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Innovación abierta y alianzas inclusivas en el sector agroalimentario: un estudio de caso de NG-seeds*

Open innovation and inclusive partnerships in agribusiness: A case study of NG-seeds

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Sumario: 1. Epígrafe de primer nivel. 1.1. Epígrafe de segundo nivel….

Resumen: Aunque la bibliografía sobre innovación abierta ha analizado en profundidad el papel de las fuentes de conocimiento externas en el rendimiento innovador de las empresas y su contribución a la innovación, en el sector agroindustrial es un tema poco estudiado. Esta laguna es especialmente relevante en los sectores de baja tecnología, donde las empresas y los agricultores pueden enfrentarse a una capacidad de absorción limitada, así como a restricciones tecnológicas y de recursos. Para abordar esta laguna, este estudio analiza NG-Seeds, una empresa agroindustrial chilena, mediante un enfoque de estudio de caso. Los resultados muestran que dos

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alianzas desempeñaron un papel clave en la reorientación estratégica de la empresa, que pasó del sector de la alimentación animal al de la nutrición humana. Estas alianzas facilitaron el acceso a conocimientos externos, recursos tecnológicos y nuevas oportunidades de mercado. Sin embargo, los resultados también indican que las alianzas por sí solas no bastan para garantizar el éxito de la innovación. Su eficacia depende de la capacidad de la empresa para desarrollar capacidades complementarias que le permitan superar las barreras productivas, tecnológicas y comerciales. Al poner de relieve la interacción entre la colaboración externa y las capacidades internas, este estudio contribuye a la literatura sobre innovación abierta al explicar cómo las alianzas pueden respaldar la reorientación estratégica y la innovación en las empresas agroindustriales. Asimismo, ofrece perspectivas prácticas sobre cómo las empresas pueden aprovechar las relaciones externas para superar las barreras a la innovación y explorar nuevas oportunidades de mercado.

Palabras clave: Empresas chilenas; ciencia y tecnología; innovación abierta; alianzas; sector agroindustrial; altramuz

Abstract:

Although the open innovation literature has extensively examined the role of external knowledge sources in firms' innovation performance, their contribution to innovation in the agribusiness sector remains insufficiently understood. This gap is particularly relevant in low-technology industries and countries with reduced technological creation, where firms and farmers may face limited absorptive capacities, as well as technological and resource constraints. To address this gap, this study examines NG-Seeds, a Chilean agribusiness firm, through a case study approach. The findings show that two partnerships played a key role in the firm's strategic reorientation from the animal feed sector towards human nutrition market. These partnerships facilitated access to external knowledge, technological resources, and new market opportunities. However, the findings also indicate that partnerships alone are insufficient to ensure successful innovation. Their effectiveness depends on the firm's ability to develop complementary capabilities to overcome production, technological, and commercial barriers. By highlighting the interplay between external collaboration and internal capabilities, this study contributes to the open innovation literature by explaining how partnerships can support strategic reorientation and innovation in low-technology industries. It also offers practical insights into how firms can leverage external relationships to overcome innovation barriers and explore new market opportunities.

Keywords: Chilean firms; science and technology; open innovation; partnerships; agribusiness sector; lupine

INTRODUCTION

Over the last decades, open innovation (OI) has become an important area of research in innovation management, with scholars examining its underlying models, drivers, and implications for firms. This literature emphasises the role of external knowledge sources, including customers, suppliers, universities, and research centres, in fostering an innovation-oriented culture and supporting the development and market introduction of product and process innovations (Ardito et al., 2020; Bertello et al., 2024; Martínez-Cháfer, 2021; Rogo et al., 2014). Within this framework, partnerships represent an important mechanism through which firms

access external knowledge, resources, and technological capabilities. Furthermore, partnerships have been examined as a component of business model innovation (BMI), highlighting their potential to support organisational change and the development of new value-creation opportunities (Daood et al., 2021).

The importance of partnerships may be particularly pronounced in laggard technological countries. In these economies, expenditure on research and development (R&D) is generally lower than in technologically leader countries, which may constrain firms' capacity to generate innovation internally, and therefore it is often associated with lower levels of innovation output (Dooley & O'Sullivan, 2018; Torrecillas et al., 2023). Consequently, external knowledge sources, technology transfer, and collaborative partnerships can play a significant role in strengthening firms' technological capabilities and fostering innovation (Casaya-Rodríguez et al., 2025; Dooley & O'Sullivan, 2018). These mechanisms are particularly relevant also in low-technology industries, such as agribusiness, where firms may depend on external actors to access technologies and knowledge that they cannot readily develop or acquire independently.

Chile provides a relevant context in which to examine these dynamics. According to the Global Innovation Index (GII), Chile ranked 51st globally in 2024, placing second among the 20 economies in Latin America and the Caribbean. Despite its relative position within the region, the country's productive structure remains closely associated with natural resources, particularly mining, agriculture, and forestry (Katz, 2020; Solimano, 2017). Chile's innovation strategy has also emphasised the development of scientific capabilities at the national level and the incorporation of scientific knowledge generated internationally. In this context, science and technology have contributed to innovation processes in Chile and other Latin American economies. Nevertheless, the translation of scientific knowledge into productive applications also depends on effective knowledge-transfer mechanisms and collaboration among firms and other relevant stakeholders. This makes Chile a pertinent setting in which to investigate how partnerships facilitate innovation in resource-based economic activities.

Within the Chilean economy, agribusiness is particularly relevant because of its economic importance and the transformations the sector is undergoing through innovation (Mesías et al., 2024). Partnerships can

facilitate farmers' access to technologies that might otherwise be unaffordable and support the integration of smaller producers, who often occupy a weaker position within the value chain, into global value chains. Through these relationships, firms and farmers may gain access to external knowledge, technological resources, and new opportunities for value creation (FAO, 2016; Vlachopoulou et al., 2021; Vellema et al., 2020). Partnerships could therefore contribute not only to the adoption of existing technologies but also to the development of innovations that respond to emerging market opportunities.

However, the capacity of partnerships to generate innovation depends not only on the establishment of collaborative relationships but also on how knowledge flows are organised and managed. Adequate planning and dynamic management can enhance the impact of knowledge exchange (Ogink et al., 2023), while firms' absorptive capacities influence their ability to recognise, assimilate, and exploit external knowledge (Müller-Seitz, 2012). These factors are particularly relevant in agribusiness, where collaboration among firms, farmers, and other stakeholders can facilitate the transfer of technological and scientific knowledge into productive applications. Accordingly, understanding the mechanisms through which partnerships operate, as well as the factors that facilitate or constrain their contribution to innovation, is essential to explaining how firms develop new products and reorient their strategies.

