Bio-inputs in Argentina: development, institutionalization, and changes in the agricultural input industry

Bio-intrants en Argentine : développement, institutionnalisation et transformations dans l'industrie des intrants agricoles

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RÉSUMÉ. Les bio-intrants constituent l'une des principales innovations agricoles face à la crise associée à l'utilisation de produits chimiques. Les micro-organismes appliqués à la nutrition des plantes et au contrôle des ravageurs apparaissent comme des technologies clés dans la transition vers une agriculture durable. Toutefois, leur développement ne dépend pas uniquement d'aspects techniques, mais aussi du système de réglementations qui les institutionnalise. Cet article présente les avancées d'une recherche exploratoire sur la production de bio-intrants en Argentine et leurs formes d'institutionnalisation. Il analyse le contexte d'émergence de ces innovations, les acteurs impliqués et le système de réglementations et de politiques publiques qui encadrent, promeuvent ou limitent leur développement. Sur le plan méthodologique, l'étude combine une analyse documentaire avec des données secondaires et quantitatives issues de sources officielles, ainsi que des entretiens approfondis et une observation participante. Les résultats montrent que, bien que les bio-intrants constituent une technologie implantée dans le pays et appuyée par une structure industrielle incluant des entreprises locales, leur institutionnalisation reste marquée par des contradictions, ce qui conditionne les possibilités de consolidation de ces intrants.

ABSTRACT. Biological inputs constitute one of the main agricultural innovations in response to the crisis associated with the use of chemical products. Microorganisms applied to plant nutrition and pest control thus emerge as key technologies in the transition toward sustainable agriculture. However, their development depends not only on technical aspects but also on the regulatory system that institutionalizes them. This article presents findings from an exploratory study on the production of biological inputs in Argentina and their forms of institutionalization. It analyses the context in which these innovations have emerged, the actors involved, and the system of regulations and public policies that regulate, promote, or constrain their development. Methodologically, the study combines documentary analysis with secondary and quantitative industry data from official sources, along with in-depth interviews and participant observation. The results show that, although biological inputs constitute an established technology in the country, supported by an industrial structure that reveals the presence of local firms, their institutionalization is contradictory, marked by advances and setbacks that condition their consolidation.

MOTS-CLÉS. bio-intrants, micro-organismes, transitions technologiques, innovation, agriculture durable.
KEYWORDS. bio-inputs, microorganisms, technological transitions, innovation, sustainable agriculture.

1. Introduction

In Argentina, the development and production of agricultural bio-inputs has been known for several decades. Its history dates to 1957, with the introduction of biofertilizers based on symbiotic microorganisms for legume crops (mainly soybeans), which were imported primarily from the United States [MAM 18, p. 8]. Nevertheless, their use remained marginal due to the rapid development of chemical products and the scientific advances that consolidated the conventional technological package. Beyond that, over the last twelve years, approximately, there has been a growing interest in

these products from the State, science and technology organizations, firms in the sector, and agricultural producer organizations.

This renewed interest in biological inputs has arisen in a context where Argentina's dominant agro-food production models have become increasingly intensive. In particular, the techno-productive paradigm that became dominant in the last decade of the twentieth century—driven by the spread of transgenic seeds, phytosanitary products (especially herbicides), and no-till farming [BIS 21] —was effective in boosting production and productivity, yet it also poses significant environmental and health challenges. These issues call into question its long-term viability, especially in a context of rising global demand for food. The supply of these inputs is dominated by a small number of firms that provide seeds and crop protection products in an integrated manner and operate on a global scale [SZT 23]. Thus, this dominant technological package accumulates tensions of different kinds that call its sustainability into question [WER 25].

Although critiques of the agricultural production model have become increasingly frequent in Argentina, the use of chemical inputs is far more widespread than in other parts of the world. and is often overlooked due to the significant role that agriculture plays in the country's productive structure and macroeconomy [AUL 17]. In this context, biological inputs emerge as an alternative technology with the potential to drive the transition toward sustainable agricultural production.These imputs have entered the agendas of the Argentine government [GOU 22], leading to the creation institutions that regulate their use, as well as policies that have promoted their development and production. Throughout this article, the concept of institutionalization is employed as an analytical category to denote the broad range of actions that include the creation of specific state bodies, regulatory frameworks, policies promoting biological inputs, and corporate representative organizations of private actors.

In turn, adopting a clear definition of biological inputs as a precise category, along with a clear delimitation of what falls within and outside it, is essential for structuring the process of institutionalization of this technology [AUL 23]. and for positioning the actors involved in it. Thus, the Advisory Committee on Agricultural Bio-inputs (CABUA)—the first specialized body within the structure of the Ministry of Agriculture to work on this issue—defines agricultural bio-inputs as "all inputs with a direct effect on agricultural production that are based on living micro- or macro-organisms, as well as compounds and/or extracts derived from them or from other biological sources, capable of improving productivity (or yield), quality, and/or health when applied to animals or plants of agricultural interest"[1]

As follows from this definition, bio-inputs include both those aimed at stimulating plant growth and development (biostimulants) and those intended to prevent and control pests (biocontrol agents). In addition to this functional classification, the definition distinguishes between two types of biological inputs—biopreparations and bio-inputs—depending on how they are produced.

Moreover, the definition of agricultural biological inputs can be reconstructed according to different socioeconomic modes of production, that is, in relation to the sociotechnical systems that provide meaning and orientation to these products. Accordingly, two types of biological inputs can be distinguished: on the one hand, biopreparations and, on the other, industrial biological inputs.

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[1] Resolución 105/2019 ANEXO Plan de acción para el sector de bioinsumos agropecuarios, Available at: https://www.boletinoficial.gob.ar/detalleAviso/primera/217732/20191001

This latter distinction, which is particularly relevant to this study as it introduces a socioeconomic perspective, is based on the presence of at least two production trajectories identified by [TEM 24]: On the one hand, there is a trajectory of self-production, carried out by networks of agroecological farmers, NGOs, and small enterprises using local resources. On the other hand, there is a trajectory associated with the industrialization of microorganism production, through which new inputs and usage conditions are standardized by agro-industrial companies. In turn, within this trajectory, actors with dissimilar characteristics can be identified, both in terms of their size and their territorial reach, as well as their development capacity within an industry that is still incipient.

