics, and capital constraints; however, their unique biodiversity and singular climatic conditions offer comparative advantages still underexplored. Desert agriculture in Arica or Antarctic research in Magallanes are examples of how these territories could become natural laboratories for innovation, supported, for instance, by differentiated tax regimes and instruments such as the R&D Law.

At a strategic level, the great challenge is to articulate these regional hubs in a coherent national system. This requires multi-level governance mechanisms, permanent articulation platforms, and public policies that not only support local initiatives, but also provide incentives to interregional collaboration. Cases such as Ñuble, which benefits from its proximity to Biobío and the generation of university spin-offs, show that the connection between territories can compensate for local gaps and accelerate maturation processes.

In summary, creating regional hubs is a task that combines challenges and opportunities. It implies overcoming structural gaps in infrastructure, talent, and funding, but also making the best of territorial comparative advantages and the growing willingness to cooperate among local actors.

09

Strategic recommendations to strengthen the national and regional ecosystems

The study confirms that Chile has a young, dynamic and expanding biotechnology ecosystem, but still fragmented and with structural challenges that limit its consolidation. The analysis demonstrates that the entrepreneurial activity is concentrated in knowledge-intensive startups, supported mainly by public funding in early stages, with business models oriented to the B2B market, and have clear internationalization potential. The existence of university spin-offs and non-DBF companies, which integrate biotechnology as a complementary component reflects the diversity of pathways that coexist in the ecosystem.

Academia constitutes a fundamental pillar in the generation of knowledge and training of advanced human capital, although its contribution to technology transfer remains constrained by misaligned timelines, intellectual property frameworks, and limited access to infrastructure. The articulation within the industry occurs in specific cases, but has not yet become a systematic and sustained practice.

Financing emerges as a critical factor. While public funds have allowed the emergence of multiple enterprises, the participation of private capital and venture funds specialized in biotechnology remains incipient. This situation forces many startups to look for investment and validation abroad, which reflects the globalization inherent to the sector as well as the weakness of the local ecosystem in sustaining scale-up processes.

Regarding aspects that enable commercialization, such as infrastructure and regulation, relevant gaps persist. The lack of certified laboratories and production facilities forces the outsourcing of pilot testing and manufacturing, increasing costs and slowing down technological development. Added to this is a fragmented regulatory framework, with timelines and criteria that do not keep up with the pace of innovation, which generates uncertainty and discourages investment. Overcoming these limitations requires not only greater investment in enabling infrastructure, but also instances of public-private dialogue so that regulations can be modernized and harmonized with international standards.

From a territorial perspective, the regional analysis reveals that, although most of the actors and capabilities are concentrated in the Metropolitan Region, emerging poles in southern Chile show a promising dynamism, especially in aquaculture and agroindustry. The creation of regional hubs and interregional articulation emerge as strategic routes to decentralize development, diversify application sectors and harness comparative regional advantages. It is important to note that this analysis is preliminary, providing a first approximation to the state of the ecosystem. Its findings point to the need for a second study that may delve deeper in regional dynamics and allow measuring the maturity of each regional node with more precision.