Previous studies have examined the relationship between partnerships and innovation in contexts characterised by technological constraints and in the agribusiness sector (Soto and Fuentes, 2015; Dooley & O'Sullivan, 2018; Muñoz- Carvajal et al., 2023). Nevertheless, the extent to which partnerships act as incentives for innovation, the mechanisms through which they contribute to firms' strategic reorientation, and the barriers that limit their effectiveness require further investigation, particularly in the context of Chilean agribusiness. More specifically, further evidence is needed on how partnerships interact with other organisational and contextual factors to enable firms to develop new innovations and explore new market opportunities. Addressing this issue is important for understanding how firms operating in resource-based economies can leverage external knowledge to overcome technological constraints and develop new sources of competitive advantage.

To address this research gap, this study examines NG-Seeds, a Chilean agribusiness firm, through a longitudinal case study covering the

period from 2014 to 2021. Following the case study methodologies proposed by Yin (2003) and Rashid et al. (2019), the study analyses the company's evolution, focusing on the factors that drove its strategic reorientation from the seed sector towards the food sector, as well as the incentives and barriers shaping its innovation process. Particular attention is paid to the role of partnerships in facilitating access to external knowledge and resources and in supporting the development of an innovation in human nutrition. By tracing the company's strategic transformation, this study aims to contribute to a better understanding of how partnerships facilitate innovation and strategic reorientation in agribusiness firms operating in economies facing technological development challenges.

Accordingly, the study addresses the following research questions:

RQ1: What factors have incentivised innovation at NG-Seeds, and what role have partnerships played in this process?

RQ2: What are the main barriers to innovation at NG-Seeds?

The remainder of the paper is organised as follows. The next section reviews the literature on open innovation and partnerships, with particular emphasis on the agribusiness sector in Chile. Section 3 describes the research methodology and the case study design. Section 4 presents the evolution of NG-Seeds and analyses the factors underlying its strategic reorientation, including the main incentives and barriers to innovation and the development of a new human nutrition innovation. Finally, the last section discusses the main findings and lessons learned, outlines the study's implications, and identifies potential avenues for future research.

1. LITERATURE REVIEW

1.1. OPEN INNOVATION AND PARTNERSHIPS

The concept of open innovation (OI) has gained considerable attention in the literature over the past decade, as it enables organizations to benefit from external knowledge, ideas, and technologies in their innovation processes (Ardito et al., 2020; Bertello et al., 2024; Rogo et al., 2014).

Open innovation encompasses various sources of knowledge, including customer and supplier involvement, networking, and R&D outsourcing (Van de Vrande et al., 2009). Through these sources of knowledge, firms can access external inputs for product and process innovation, while partnerships can also foster organizational learning and contribute to the development of new business models (Osterwalder & Pigneur, 2010).

The successful implementation of open innovation requires strategic planning, dynamic management, and sufficient absorptive capacity to identify, assimilate, and exploit external knowledge (Ogink et al., 2023). These capabilities are particularly important for small and medium-sized enterprises (SMEs), which may face resource constraints when seeking to adopt or develop emerging technologies. Accordingly, the benefits of open innovation depend not only on access to external knowledge but also on firms' ability to integrate that knowledge into their internal processes and innovation activities.

Inter-firm alliances and partnerships are key mechanisms through which open innovation can be implemented. These collaborations may involve suppliers, customers, competitors, universities, and specialised research centres, each providing different forms of knowledge and expertise (Ardito et al., 2020). Partnerships can also support business model innovation (BMI), enabling firms to reconsider how they create, deliver, and capture value (Daood et al., 2021). In some cases, intermediaries are required to establish connections between firms and knowledge-producing organisations, particularly when emerging technologies are not sufficiently connected to potential users (Katzy et al., 2013).

Collaboration with external knowledge sources is particularly important for science-based innovation, as firms may lack the specialised knowledge and resources required to develop such innovations independently (Zhao et al., 2023; Martínez-Cháfer et al., 2021). External collaboration can help firms overcome these limitations by providing access to new knowledge, ideas, and resources, while also supporting organisational learning (Ardito et al., 2020). However, the effectiveness of these relationships depends on the ability of firms to manage knowledge exchange and integrate external contributions into their innovation processes.

Among the different forms of collaboration, partnerships with universities and research centres and those with suppliers deserve particular attention. These relationships provide access to complementary sources of knowledge that can support different stages of technological development and innovation (Archibugi, 2001). Nevertheless, collaboration between firms and external knowledge providers can involve challenges related to intellectual property rights, knowledge spillovers, conflicting objectives, and institutional differences (Holgersson & Aaboen, 2019). Furthermore, absorptive capacity is essential for transforming external knowledge and technologies into innovation. Human capital, appropriate facilities, and geographical proximity may also influence firms' ability to benefit from these collaborations (Mahmood & Mubarik, 2020).

Partnerships with universities and research centres are particularly important for developing advanced and radical innovations, as they enable firms to access scientific knowledge and expertise beyond their existing technological capabilities (Flor et al., 2018). These collaborations can strengthen firms' innovation capabilities and facilitate the development of more complex forms of innovation (Ardito et al., 2020; Martínez-Cháfer et al., 2021). However, transferring scientific knowledge from research institutions to firms remains challenging, and the relationship between scientific research and innovation continues to be debated (Heimstädt & Friesike, 2020).

Early approaches to innovation often relied on a linear model in which basic scientific research was considered the starting point of the innovation process. However, subsequent perspectives have emphasised the interactive and multidirectional nature of innovation. Kline and Rosenberg (1986), for example, challenged the limitations of linear approaches by highlighting the importance of feedback and interactions among different stages of innovation. Similarly, Caraca et al. (2009) emphasised a multi-channel, interactive learning model that incorporates experience-based learning and interactions among firms and other actors. This perspective recognises the importance of continuous engagement with users, suppliers, competitors, universities, and other research institutions throughout the innovation process (Chesbrough et al., 2014).

From this perspective, partnerships with universities and research centres should not be understood solely as mechanisms for transferring scientific knowledge to firms. Rather, they represent collaborative

relationships through which knowledge can be exchanged, adapted, and applied to specific technological and commercial needs. Their effectiveness depends on the ability of research institutions to understand users' requirements and on firms' capacity to absorb and exploit the knowledge generated. Appropriate collaborative arrangements, complementary expertise, and internal capabilities are therefore essential to translating scientific advances into practical innovation outcomes (Bertello et al., 2024; Ogink et al., 2023).

Partnerships with suppliers represent another important dimension of open innovation. Suppliers possess specialised knowledge of materials, components, production processes, and operational requirements, which can complement firms' internal expertise. Collaboration with suppliers can generate synergies through knowledge exchange and contribute to improvements in production processes (Ardito et al., 2020; Obradović et al., 2021).