In sum, agricultural biological inputs articulate alternative socioeconomic logics that shape both the mode of production and the capacity for diffusion and adoption of these innovations.

This article focuses on the industrial trajectory and seeks to answer the question of who the business actors participating in the biological inputs industry in Argentina are, and how they relate to the process of institutionalization of these technologies.

The article aims to characterize the actors involved in the industrial trajectory and to describe the process of institutionalization in Argentina, highlighting the advances and setbacks in this process and inferring the consequences these dynamics may have for a diverse structure of actors. In this way, its main contribution lies in relating the industrial structure to the set of actions linked to biological inputs carried out by the state.

To fulfill this general objective, the article focuses on characterizing the main actors involved in the production of biological inputs based on three dimensions: the origin of capital, the type of inputs they produce, their participation in registered inputs, and their membership in business associations. Second, the article identifies the main milestones that have shaped the process of institutionalization to date, as well as the actors favored by these developments.

The article is structured as follows. The next section presents key concepts related to the processes of institutionalization involved in this type of technological transition, as well as the relevance of the socioeconomic structure in providing support for these processes. The second section describes the context in which biological inputs emerged in Argentina. The third section characterizes the structure of actors involved in the production of biological inputs within the industrial trajectory in Argentina. The following section presents the milestones that define the process of institutionalization of biological inputs for agriculture. Finally, the article offers the main interpretations that can be inferred from the observations, as a preliminary conclusion to this exploratory process.

2. Institutionalization processes and socioeconomic change in technological transitions

Technology and the incorporation of innovations into productive systems have long occupied a central place across different strands of economic thought, as they are regarded as a necessary condition for growth and development, particularly through their contribution to productivity enhancement. Likewise, various authors have underscored how the control and command of specific innovations shape hierarchical structures among regions and industries [FRE 02], [MAL 97]. Consequently, periods characterized by the emergence and transition of technologies create opportunities to alter existing structures of centrality and the relative influence of both regions and actors within a productive sector [KAP 98], [ALT 08], [SZT 23]

In recent decades, greater recognition of climate change, environmental degradation, and the ecological limits that constrain current production and consumption models has placed environmental sustainability at the center of debates on technological change. Within this context, technological

transition cannot be understood solely as the development of innovations that generate new products, processes, or markets. It must also involve technologies capable of enabling more sustainable production systems. In other words, a shift toward more sustainable productive models necessarily requires a corresponding technological transition.

For countries whose productive specialization is rooted in natural resources—such as Argentina and Latin America more broadly—this transition represents a strategic opportunity to leverage comparative advantages through the generation and application of new knowledge and technologies. As Marín and Pérez argue, this shift "would fulfill two purposes: (i) generating value and innovating in association with nature—regenerating and revalorizing it instead of exploiting and degrading it; and (ii) diversifying the productive and technological structure toward knowledge- and innovation-intensive sectors driven by the raw material requirements of the transition process" [MAR 24, p.42].

In the current phase of technological transition, two major technological domains—each encompassing a broad set of innovations—are driving global transformation: information and communication technologies (ICTs) and biotechnology [LAV 25]. Although both domains are relevant to agricultural production, our focus is on biotechnology, and more specifically on agricultural biological inputs as alternative technologies to chemical inputs.

Our analysis focuses on examining, at different levels, the technological transition in which bio-inputs are conceived as alternatives to chemical inputs, although not necessarily as perfect substitutes. Following Goulet and Hubert, we contend that "the processes by which alternative technologies emerge as their counterparts decline are actually more complex than these dichotomous readings suggest" [GOU 20b, p. 2], as such interpretations often assume that one technology will rapidly displace another. Moreover, the trajectory that each technology follows depends not only on its own development dynamics but also on regulations, economic incentives, and broader institutional changes that affect technologies in differentiated ways [FREE 96].

The period of coexistence between two technological regimes "creates an impasse within the existing structure and enables the emergence of new actors, strategies, and productive practices that hold the potential to challenge the rigidity of established positions" [SZT 23, p. 3]. From the perspective of the geography of transitions, it has been observed that although sustainability issues are inherently global, there are "clear signs of change in the geographical location of relevant innovation and transition processes. Very prominently, emerging economies have taken on leadership roles in support of the industries and innovations associatedwith sustainability transitions" [TRU 15, p. 1].

This underscores the importance of considering the socio-spatial embeddedness of transition processes, the diversity of actors involved, and the multiple scales at which sociotechnical change unfolds. In this context, it becomes essential to make visible the unequal relations that operate throughout transition processes—for example, which voices lead situated transitions, which are marginalized, and how these asymmetries shape the trajectories of competing technologies.

Although this article adopts an exploratory and descriptive approach to the bio-inputs sector in Argentina—and therefore does not offer a comprehensive analysis of these dimensions—we argue that understanding the evolution of the national regulatory and institutional framework, along with identifying the main actors that constitute the sector, represents an important step toward formulating hypotheses that can illuminate these dimensions of the transition.

In this context, a feedback relationship emerges between socioproductive systems and processes of institutionalization that cannot be established a priori. Based on these considerations, the article adopts three fundamental concepts. First, technological change processes are not binary but unfold in combined and complex forms, in which different technologies may coexist in both complementary and

conflicting relationships. Second, these processes are socially articulated through a plurality of actors operating across different scales and multiple territorialities. Third, technological change always requires a framework of institutionalization within the state sphere, whether through regulation (positive or negative), policy action oriented toward achieving specific outcomes, or other forms of intervention.

3. Bio-inputs emergence context

Argentina's economy is shaped by a productive structure in which natural-resource-based activities play a central role. Agricultural and agro-industrial activities are key drivers of the country's output and export profile. Several indicators help illustrate this point: considering only the five most relevant crops (soybean, maize, wheat, sunflower, and sorghum), Argentina devotes around 30 million hectares to their cultivation—nearly five times the cultivated area in 1960—and produces more than 130 million tons of these crops (ten times the volume recorded in 1960), according to data from the Agricultural and Forestry Information Directorate of Argentina.