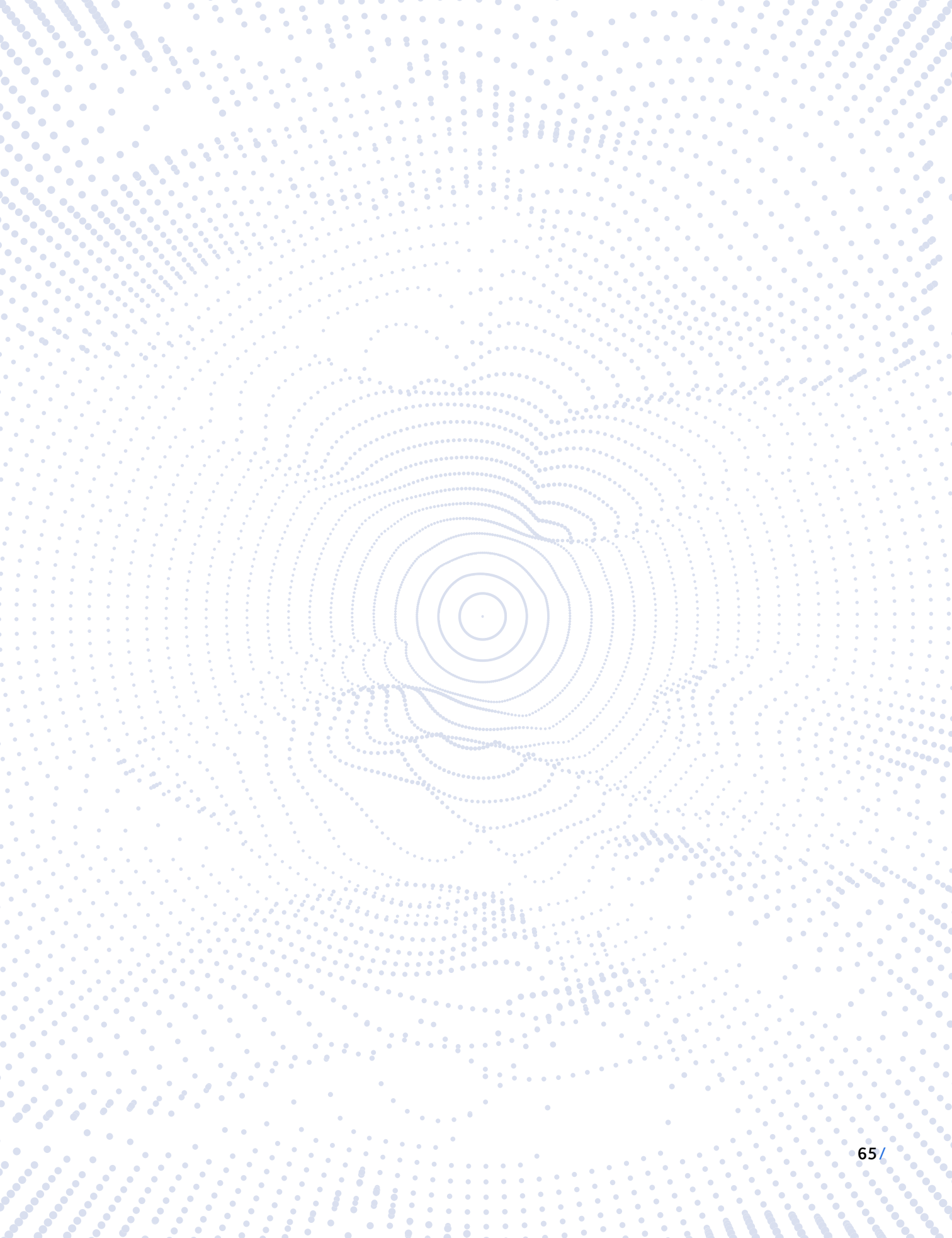
In this context, intermediaries such as the CBT emerge as strategic actors to articulate science and industry, catalyze technology transfer and facilitate scale-up solutions. The CBT model, based on the integration of scientific, production, regulatory and financing capacities, constitutes a key element to transform the current fragmentation into solid and sustainable networks.

Chile is at a turning point: it has a growing ecosystem, with a critical mass of established firms and capabilities, but faces gaps in infrastructure, financing, human capital, and regulation. To exploit its comparative advantages and consolidate its positioning, strate-

gic actions that involve public and private actors are required:

- Create permanent instances of coordination between public, private, and academic actors to align priorities and reduce fragmentation.
- Focus advanced programs to train human talent on the integration of science, management, entrepreneurship, and regulation, aligning profiles with the needs of the sector.
- Activate local support networks through technology brokers, mentor networks, and seed capital funds with a regional focus.
- Establish sectoral roadmaps (agriculture, aquaculture, health, green mining) that define common technological goals and guide investment efforts.
- Promote public-private cofinancing instruments that allow joint pilot projects and industrial validations under real-world conditions.
- Strengthen regional hubs through shared infrastructure, pilot testing capabilities, and incubation mechanisms with a sectoral focus.
- Connect territories through digital collaboration platforms, talent mobility, and internship or collaborative programs that bring science and industry closer together.
- Position Chile as a natural laboratory for the validation of biotechnological solutions, taking advantage of its diversity of ecosystems and sectoral comparative advantages.
- Promote the creation of venture capital funds specialized in biotechnology and Deep Tech.
- Articulate the Chilean ecosystem with international biotechnology hubs, especially in Latin America, to facilitate scale-up and attract specialized investments.

Chile has a real opportunity to transform biotechnology into a driver of sustainable development. Achieving this requires a shared vision, effective collaboration and solid intermediary structures that connect local capabilities with global challenges.





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