These partnerships can also facilitate access to applied knowledge and practical experience, which are particularly valuable when firms seek to develop or implement innovations. In addition, collaboration with suppliers provides opportunities to share the costs and risks associated with innovation projects. By involving suppliers in the innovation process, firms can incorporate their technical expertise and production experience more effectively, thereby improving their ability to address complex operational and technological challenges (Adomako et al., 2019).

Supplier partnerships are therefore particularly relevant when innovation requires the integration of specialised knowledge with practical production capabilities. While universities and research centres can contribute scientific and technological expertise, suppliers can help firms translate knowledge into operational improvements and commercially viable applications. These forms of collaboration can consequently provide complementary benefits within an open innovation strategy.

1.2. Open Innovation and Partnerships in the Agribusiness Sector and Chile

The importance of open innovation and inter-organisational partnerships has been recognised across a range of fields, including social innovation (Murray et al., 2010), eco-innovation (Ghisetti et al., 2015),

high- and low-technology industries (Santamaría et al., 2010), and agribusiness (FAO, 2016).

In the agribusiness sector, partnerships can help address the financial, technological, and organizational constraints faced by farmers. Through collaboration, farmers can gain access to financial resources and technologies, share risks, and obtain support in overcoming the challenges associated with agricultural production and market participation. Such partnerships may also foster more sustainable and inclusive forms of agricultural development and generate positive social impacts (Dooley & O'Sullivan, 2018; Casaya-Rodríguez et al., 2025).

Two types of partnerships are particularly relevant to innovation in agribusiness. The first involves collaboration with universities and research centres, which can provide firms with access to scientific knowledge, technological expertise, and research-based innovations.

These partnerships can contribute to agricultural modernisation and facilitate technology adoption, particularly when the costs of developing or acquiring new technologies are substantial (Vlachopoulou et al., 2021). However, effective technology transfer requires appropriate collaborative arrangements and strong connections between knowledge producers and potential users. Universities and research centres must understand the practical needs of firms and agricultural producers, while firms need complementary expertise, sufficient absorptive capacity, and internal mechanisms to integrate and apply the knowledge acquired (Bertello et al., 2024; Ogink et al., 2023).

The second type involves partnerships with farmers and other actors along the value chain. These collaborations are particularly important because farmers may occupy relatively weak positions within agricultural value chains and have limited opportunities to participate in strategic decision-making. Their involvement in collaborative arrangements can ensure that their knowledge, needs, and production challenges are considered in innovation processes. It can also strengthen their participation in value creation and improve coordination between primary producers and downstream firms.

Furthermore, partnerships with farmers can enhance the competitiveness of agricultural value chains at the local, national, and international levels. By strengthening relationships between producers and local processors, these collaborations can improve coordination, increase

efficiency at both the farm and firm levels, and encourage the development of innovations that better reflect production conditions and market requirements (Klerkx, 2023; Krishnan et al., 2021; Vellema et al., 2020; Vlachopoulou et al., 2021).

These two forms of collaboration provide complementary resources for innovation in agribusiness. While research centres contribute scientific and technological knowledge, farmers offer practical production expertise and insights into the challenges encountered along the value chain. Nevertheless, establishing partnerships does not necessarily guarantee successful innovation. Their effectiveness depends on how firms coordinate and integrate external knowledge with their internal capabilities and how effectively they address technological, production, and commercial constraints. Understanding the interplay between these different forms of collaboration is therefore essential to explaining how agribusiness firms develop new products, strengthen their competitive position, and explore new market opportunities.

In Chile, empirical research has highlighted the importance of collaboration and external knowledge sources for innovation in agriculture and other productive sectors. Soto and Fuentes (2015), for example, found that cooperation and networking with customers and suppliers are associated with innovation in Chilean agricultural firms. Similarly, Boza et al. (2021) examined a collaborative agricultural extension programme involving universities, public institutions, and farmers, highlighting its potential to promote inclusive innovation and generate positive short-term outcomes for agricultural producers. Research on productive alliances between smallholder farmers and purchasing firms has also emphasized the role of collaborative relationships and technical support in strengthening producers' capabilities and facilitating market access. In addition, research on technology transfer in Chile has highlighted the importance of aligning the needs, capabilities, and expectations of firms and research institutions to facilitate effective collaboration (Stoll et al., 2023).

Collaboration within Chile's Agricultural Knowledge and Information System for Rural Development (AKIS/RD) benefits from institutional diversity, public–private partnerships and established agricultural extension mechanisms. However, the system faces challenges in institutional coordination, service quality, accountability, and support for smallholder farmers (Rivera et al., 2005). Limited public investment and

the need to strengthen innovation, sustainability, and climate resilience further constrain its capacity to promote inclusive, productive, and sustainable agricultural development (OECD, 2025). In addition, Van der Ploeg (2014) emphasizes that socio-productive factors embedded in farmers' culture hinder the adoption of innovations, given that agriculture is frequently a family activity providing both an economic livelihood and a way of life.

Strategic partnerships among key value chain actors—including farmers and producer cooperatives, research centres, the public sector, and commercial suppliers—foster inter-organizational trust and reduce perceived risks. Rogers (2003) highlights that such multi-stakeholder collaboration lowers barriers to entry, thereby accelerating the adoption and diffusion of agricultural innovations

Although these studies provide valuable insights into collaboration and innovation in Chile, further research is needed to understand how different types of partnerships interact to support firm-level innovation and strategic reorientation in agribusiness. In particular, limited attention has been paid to how partnerships with research centres and farmers who have traditionally been excluded from innovation processes may complement one another in enabling firms to develop new products and access new markets. Examining these relationships can therefore help clarify how firms combine scientific and technological knowledge with practical production expertise to overcome innovation barriers and pursue new strategic opportunities.

2. METHODOLOGY

We apply a case study methodology based on Rashid et al. (2019) and Yin (2003). This methodology is widely used in qualitative research and allows us to combine information obtained from multiple data sources (Rashid et al., 2019).

In this paper, data collection was conducted using semi-structured, open-ended interview guidelines. Rather than using rigid questionnaires, interviews were structured as guided conversations to enable a more fluid exchange of information (Yin, 2017; Cruz Cruz et al., 2023). A total of eight semi-structured interviews (45–60 minutes each) were conducted across the entire value chain. Primary interview data were supplemented by secondary documentary sources, including corporate reports from NG-

Seeds and institutional publications from the CGNA research centre (Table 1). The interviews were conducted between July 2023 and March 2024 using a pre-established protocol designed to gather key insights into corporate strategy, production, sales, customers, and suppliers. Additionally, the questions specifically addressed the adoption of technology developed by CGNA to support science-based product innovation.