At the same time, it is one of the world's leading exporters of these products: the leading exporter of soybean oil and soybean meal, accounting for 35.6% and 31% of the global market, respectively; the second-largest exporter of maize and sorghum; the third-largest exporter of sunflower oil and sunflower meal; and the seventh-largest exporter of wheat (Food and Agriculture Organization of the United Nations – FAO).

The significance of agricultural and agro-industrial exports also shapes the domestic economy, as this sector constitutes the country's principal source of foreign currency. In 2024, the oilseed and cereal complexes accounted for 43% of Argentina's total exports. The balance-of-payments constraint on Gross Domestic Product growth heightens the importance of increasing exports. It should be noted that Argentina's last significant economic expansion was made possible by the rise in the relative prices of primary commodities that took place between 2002 and 2011. During this period, exports increased by 223%.(International Accounts, National Institute of Statistics and Censuses -INDEC-), enabling a 95% increase in real GDP (National Accounts, INDEC) and the creation of approximately 4.3 million jobs (Superintendence of Occupational Risks), nearly doubling the initial employment level.

Regarding the dominant technological model in Argentine agriculture, production across most crops is largely based on the use of genetically modified seeds, no-till farming, and chemical phytosanitary products—particularly herbicides, which are essential to no-till systems and are used in conjunction with herbicide-resistant seed

Several indicators illustrate the extent to which this technological package has penetrated Argentine agriculture. According to the Argentine Association of No-Till Producers (AAPRESID), in 2025, 82% of the country's agricultural land was farmed under no-till practices. Regarding the use of genetically modified seeds, virtually all soybean, cotton, and maize crops rely on this type of technology, and although still incipient, the cultivation of transgenic wheat, alfalfa, and potatoes has also begun.

Chemical input use in Argentine agriculture has been increasing since the 1960s, but a significant jump in total quantities can be observed from 1998 onward. This increase is explained by the expansion of crop production and the shift in the technological package, centered on herbicide-resistant transgenic soybeans, along with the advancement of the agricultural frontier made possible by this technological shift.

An examination of pesticide use between 1990 and 2023 (see Figure 1) clearly reveals this upward trend. According to FAO data, in 2023 Argentina used 6.7 times more pesticides per hectare than in 1990. The intensity of use is also high compared with other countries characterized by extensive agriculture and similar technological models; for instance, pesticide use per hectare is double that of the United States. Likewise, the high levels observed in Brazil and Uruguay indicate that this input-intensive technological package has also spread to other countries in the region.

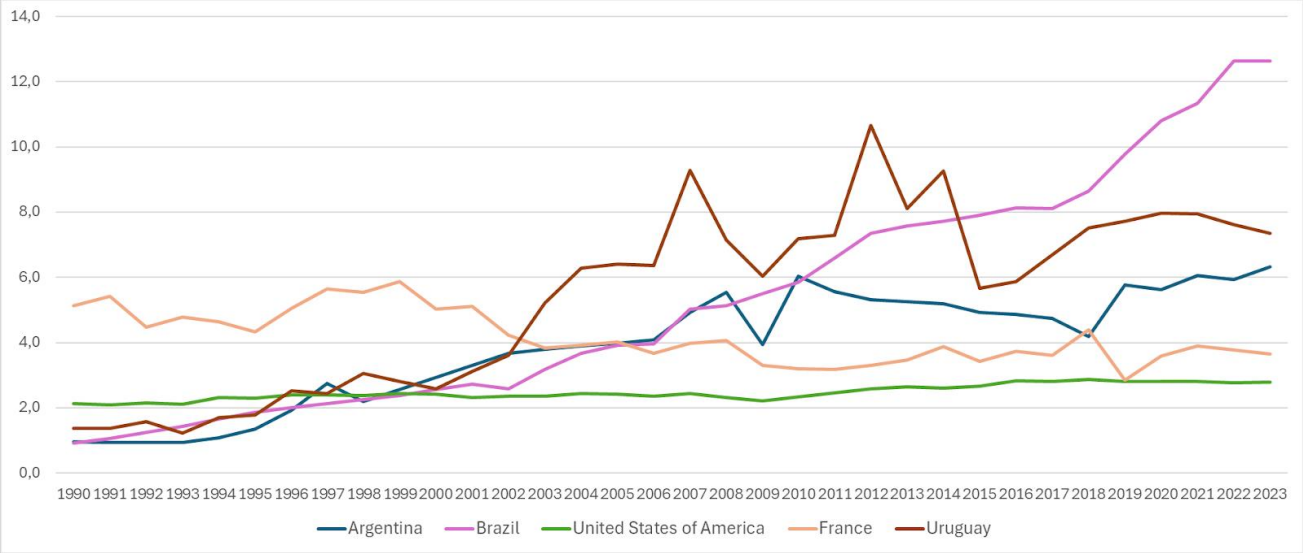

Figure 1. *Evolution of pesticide use (kg/ha), 1990–2023. Selected countries*

Source: authors' own elaboration based on data from FAO.

The rapid adoption of the technological package was decisive in sustaining agricultural expansion through the incorporation of new territories and higher yields. The extensive and intensive growth of production made it possible to meet the increase in external demand which, together with the rise in commodity prices in the early 2000s, underpinned economic growth during the first decade of the twenty-first century.

However, critiques of the productive model—particularly regarding the safety of chemical input use—have gained increasing prominence. Although opposition movements took time to consolidate, today civil society organizations and scientific and health sectors form a network of actors that, while failing to modify national agrochemical regulations, has promoted advances at subnational levels and through judicial rulings [ARA 22].These critiques primarily target the effects of this mode of production on health and the environment, as well as the consequences of the process of agriculturalization across the country's diverse territories. Agricultural intensification in the Pampas region, together with the relocation of livestock production to less productive lands—including the expansion into native forests and deforestation in the central-northern regions—has been identified as a set of ecosystem transformations that amplify the negative impacts of climate change, such as floods and droughts [PAR 05].