To ensure analytical rigor, a four-step data analysis and triangulation process was applied: (1) Data Convergence and Comparison: Claims made by internal key informants were systematically cross-checked against evidence provided by external stakeholders; (2) Pattern Matching and Verification: Operational capabilities reported by the Production Manager were cross-referenced with the supply consistency reported by agricultural suppliers, while qualitative statements regarding R&D progress were validated against the company's technical metrics; (3) Synthesis and Structural Mapping: Any discrepancies were analysed, and converging evidence was synthesized using Porter's (2016) structural framework to map innovation drivers, barriers, and strategic outcomes. Table1 collects the methodological design and data collection.

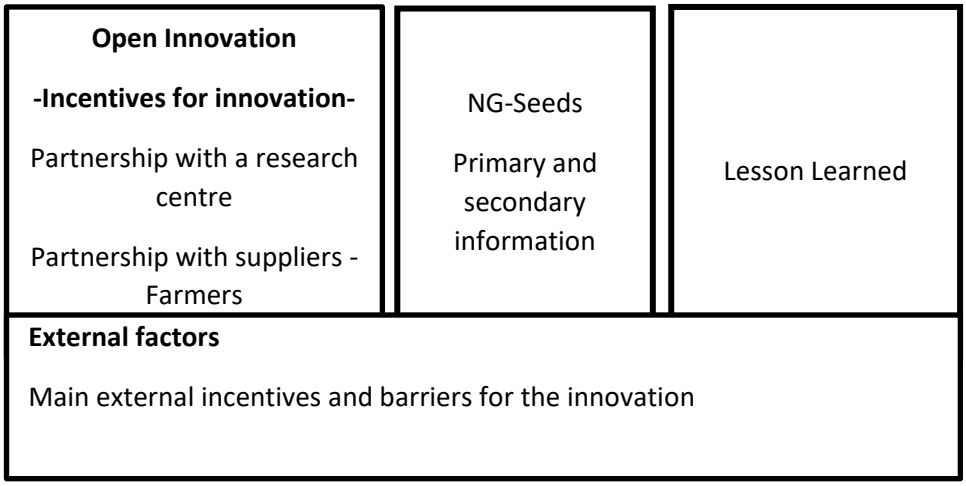
Table 1. Summary of Methodological Design and Data Collection Framework

Dimension	Description & Implementation
Interviewees & Profiles ($N = 8$)	· CGNA: Director, D&i Manager. · NG-Seeds: Director, CEO, Production Manager. · External: 1 Main Customer, 2 Key Agricultural Suppliers.
Instrument & Question Focus	Semi-structured open-ended guide addressing 6 key axes: (1) Historical performance, sales, customers (2) Core value proposition, (3) Market growth barriers, (4) Internal weaknesses, (5) Future sustainability actions, and (6) Strategic shift from Feed to Food supported by CGNA.
Analysis & Coding Method	Structural strategic process analysis (Porter, 2016). Transcripts and documents were coded to identify external incentives/barriers, open innovation dynamics, and technology adoption drivers to map the case process
Data Triangulation	Three-way validation: Triangulating internal executive insights with external stakeholder feedback (suppliers/customer) and secondary documentary evidence to prevent managerial bias and ensure construct validity.

Source: own elaboration

For the case study, we conducted a structural analysis based on the strategic process described by Porter (2016), identifying key factors related to innovation, including the main drivers of innovation and the principal barriers to its adoption. We then describe the outcomes of this process, which resulted in a new science-based innovation: a new food ingredient. Finally, we present the main conclusions drawn from the case study and relate them to the existing literature, highlighting the lessons learned. The steps followed in the analysis are included in Figure 1.

Figure 1. Analysis of the case study of NG-Seeds



Source: Own elaboration

3. CASE ANALYSIS

Productora de Semillas S.A. (NG-Seeds) is a Chilean company dedicated to the production and processing of flaxseed and lupin[1], two specialized crops used in the food industry. In 2015, the company established a partnership with a research centre: NG-Seeds obtained a commercial exploitation license for a new lupin variety developed by the CGNA Science and Technology Center, known as AluProt-CGNA®. Its main distinguishing characteristic is its high protein content (60% on a dry

[1] Also known in Spanish as lupino.

basis in the dehulled grain), an attribute that earned it the Chilean AVONNI Innovation Award[2] in 2016.

The company was established through a partnership between the research centre and five Mapuche farming cooperatives[3]—a form of partnership with suppliers—to exploit the commercial potential of AluProt-CGNA® and produce plant-based protein initially intended for salmonid feed[4] in Chile's aquaculture industry[5]. In the mid-2010s, this industry was projecting high growth rates, and demand for fish feed was increasing rapidly. These favourable market conditions made it attractive for the company to specialize in protein production for salmon feed and develop its strategy around this promising market opportunity.

NG-Seeds was expected to reach an annual grain-processing capacity of approximately 20,000 tons within five years, generating annual sales of more than US$10 million. The grain's nutritional and techno-functional properties were expected to enable it to compete successfully with soybean, its main substitute and competitor. Consequently, the company did not anticipate significant competitive pressure.

Leading feed manufacturers in Chile's aquaculture sector expressed a need to incorporate this grain into fish feed. In response, NG-Seeds adopted an innovative approach to cost management and strategic alliances, with the aim of cultivating AluProt-CGNA® across more than 12,000 hectares within the following five years. This investment was expected to establish the company as an important player in the domestic market and provide farmers with a new alternative offering significant advantages for crop rotation with cereals and oilseeds. However, barriers emerged during the innovation process, prompting the company to change its strategic direction in response to the exponential growth in demand for food products intended for human consumption.

The following sections describe the incentives and barriers that led to this strategic reorientation, highlighting partnerships with a research centre and agricultural suppliers as key drivers of innovation. Therefore, we answer RQ1 and RQ2 in the following lines. The underlying objective was to capture the value created by science and technology, while also

[2] AVONNI is Chile's most prestigious honorary recognition for innovation.

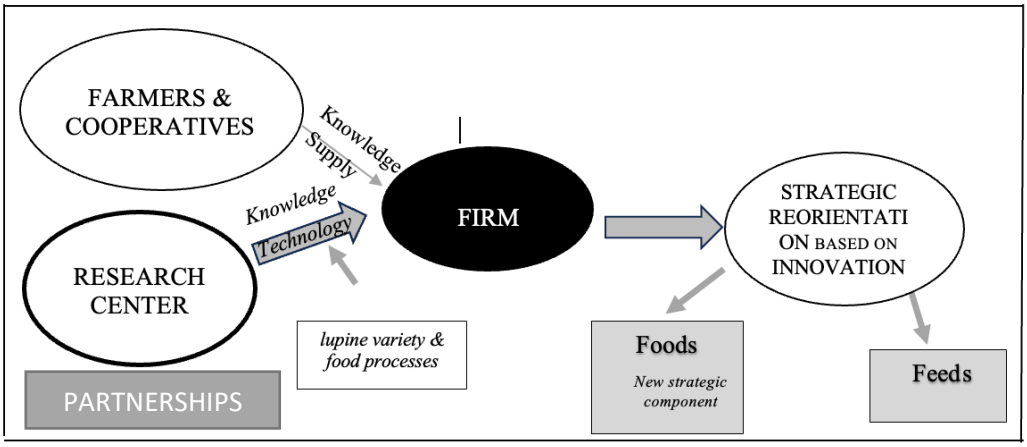
[3] The Mapuche are an Indigenous people of southern Chile with strong ties to rural life and traditional agricultural practices.

[4] Mainly salmon and trout.

[5] Aquaculture refers to the activities, techniques, and knowledge involved in the farming of aquatic plant and animal species.

leveraging the experience and knowledge of supplier-farmers. In the medium term, this approach enabled the introduction of two product lines into the domestic market, with potential global reach: one for animal feed and another for human food. This process is illustrated in Figure 2.

Figure 2. The introduction of technology and knowledge in NG-Seeds from the main partner as a basis for innovation and strategic reorientation.



Source: Own elaboration

3.1. Incentives to innovation. The role of the Partnerships for the generation to innovation.

The interviews and information about the company highlighted the incentives that led to a strategic reorientation which made innovation possible. The main enablers identified were partnerships with a technology supplier-CGNA- and partnerships with the farmers. Therefore, these are the incentives that answer RQ1 in this paper.

a. Partnership with technology supplier: CGNA

In 2010, the Center for Agri-Aquaculture Nutritional Genomics (CGNA) was established in the La Araucanía Region of Chile. The initiative was supported by the Chilean government, which aimed to decentralize scientific research and develop regional capacities to address

local industry challenges. To achieve this goal, CONICYT[6] launched funding calls to create new science and technology centers. Universities and research institutions based in the regions could apply for these funds. Universidad de La Frontera, Universidad Católica de Temuco, and the Agricultural Research Institute (INIA) joined forces to submit a proposal. They received the grant in 2005, which led to the establishment of CGNA as a new legal entity in 2010.

CGNA focuses on two main areas: plant science and food science and technology. Its goal is to connect agriculture with the food and animal feed industries. Its work aims to develop specialized agricultural raw materials, such as grains, for food production, improve agro-industrial processes, and create innovative, value-added food products. One important focus was the growing demand for protein ingredients in the aquaculture industry, especially for salmon and trout feed. At the time, this industry was expected to grow rapidly and relied mainly on imported soybeans and other grains to produce fish feed.

In 2014, after several years of genetic research, controlled breeding, genomic-assisted selection, and field and laboratory testing, CGNA developed AluProt-CGNA®, a sweet lupin variety belonging to the Lupinus luteus species. It was the first cultivar of this species developed in Chile. With a protein content of 60% in the dehulled grain[7][8] , this variety achieved an exceptionally high protein concentration for an agricultural raw material. It later received the AVONNI Innovation Award in 2016.

AluProt-CGNA® has several valuable properties for the food and animal feed industries. It contains functional compounds, including carotenoids such as zeaxanthin and lutein. Its low oil and fiber content makes industrial processing easier, while its protein contains all the essential amino acids. The grain also has useful technological properties that allow it to be used in different industrial processes. These characteristics meet the long-term needs of the food and animal feed industries.

[6] CONICYT (National Commission for Scientific and Technological Research), now known as ANID (National Agency for Research and Development), under Chile's Ministry of Science, Technology, Knowledge, and Innovation.

[7] Grit refers to the dehulled grain.

[8] Protein content expressed on a dry-weight basis.

Unlike soybean, its main competitor, AluProt-CGNA® does not require a defatting process using organic solvents to produce ingredients with protein concentrations of 40–50%. The grain also contains natural antioxidants and is non-GMO[9] .

Its growing conditions also offer advantages over soybean. AluProt-CGNA® can grow in cool, temperate climates, such as those found in southern Chile, where it is well adapted to local soil and climate conditions. It may also be suitable for other areas of South America with similar conditions.

As a legume, AluProt-CGNA® can absorb nitrogen from the air through a symbiotic relationship with soil bacteria. Its roots also release organic acids that help make phosphorus trapped in the soil available to the plant. These characteristics reduce its need for external nitrogen and phosphorus inputs, supporting environmental sustainability and agricultural resilience.

b. Partnership with farmers

To capitalize on the business opportunities created by this technological development and promote economic opportunities for farming communities in La Araucanía, CGNA supported the creation of NG-Seeds. The company was established through a partnership between five farming cooperatives (Cooperativa Los Robles, Cooperativa Huichahue Newen, Cooperativa Peñihuen, Cooperativa Wull Agro, and Cooperativa Moñenco) and CGNA, which held a minority stake. CGNA's main contributions included a license to commercially exploit Alu*Prot*-CGNA®, technological support, and business incubation.

In an unconventional move, CGNA brought small-scale farmers into the initiative, creating a collaborative model for the development, production, processing, and marketing of lupin and its derivatives. The five cooperatives involved in NG-Seeds, together with their networks, represented more than 100 farmers who could potentially become suppliers. The company's initial supply strategy therefore focused on building close, flexible relationships with small-scale farmers who belonged to the cooperatives or were connected to them. NG-Seeds

[9] GMO stands for genetically modified organism.

provided seeds and other agricultural inputs, while the farmers cultivated the lupin.

This initial approach was later extended to other small- and medium-sized farmers, enabling the company to expand the cultivated area to more than 1,000 hectares in its first few years. The strategy strengthened the company's grain supply, increased the area under cultivation, and generated valuable feedback on crop management practices.

3.2. Barriers to innovation.

Several barriers had to be overcome to advance the innovation process and address RQ2. During this process, the company also faced several entrepreneurial challenges. These barriers are listed in Table 2 and discussed in detail below.

In years 2016 and 2017 the innovation progressed as projected, achieving sales to the aquaculture industry of more than US$1 million. Even though the implementation of the NG-Seeds strategy covered all the cryptic points detected in the business planning, some aspects still needed to achieve the expected results. Production did not reach the desired yields in the field, even though permanent corrections were made to the agricultural management plan to respond to the agronomic challenges detected. Some industrial process-level drawbacks were observed and resolved quickly, thanks to the alliance with CGNA, even creating new equipment.