In addition, precision agriculture strategies—initially presented as promising tools to reduce the use of chemical inputs—did not achieve the expected results, at least in the Argentine case. Although the adoption of these technologies increased significantly across all segments [VIL 20], the use of chemical inputs intensified, as previously noted.

Beyond the criticisms voiced by civil society, producers are increasingly confronted with restrictions or requirements imposed by certain countries or regions on goods produced under these practices (for example, the EU regulation on deforestation), as well as with challenges inherent to the

current technological package—most notably the emergence of herbicide-resistant weeds. According to AAPRESID, more than 25 million hectares are affected by at least one herbicide-resistant weed species, a development that undermines the viability of the prevailing production model and has prompted the sector itself to seek more environmentally sustainable alternatives.

In this context, biological inputs have emerged as a cross-cutting alternative that is gaining momentum not only on the political agenda and among actors who have historically advocated for agroecological production, but also among stakeholders in the agro-industrial sector—traditionally aligned with productivist approaches and defenders of Good Agricultural Practices (GAP) as a guarantee of the safety of the prevailing techno-productive model. In this way, a potential window opens for the incorporation of new technologies based on biology and the functionality of microorganisms, through the development and adoption of biological inputs. This opening does not respond solely to international dynamics, but also to the growing contradictions of the dominant technological package, which are increasingly difficult to resolve and compromise its own sustainability.

In this sense, different logics converge within this opening: on the one hand, as a challenge to the dominant techno-productive model of recent decades; on the other, as a technological adaptation of that same model aimed at providing more stable responses to its internal contradictions. The institutionalization of this opening, as well as of the initial development and adoption of these new technologies, reflects these tensions and opposing logics, which become evident in the milestones that have marked this process.

4. Agricultural Inputs in Argentina: Socioeconomic Reconfiguration in the Chemical–Biological Transition

The agricultural input industry and market display differentiated configurations across their various segments. While some actors specialize in specific types of products, others operate across multiple markets, incorporating products and technologies that allow them to position themselves in relation to emerging technological alternatives. This section describes the main characteristics of these segments, identifying the most significant changes associated with the shift from the chemical to the biological industry.

These transformations are unfolding within a highly concentrated input industry, where the entrenched position of both domestic and foreign firms creates significant entry barriers for new actors.

As noted above, we argue that biological inputs are not positioned to challenge—at least in the short term—the market dominance held by these incumbent firms in the agricultural input sector. Nonetheless, we contend that the expansion of the market for biological products is creating opportunities for an input industry with new segments in which emerging actors may enter and attain positions of relevance

The production of chemical fertilizers depends on the availability of mining raw materials and hydrocarbons, and the structure of its market is shaped by soil characteristics and the nutrients that must be supplied.

In Argentina, the fertilizers most widely used are nitrogen-based fertilizers—primarily derived from natural gas—and phosphate fertilizers produced from phosphate rock. Together, they account for 94% of agricultural fertilizer consumption. Although these products are manufactured domestically, local supply is insufficient, and more than 60% of demand is met through imports (data from the Argentine Chamber of Fertilizers and Agrochemicals—CIAFA—for 2024).

The supply of these products is concentrated among a small group of firms: Profertil SA (jointly owned by Nutrien Inc.—Canada—and YPF SA—an Argentine company with majority state ownership), Bunge Argentina SA (United States), Fábrica Militar de Río Tercero (state-owned, Argentina), Yara International ASA (Norway), Mosaic (United States), and Terminal de Fertilizantes Argentinos SA (Argentina).

Reliance on imports has negative consequences, both because of the outflow of foreign currency associated with the agricultural sector and because price increases tend to reduce purchased quantities and, consequently, limit soil nutrient replenishment.

As for the pesticide industry, is highly concentrated at the global level, largely as a result of complex biotechnological developments carried out by firms that integrate technology across seeds and inputs, and that concentrate multiple stages of the value chain, ranging from research and development to commercialization.

In this context, the Argentine market for chemical pesticides—estimated at roughly USD 3.5–4 billion—is dominated by major multinational corporations. Prominent among them are ChemChina–Syngenta (China), Bayer Crop Science (Germany–United States), BASF Argentina SA (Germany), Corteva Agriscience (United States–France), and Atanor (United States)[2]. Some Argentine firms also maintain a relevant presence, including Agrofina, Sigma Agro, Asociación de Cooperativas Argentinas, Chemotécnica, and Nova, among others.

The technological model based on the intensive use of chemical inputs, consolidated in Argentina, is characterized by a strong presence of foreign capital. Moreover, both the fertilizer and pesticide segments run trade deficits, placing the country in a structurally dependent external position.

Meanwhile, the Argentine bioinputs market has been showing sustained growth. According to CASAFE data, its size was estimated at USD 124 million in 2024, representing a 10.4% increase compared to the previous year. In the same year, half of the country’s cultivated area made use of some type of bioinput

Biofertilizers—particularly nitrogen-fixing bacterial inoculants—stand out in the Argentine context due to their early adoption and their complementarity with chemical fertilizers; in other words, they have become integrated into the core technological package.

Data for 2024 (see Figure 2) on the distribution of the bioinput market show a clear dominance of plant growth promoters (including fertilizers, stimulants, and many seed-treatment products) over biocontrol agents.

[2] According to [SHA 22], the U.S.-based company Corteva (formed through the merger of DuPont and Pioneer), the German firms BASF and Bayer (which acquired the U.S.-based Monsanto), and the state-owned ChemChina (which acquired the European company Syngenta) accounted for 62.3% of the global agrochemicals market in 2020.