It was also evident that a large group of farmers needed help to grow their crops under the indications provided by the technical assistance team. It was mainly due to a lack of capital, deterioration of the quality of soils, and an agricultural culture not used to the discipline and use of new technologies and the rigorousness that this implies. This last aspect, later diagnosed as a low technological absorption capacity, generated that many producers did not reach the economic break-even point, abandoning this crop and causing high supplier turnover in NG-Seeds. This projected growth was delayed and prevented the supply of grit *[shelled grain]* to its primary customer, as foreseen in the company's growth forecast.

Table 2. Main barriers identified in the phases of technology transfer to farmers.

Barriers to innovation	Diagnosis	Impact	Strategy implemented
Agricultural crop management does not conform to recommendations.	Insufficient local capacities to adopt technical crop management proposals.	Lower yield; reduced profitability in the field.	Development of a new crop management plan adjusted to local capacities. Change of technical assistance system.
Pathogen increase.	The increased pressure of fungi affects the crop. Climate change generates favorable conditions for pathogens.	Lower grain production, reduced field profitability, and high turnover of suppliers.	Development of new disease management strategies in the field. Development of new tolerant varieties.
High presence of weed.	High soil infestation of weeds. Low competition capacity of Alu*Prot*-CGNA.	Lower grain production; reduced profitability in the field.	Redefinition of planting conditions. Re-introduction of selective herbicide molecules for lupin.

Source: own elaboration

Along with the initial growth of the cultivated area, there were more intense attacks of fungi that caused the disease known as anthracnose, which negatively affects foliage, inflorescence, and pods, thus impacting the quality and quantity of the harvested grain. Additionally, some signs of climate change caused unseasonably high temperatures and heavy and

atypical rains in spring. The proposed solution implemented was mainly to improve the quality and health of the seeds and use fungicides, which effectively stopped the pathogen, but their cost was high. It led to the implementation of new management measures that included elements associated with seed quality, intensified monitoring of diseases, selection of farms and territories with less environmental pressure and inoculum load, and extension of the rotation cycle, among others.

There was also, albeit with less impact, the abundant presence of broadleaf weeds, for which there were no control solutions in Chile, after the crop was established, generating significant losses for farmers with high weed infestation in their farms. The answer came in 2018 with an herbicide that was authorized for use thanks to the registration process of an agrochemical company in Chile and CGNA's field evaluation work. All these negative factors slowed down the growth plan, reducing the attraction of customers for this product due to the impossibility of supplying it regularly and in large volumes. In addition, the increased presence of diseases in the crop and the difficulty for farmers to properly implement management plans reduced agricultural profitability and made it unattractive.

3.2. Discussion of the main factors that triggered the company's strategy reoganisation and innovation outputs.

Three main factors contributed to the company's innovation outcomes. First, the growing demand for plant-based proteins created a market opportunity that NG-Seeds was able to exploit. In particular, the expansion of salmonid farming in Chile increased demand for fish feed, creating a market niche for the company's product. Second, the company's cost structure was a key success factor. By avoiding high fixed costs and introducing a pricing system for harvested crops, NG-Seeds reduced the risks faced by farmer-suppliers. Finally, partnerships with a research centre and local farmers played a key role in the company's reorganization. This finding is consistent with FAO (2016), which highlights the importance of collaboration in agricultural development.

In the following lines we describe these three factors:

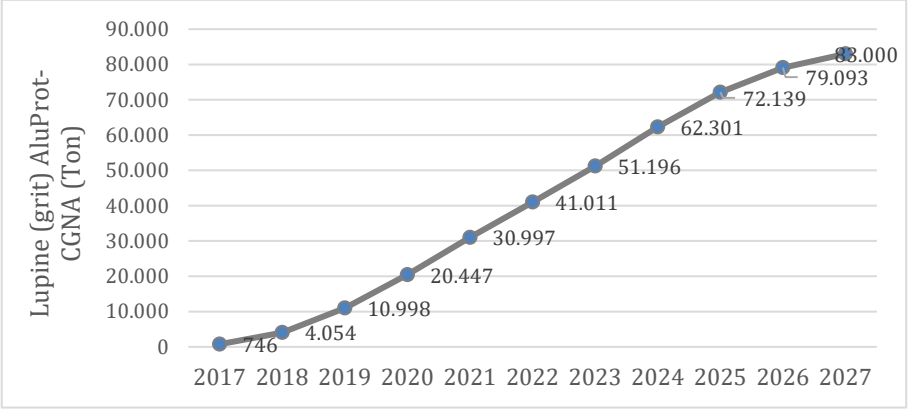
Positive evolution of the Demand

Thanks to its nutritional, industrial, techno-functional, and agronomic properties, together with the growth prospects of the food and animal feed industries, AluProt-CGNA® represented an attractive business opportunity with strong growth potential.

Based on market analysis, the company estimated that demand for approximately 80,000 tons of dehulled grain (*grit*) could be reached by year 10 (2017–2027). This would require around 110,000 tons of grain, representing less than 15% of national consumption. These estimates are presented in Figure 3.

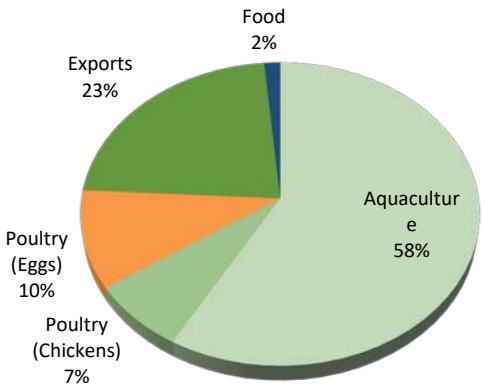
Of this projected volume, 23% was expected to be exported, providing a buffer against potential problems in the domestic market. Most of the remaining production would be used for animal feed, particularly in aquaculture, which was expected to account for 58% of total demand. This growth was driven by the expansion of salmonid farming in Chile, which increased the need for fish feed. Chile had become the world's second-largest producer of farmed salmonids. These projections are summarized in Figure 4.

Figure 3. Projected demand to be captured by NG-Seeds from 2017 to 2027



Source: NG-Seeds business model.

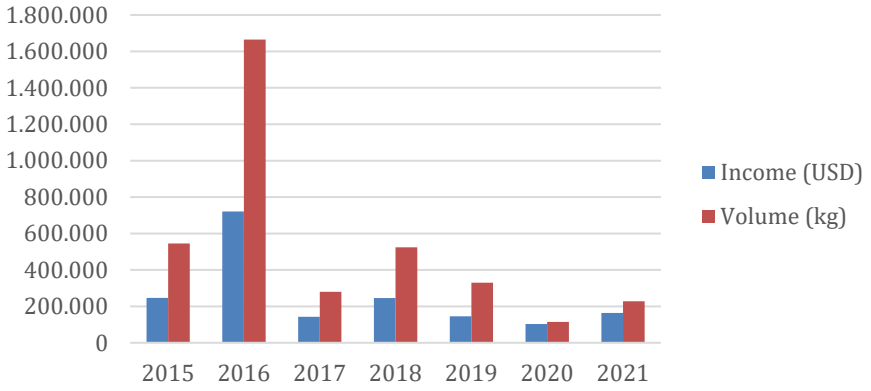
Figure 4. Distribution of projected sales to year 10 (2017 to 2027) according to the market segment



Source: NG-Seeds business model.

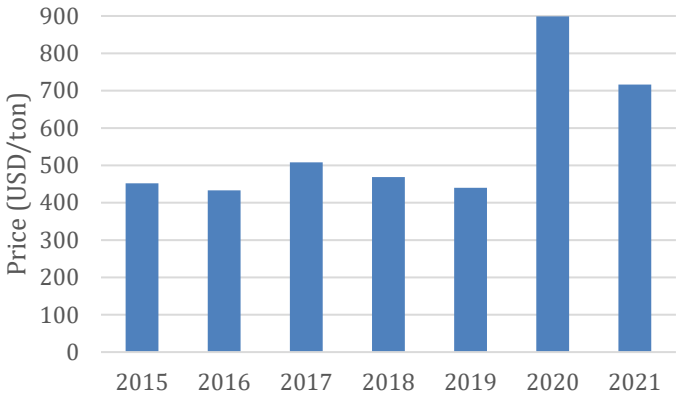
Figures 5 and 6 show the evolution of annual sales and prices between 2015 and 2021. Figure 5 shows that revenue increased in 2016 but then declined sharply in the following years, putting pressure on the company to reconsider its strategy. Figure 6 shows that sales prices increased in 2020 following a change in the company's target market.

Figure 5. Annual Sales 2015-2021 of NG-Seeds



Source: own elaboration

Figure 6. Evolution of the prices: 2015-2021



Source: own elaboration

Evolution of Costs

The business model was designed to avoid the high fixed costs typically associated with agribusiness and to build strong partnerships with suppliers and customers. Contracts with farmers in the La Araucanía Region established grain production plans, while cultivation gradually expanded into neighbouring regions, including Ñuble, Biobío, Los Ríos, and Los Lagos. These contracts guaranteed a purchase price for the grain, provided seeds that farmers paid for at harvest time, and included free technical assistance from CGNA as a public service. In line with the philosophy of NG-Seeds' shareholders, the company prioritized small-scale farmers.

NG-Seeds received the harvested grain at rented facilities, processed it into grit (dehulled grain), and sold it to previously identified markets, mainly the animal feed industry. During the first two to three years, short-term loans from INDAP[10] provided working capital to pay for grain purchases and processing costs. The industrial equipment required during this initial period was relatively simple, with an investment of less than US$50,000. The company could also rent facilities and hire temporary workers. By the fourth year, however, an investment of US$1.5 million

[10] INDAP (Agricultural Development Institute) is part of Chile's Ministry of Agriculture.

was expected to be necessary. At that stage, the company anticipated having established a strong market position and generated positive cash flows, which would facilitate access to credit.

The company focused on implementing technical recommendations to improve crop yields. It also developed seed multiplication as a complementary business alongside grain production for protein ingredients. Seed growers were carefully selected, with priority given to farmers belonging to NG-Seeds' partner cooperatives.

Seed selection and cleaning used the same facilities and equipment as grit production, creating synergies and reducing costs. Overall, the company's growth strategy relied on careful production planning and a simple, cost-efficient management structure

The generation of two Partnerships

NG-Seeds combined a business strategy based on strategic alliances with local suppliers, a flexible industrial cost structure, and deferred investment. This approach was well suited to the characteristics of the business. It is worth noting that, in Chile, as in other countries, local cooperatives play an important role in the development of the agribusiness sector (Llombart, 2024). The Regional Government of La Araucanía supported this business model by strengthening business incubation and technical assistance, particularly given the profile of the company's partners and suppliers and its potential impact on the region.

At that time, the human food market offered an attractive opportunity because of its size and potential prices[11] . However, accessing this market required NG-Seeds to adopt additional technologies and develop new products. Grit (dehulled grain) was only a raw material for animal feed. Meeting the needs of more sophisticated markets required further processing and new technologies.

NG-Seeds therefore defined its value proposition as follows: “Producer of high-quality plant-based protein for the animal feed industry.” To deliver this value proposition, the company relied on a strategic partner and technology provider (CGNA), a network of suppliers (farmers belonging to cooperatives and other partner farmers), a flexible

[11] Estimates suggested that the selling price could be twice as high as in the animal feed market if the company gained access to higher-value-added market segments.

cost structure, and a market with strong demand for products offering unique attributes.

3.3 The final innovation output. New nutritional human product

In 2018, the Inter-American Development Bank (IDB) provided a grant to support technical assistance for grain producers working with NG-Seeds. It also provided credit to help farmers access agricultural inputs and services. However, these measures did not fully resolve the innovation barriers.

By the end of the decade, the situation had become increasingly complex. Although demand continued to grow, NG-Seeds struggled to establish a strong market position and expand its business in a market dominated by large competitors. Anthracnose continued to limit crop profitability and expansion, while small-scale farmers faced difficulties in adopting the required technologies. These difficulties were not primarily related to access to capital, as initially assumed.

Despite its close partnerships with farmers, particularly small- and medium-sized producers, NG-Seeds could not secure the grain supply required to meet market demand. This was partly due to environmental challenges and partly to farmers limited technological capabilities. Meanwhile, the market for plant-based protein ingredients for human consumption continued to expand, growing at an estimated annual rate of around 10% and reaching US$10.1 billion in 2021 (Emergen Research, 2022). This growth was driven by changes in consumer habits and preferences.

Rising per capita incomes in several countries increased consumers' ability to purchase higher-priced, higher-quality food products. At the same time, growing environmental and ethical concerns influenced consumer attitudes toward animal protein. Interest in healthy foods and products with functional nutritional benefits also increased.

The food market was characterized by the coexistence of large companies seeking to dominate the sector and smaller, highly dynamic businesses. Consumers increasingly showed interest in new brands and products from companies with strong social and environmental commitments. They also valued products that reflected local identity, regional traditions, and geographical origin.

Faced with the difficulties of pursuing its original strategy of specializing in protein ingredients for animal feed, NG-Seeds identified a new opportunity in the human food market. To enter this segment, the company needed to develop new ingredients and food products. This led to renewed collaboration with CGNA, a key partner with strong scientific and technological capabilities.

CGNA developed the knowledge and technologies required to produce several lupin-based protein ingredients: a protein flour (HarinaProt), a protein isolate (Ultraprot-CGNA), and textured proteins (ExtruLupin-CGNA and TextuLupin-CGNA). Together, these products addressed the main forms of plant-based protein ingredients required by the food industry.