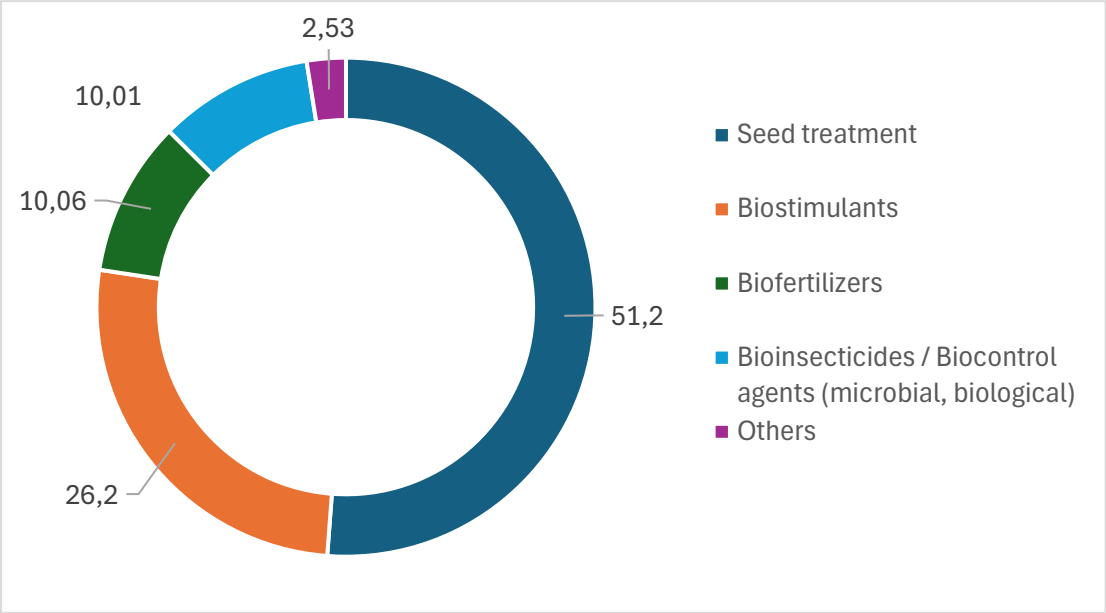

Figure 2. *Distribution of Argentina's bioinput market by product type, 2024*

Source: authors' own elaboration based on data from CASAFE.

Nevertheless, data on the evolution of this market reveal significant growth across several product categories. Between 2023 and 2024, bioinsecticides recorded the highest expansion, increasing by 109%, followed by biofertilizers (68.9%), biofungicides (34%), biostimulants (8.4%), and, finally, seed treatments (2.7%).

Reinforcing this trend, a survey conducted by AAPRESID shows that 27.7% of the producers affiliated with the association had used at least one type of biological input in 2023. Of this share, biostimulants represented the largest segment (58.9%), followed by biofertilizers (30.3%) and, far behind, biocontrol agents (9.8%)[3].

Regarding the actors that make up Argentina's bioinput industry, it is worth highlighting both the significant number of firms involved and their heterogeneity in terms of size and origin.

In the biostimulant segment, 985 products were registered according to SENASA's list as of April 2025[4]. Fertilizers and inoculants account for 98% of these registrations, with 969 products.

Although the data do not allow for the identification of the specific ingredients in fertilizers and inoculants, according to [DA S 24] and information available on company websites, it is possible to assert that the majority of these products are formulated based on bacteria.

A total of 147 companies holding registrations for biofertilizers or inoculants were identified. Table 1 presents the 26 companies with at least ten registered products. As shown, Rizobacter—the leading Argentine firm in the development of biological fertilizers—stands out, with a number of registrations that is more than twice that of the second-ranked company. Taken together, these 26 firms account for nearly 60% of all registrations, 40% of which correspond to Argentine companies.

Among the foreign companies, several of the world's leading producers of biologicals are represented, including Nitrasoil (owned by the Dutch firm Koppert), Novozymes (Denmark), and the Brazilian company Simbiose, among others. Also notable is the participation of major global actors

[3] See https://www.aapresid.org.ar/blog/bioinsumos-biocontroladores

[4] More recent data were not used, as they do not distinguish between biological and chemical fertilizers

with a long-standing presence in the chemical input industry, such as BASF and Palaversich (a subsidiary of the Dutch company Barenbrug).

These data indicate that the actors in the biofertilizer industry are fragmented. Although information on market share is not available, the fact that there is a significant number of firms with registered products, and that only 10% are foreign, highlights that this is a sector in which Argentina has development potential.

Company	Number of registered products	Share (%)	Cumulative share (%)	Origin of capital
RIZOBACTER ARGENTINA S A	153	14%	14%	Argentina
NITRASOIL ARGENTINA SOCIEDAD ANONIMA S. A.	49	4,50%	19%	Netherlands
NOVOZYMES BIOAG S.A.	44	4,00%	23%	Denmark
LABORATORIOS ARBO S.R.L.	42	3,80%	26%	Argentina
NOVA S. A. U.	32	2,90%	29%	Argentina
SIMBIOSE - INDUSTRIA, COMERCIO E DISTRIBUICAO DE FERTILIZANTES E INSUMOS MICROBIOLOGICOS S. R. L.	30	2,70%	32%	Brazil
BASF ARGENTINA S A	28	2,60%	35%	Germany
NITRAP SOCIEDAD DE RESPONSABILIDAD LIMITADA	24	2,20%	37%	Argentina
PALAVERSICH Y CIA S AC	22	2,00%	39%	Netherlands
LABORATORIOS C.K.C. ARGENTINA S.A.	20	1,80%	41%	Argentina
FRAGARIA S.A.	18	1,60%	42%	Argentina
LABORATORIO SAN PABLO PRODUCTOS BIOLOGICOS S.R.L.	17	1,50%	44%	Argentina
FACYT I + D SA	15	1,40%	45%	Argentina
PRODINSA ARGENTINA S A	15	1,40%	46%	Argentina
BILAB S.A	14	1,30%	48%	Argentina
CERGEN S R L	14	1,30%	49%	Argentina
CRINIGAN S A	14	1,30%	50%	Argentina
FITOQUIMICA S.A.}	14	1,30%	52%	Argentina
FORBIO S.A.	14	1,30%	53%	Argentina-Brazil
PROTERGIUM AGROCIENCIAS S. A.	14	1,30%	54%	Argentina
STOLLER ARGENTINA S. A. U.	12	1,10%	55%	United States of America
AGRO ADVANCE TECHNOLOGY S.A.	11	1,00%	56%	Argentina
AGROFACIL S A	10	0,90%	57%	Argentina
ASOCIACION DE COOPERATIVAS ARGENTINAS - COOP. LTDA.	10	0,90%	58%	Argentina
GREEN QUALITY S.A	10	0,90%	59%	Argentina
INDIGO AGRICULTURE ARGENTINA S.R.L.	10	0,90%	60%	United States of America

Table 1. *Leading 26 Companies by Number of Biofertilizers Registered), with Their Share of Total Registrations, Cumulative Share, and Origin of capital. SENASA (April 2025*

Source: authors' own elaboration based on data from SENASA and company websites.

Regarding the biocontrol segment, the data were compiled from SENASA's plant protection product registrations as of December 2025. This information allows for inferences about the industry structure within this segment.

Table 2 presents a total of 44 companies operating in this segment, which have registered 99 biocontrol products. Among these products, microorganisms predominate, accounting for 84% of the total, with bacteria representing 50% and fungi 30%, while the remaining products are virus.

Company	Number of registered products	Share (%)	Cumulative share (%)	Origin of capital
RIZOBACTER ARGENTINA S A	13	13%	13%	Argentina
LABORATORIO SAN PABLO PRODUCTOS BIOLOGICOS S.R.L.	6	6%	19%	Argentina
CORTEVA AGRISCIENCE ARGENTINA SRL	5	5%	24%	United States of America
NITRASOIL ARGENTINA SOCIEDAD ANONIMA S. A. (KOPPERT)	5	5%	29%	The Netherlands
MITSUI & CO. (ARGENTINA) S. A.	4	4%	33%	Japan
AGRO ADVANCE TECHNOLOGY S.A.	3	3%	36%	Argentina
BAYER	3	3%	39%	Germany
CERGEN S R L	3	3%	42%	Argentina
FITOQUIMICA S.A. (Savena)	3	3%	45%	Argentina
INDUAGRO SRL	3	3%	48%	Argentina
NITRAP SOCIEDAD DE RESPONSABILIDAD LIMITADA	3	3%	52%	Argentina
PROTERGIUM AGROCIENCIAS S. A.	3	3%	55%	Argentina
SUMITOMO CHEMICAL ARGENTINA S.A.	3	3%	58%	Japan
AGRI CHECK SRL	2	2%	60%	Argentina
AGRI STAR S. A.	2	2%	62%	Argentina
AGROBIO ARGENTINA SAU	2	2%	64%	Argentina
BASF ARGENTINA S A	2	2%	66%	Germany
FORMULAGRO SOCIEDAD RESPONSABILIDAD LIMITADA	2	2%	68%	Argentina
IMERYS MINERALES ARGENTINA S.A.	2	2%	70%	Argentina
INDIGO AGRICULTURE ARGENTINA S.R.L.	2	2%	72%	United States of America
MICROVIDAS SRL	2	2%	74%	Argentina
NATURALIS S.A.	2	2%	76%	Argentina
S ANDO Y CIA SACIIF	2	2%	78%	Argentina

TERRABIO S.A.S.	2	2%	80%	Argentina
BROMETAN S R L	2	2%	82%	Argentina
BIOCICLO S.A.	1	1%	83%	Argentina
BIOCORP-HO S. A. (Horus Agro)	1	1%	84%	Argentina-France
BPANALITYCAL SOCIEDAD ANONIMA (agrocapital)	1	1%	85%	Argentina
COMPAÑIA ASCARISCER S.A.	1	1%	86%	Argentina
DOMANICO EDUARDO ARTURO	1	1%	87%	Argentina
INSTITUTO NACIONAL DE TECNOLOGIA AGROPECUARIA	1	1%	88%	Argentina
LABORATORIOS ARBO S.R.L.	1	1%	89%	Argentina
MESSINA MARINUCCI S.A.	1	1%	90%	Argentina
NOVA S. A. U.	1	1%	91%	Argentina
PUNCH QUIMICA S A	1	1%	93%	Argentina
RAUL OSCAR AGUERRE E HIJOS S A	1	1%	94%	Argentina
SINER S A	1	1%	95%	Argentina
SUMMIT AGRO ARGENTINA S A	1	1%	96%	Japan
SYNGENTA AGRO SOCIEDAD ANONIMA	1	1%	97%	China
TROPFEN S. A.	1	1%	98%	Argentina
UPL ARGENTINA S. A.	1	1%	99%	India
WAYNE CHEMICAL SRL	1	1%	100%	Argentina

Table 2. *Companies by Number of Biopesticides Registered, Their Share of Total Registrations, Cumulative Share, and Origin of capital. SENASA (December 2025),*

Source: authors' own elaboration based on data from SENASA and company websites.

As can be observed, Argentine companies predominate in this segment, accounting for 70% of registered biopesticides. These are specialized SMEs focused on bioinputs, although when considering the number of registered products, most of these firms have only one or two. This segment also includes some of the major global input companies, such as Corteva and Bayer, among others, as well as several firms specialized in biological inputs (European and Japanese), such as Koppert (Nitrasoil) and Mitsui.

It is worth highlighting that Rizobacter stands out within this group, as it does in the case of biofertilizers, leading in both segments in terms of the number of registered products. This reflects the firm's leadership in the Argentine bioinputs industry. This position is based not only on the development of these technologies, but also on the firm's capacity to navigate the regulatory processes required for the registration of these inputs.

Regarding the corporate organization of these firms, it is noteworthy that the largest ones of foreign origin—such as Koppert, BASF, Corteva, and Sumitomo—are members of CASAFE, an association linked to the dominant production model and one that has historically defended the safety of chemical inputs, based on Good Agricultural Practices (GAPs). However, in recent years CASAFE has incorporated the promotion of bioinputs into both its activities and discourse.

In contrast, domestic companies are mainly grouped within CABIO, an organization that emerged from firms dedicated to bioinputs and that, in addition to promoting their use, has as one of its main objectives influencing registration processes so that they are accessible to its member companies. A special mention should be made of Rizobacter, which is the only firm participating in both associations.

This reflects the growth experienced by the segment in recent years and indicates that the industry is fragmented across many firms. Another relevant characteristic is that, unlike the chemical inputs sector—where companies are concentrated in the core agricultural production area—in the case of bioinputs firms are more geographically dispersed across Argentine territory and develop products for a wide range of crops.

Thus, based on the reconstruction carried out, it can be observed that, schematically, the bioinputs industry in Argentina is composed of:

- Medium-sized domestic firms that develop biological products—from R&D through formulation and commercialization. Among these firms, some offer both chemical and biological inputs, while others specialize exclusively in biologicals.
- Large global companies that lead international markets for either biological or chemical inputs, and that incorporate biological products into their portfolios in response to growing demand for these technologies.
- A broad group of SMEs and start-ups, including some dedicated solely to the formulation of biological products and others with their own technological developments (many operating as spin-offs from the national scientific system).

5. Milestones in the Institutionalization of Biological Inputs

The institutionalization of bioinputs in Argentina can be reconstructed through a series of milestones that mark the trajectory of these products within national institutions and regulatory frameworks.

Based on key documents such as public policy resolutions and regulatory frameworks, it emerges that a seminar held in 2013 between the then Ministry of Agriculture, Livestock and Fisheries of Argentina and the Inter-American Institute for Cooperation on Agriculture (IICA) constituted a foundational milestone that structured the sequence of subsequent events and developments. This seminar, entitled *"Institutionality for the Development, Regulation, and Commercialization of Bioinputs in Argentina"*, highlighted the need to create specific regulations to streamline and facilitate the use of bioinputs in agricultural production (PROFOBIO Resolution).

In December of that same year, through Resolution No. 7/2013, the Advisory Committee on Bioinputs for Agricultural Use (CABUA) was established, with the following objectives: (i) to provide advice on the technical requirements of quality, efficacy, and biosafety that bioinputs must meet for their release into the agroecosystem; (ii) to propose new regulations and issue opinions regarding the regulation and promotion of this type of products; and (iii) to establish its internal operating rules. This

Committee remains active and has progressively modified its composition to incorporate actors from both the scientific and productive sectors.

In 2015, the first public policy aimed at promoting the use of biological inputs was launched: the Program for the Promotion of the Use of Bioinputs (PROFOBIO), within the Ministry of Agriculture. Among its objectives, the program sought to "familiarize" producers with their use and consisted of three components: direct delivery of products, training activities, and systematization of information on use and user perceptions (Resolution No. 256/2015). In total, 12 projects were funded across 12 Argentine provinces, reaching 744 producers.

By 2017, a key institutional milestone was the creation of the Argentine Chamber of Bioinputs (CABIO), established as a nonprofit civil association. Initially formed by eight companies, it now brings together more than thirty and has become a central strategic actor in promoting the expansion of biological products. In its institutional narrative, CABIO emphasizes its collaboration with IICA during its formation, positioning the latter as a key technical-epistemic network in advancing socio-ecological transitions in Argentina.

Also, regarding the cooperative organization of actors along the industrial trajectory, a key milestone was the creation in 2020 of the Biologicals Commission within the Argentine Chamber of Agrochemical and Fertilizer Health (CASAFE). This development is significant, given that this chamber brings together the most important companies in the chemical inputs market. However, as stated in its official communications: "85% of the chamber's member companies develop, produce, and/or commercialize biological products. Moreover, leading companies in the biologicals market have been part of the organization for years. Of the total bioinputs market in Argentina, CASAFE member companies account for 75%" (CASAFE website)

In 2022, the Commission on Bioinputs for Agricultural Use (CBAG) was established within SGT No. 8 "Agriculture" under the framework of the Southern Common Market (MERCOSUR) 5. This milestone is relevant for the construction of a regional perspective on bioinputs. More recently, in April 2025, a regulation was adopted to approve a common definition of bioinputs in order to "facilitate trade and promote their development, use, and the exchange of knowledge" among the Member States (Resolution No. 04/25).

Between 2021 and 2023, the sector received renewed momentum through the creation of two support programs. BIODESARROLLAR (2022), aimed at national developers, provided funding for innovation; however, it was not a policy exclusively focused on agricultural bioinputs, as it also covered other products such as biomaterials and bioenergy. For its part, the Argentine Agricultural Bioinputs Program (PROBIAAR) (2021–2023) targeted small and medium-sized domestic input producers and offered funding and technical support to scale projects and achieve product formulation, approval, and commercialization. Although both programs received numerous applications—reflecting strong interest from the sector—the allocated funds were ultimately not disbursed, which represented a setback for promotion policies.

Thus, while the policies sought to consolidate the bioinputs sector—addressing both potential users (producers) and developers across different segments, including entrepreneurs and SMEs—the three public interventions faced implementation difficulties. Consequently, these initiatives fall short of constituting a medium- or long-term state policy aimed at fostering the development of these technologies. Rather, the analysis suggests that these initiatives emerged from a degree of momentum

[5] The Southern Common Market (Mercosur) is a strategic trade alliance among Argentina, Brazil, Uruguay, Paraguay, Bolivia, and Venezuela, established in 1994.

driven by international organizations and mediated by technical experts, rather than from a concerted strategic planning process involving the diverse actors shaping the agri-food sector in the country.

The last two milestones relate to regulation and help explain one of the main difficulties faced by producers of this type of input, which particularly affects smaller firms lacking the experience and resources required to navigate registration processes for commercialization.

In Argentina, until 2023, there was no specific regulatory framework for the registration of biological inputs; instead, they were governed by regulations originally designed for chemical products.

More specifically, as explained by [MAM 18] the regulatory architecture for registration was based on several resolutions. On the one hand, biological inputs were registered under the National Register of Plant Protection Products (Registro Nacional de Terapéutica Vegetal) (MAyG Decrees 3489/58 and 5769/59), following the Manual of Procedures, Criteria, and Scope for the Registration of Phytosanitary Products in the Argentine Republic (ex-SAGPyA Resolution 350/99). However, since this register did not include Biological Control Agents (BCAs), transgenic products, or macro-biological control organisms (predatory and parasitic mites and insects), SENASA—through the National Directorate of Plant Protection—established a specific procedure for the importation, quarantine, and release of BCAs (ex-SAGPyA Resolutions 758/1997 and 715/1998). Meanwhile, bioinputs intended for fertilization and the promotion of plant growth, among other products (such as effective microorganisms), were registered under the National Register of Fertilizers, Amendments, Substrates, Conditioners, Protectors, and Raw Materials (SENASA Resolution 264/11).

This situation changed in 2023 with the enactment of two SENASA resolutions. Resolution No. 1003/23 was exclusively devoted to establishing protocols and regulations to produce biopreparations, while Resolution No. 1004/23 created a specific regulatory framework for industrially produced biological inputs. This regulatory distinction reflects the two conceptions and trajectories that can be identified within the broad field of biological production and use in agriculture. One corresponds to what we term an *artisanal* trajectory, associated in Argentina with family farming and agroecological production, while the other follows an *industrial–business* trajectory.

It is worth noting that SENASA, through the Coordination for Family Farming, played a key role in promoting the development of a regulatory framework to formalize biopreparations and provide a legal basis for artisanal production (according to interviews with sector actors). However, this regulation did not align with the demands expressed by the industrial trajectory—articulated through CABIO—within CABUA. As a result, a specific resolution for industrial bioinputs (No. 1004) was drafted. This regulation established technical requirements and registration procedures for bioinputs, adapting safety and efficacy standards to facilitate registration.

Although both regulations were developed through participatory processes, tensions between trajectories persisted. Industrial actors criticized Resolution No. 1003 for granting excessive flexibility to biopreparations, while welcoming Resolution No. 1004 as responsive to their own demands.

Despite their significance, both resolutions remained in force only briefly. Resolution No. 1003 was repealed in 2024 and Resolution No. 1004 in 2025, leading to a reversion to a generalized regulatory framework once again aligned with chemical inputs. This reversal represents a major setback for the sector, as it reinstated regulatory conditions that reinforce existing lock-ins and limit the capacity of both artisanal producers and industrial firms to register and commercialize bioinputs. Although the full effects of this change are not yet evident, actors across both trajectories have expressed strong opposition to the repeal, viewing it as detrimental to the consolidation and scaling of bioinputs in Argentina.

6. Final remarks

The main objective of this article was to describe the industry of microorganism-based bioinputs in Argentina and the process of institutionalization of the technological transition it entails, relating it to the structure of business actors that make up the sector. In this way, the aim was to develop initial ideas that would help characterize the problem with a view to future research of greater empirical depth. On this basis, a set of observations was developed that constitute the main conclusions of this study, summarized below.

First, it was observed that although the biological inputs industry is led by a small number of firms, it nonetheless involves a significant number of companies, predominantly domestically owned and of relatively small size. This suggests that the country possesses technological and entrepreneurial capabilities, representing a potential window of opportunity for the development of an innovative business ecosystem with local roots and the potential for international expansion. A paradigmatic case is that of Rizobacter, a national firm that leads both the biopesticides segment and the biofertilizers and inoculants segment, in which it also stands out at the global level.

At the same time, the presence of some of the major firms in the chemical inputs industry that have expanded into biological products was also observed. These companies benefit from advantages derived from their established presence in input markets, their recognized distribution systems, as well as their expertise and economic and managerial resources for product registration. The interest of this subsector in microorganism-based inputs has also been reflected in the creation of CASAFE's Biologicals Commission, indicating an effort to position themselves as relevant actors within this industry.

In this context, the agricultural biological inputs industry could take shape with characteristics distinct from those of the chemical inputs industry, with a greater presence of national firms and technologies and lower dependence on imports. However, we argue that the consolidation of a biological inputs industry with these characteristics depends largely on the orientation of public policies and regulatory frameworks.

The reconstruction of the institutionalization process shows that although biological inputs have been present on the public agenda since 2013, there has been no sustained plan to promote a transition toward an agricultural production model in which these technologies play a more significant role. On the contrary, except for CABUA—which has remained in operation since 2013—other policy and regulatory advances have been temporary or have even been dismantled. This has been the case both for the promotion programs identified (PROFOBIO, BIODESARROLLAR, and PROBIAAR) and for the specific regulations governing the registration of biological inputs.

Despite the short duration of these measures, they make it possible to observe that small and medium-sized domestic actors—who were the main beneficiaries of these initiatives—require incentive mechanisms, as evidenced by the large number of applications submitted, as well as their involvement in the development of regulations that respond to their specific needs, particularly through CABIO. In this regard, the absence of promotion policies—and especially the lack of appropriate registration systems—implicitly advantages firms with greater experience, most of which belong to the chemical inputs industry.

This raises the question of whether, in this context, bioinputs may in fact be reinforcing a production model based on the intensive use of chemical inputs, thereby preserving a productive logic that fails to transform the extractive and inequitable structures that have hindered sustained and balanced development in Argentina. Alternatively, and more cautiously, it raises the question of whether the

existing structure of actors may shape an institutionalization process that remains limited, excludes alternative logics, and remains subordinated to the chemical-input-based system.

In sum, based on the results presented, we argue that the characteristics of the identified actors demonstrate the potential to build a biological inputs industry with a stronger presence and role of local actors capable of generating quality employment, high value added, and dynamizing regional economies, in line with the two objectives highlighted by Marín and Pérez (2023). However, realizing this potential requires an institutionalization process that overcomes the limitations identified, particularly its instability. In this regard, the construction of regulatory and promotional bodies with high technical standards, while also being rooted in the realities of the actors involved—especially domestic firms—could help consolidate a sustainable trajectory.

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