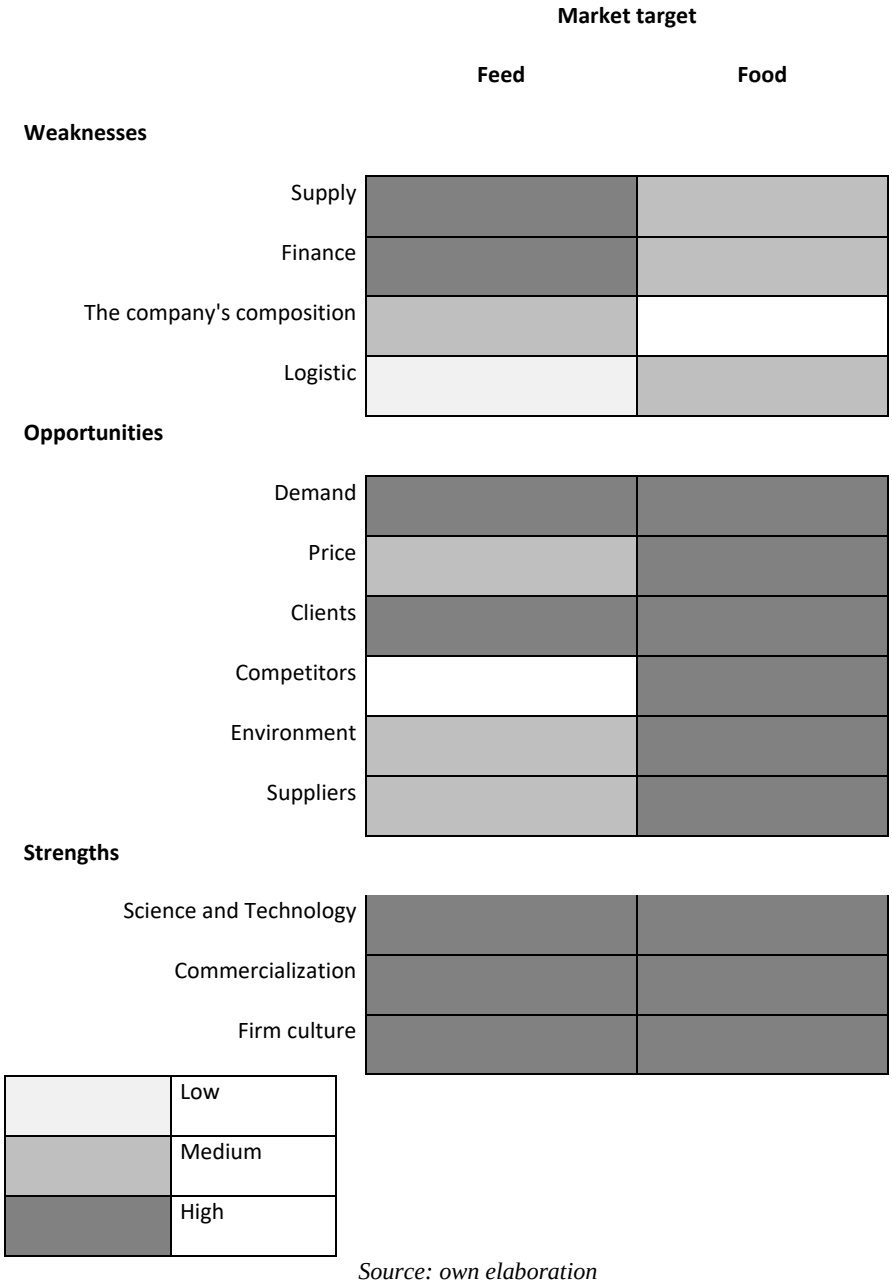
Food manufacturers tested the products and obtained promising results in a wide range of applications, including bakery products, snacks, protein bars, sauces, liquid and powdered beverages, and soups. Demand for NG-Seeds' products grew rapidly, supported by small- and medium-sized companies in both domestic and international markets. These customers used the ingredients to develop distinctive food products that were high in protein, entirely plant-based, vegan, non-GMO, and gluten-free, with an excellent nutritional profile.

The products NG-Seeds currently offers to the human food market generate more than 300% added value compared with grit (dehulled grain). This has increased the company's profitability and made its business model more attractive. Demand also comes from customers with different purchasing volumes, including small and medium-sized companies. This diversity has reduced the pressure to expand production rapidly and has allowed NG-Seeds to operate profitably at a relatively small scale.

At the agricultural level, the company introduced two key strategies. The first involved selecting growing areas with lower environmental pressure, where crops were less exposed to severe anthracnose attacks and conditions were more favorable for lupin growth and production. The company also introduced a remote-monitoring system and regular field visits to detect fungal infections early and apply appropriate control measures, including the use of biological control agents.

The second strategy involved developing a new *Lupinus luteus* variety using genomic tools. This variety is resistant to anthracnose, has a production potential 50% higher than that of AluProt-CGNA®, and produces larger seeds, improving industrial processing efficiency.

Table 3. Weaknesses, opportunities and strengths that contributed to innovation output and the strategic reorientation from feed to food.



Source: own elaboration

Finally, Table 3 shows the weaknesses, opportunities and strengths that contributed to innovation output and the company's strategic reorientation. Table 4 summarizes the main incentives and barriers affecting innovation development in this case study.

Table 4. Summary of the incentives and barriers for the strategic reorganization and innovation results from the feed to the food.

Incentives	**Barriers**
Technology-Genetics	Access to credit: Guarantee, flows and composition of the company
Suppliers-Alliance	
Agricultural access	Crop: Small scale production units, pathogen sensitivity and productivity
Resilient crop	
Partner cooperatives	

Source: own elaboration

The successful implementation of innovation translated into significant entrepreneurial and commercial outcomes for NG-Seeds. The cultivated area under the company's partnership model with local farmers increased from 42 hectares in 2018 to more than 500 hectares in 2024, representing a remarkable expansion of its production network.

Sales grew rapidly, driven by both increased production volumes and higher product prices resulting from the incorporation of value-added characteristics. By 2024, annual sales had reached approximately USD 500,000, accompanied by an expansion in both the number and diversity of customers.

The development of more adaptable and commercially attractive varieties also enabled the company to expand its geographical reach, establishing production in new locations across Chile and extending its activities into Argentina. This expansion demonstrates the potential of innovation to create new business opportunities while strengthening agricultural value chains and generating economic opportunities for partner farmers.

Looking ahead, the company's growth projections indicate the potential to establish production operations in three countries by the end of the 2020s, involving more than 5,000 hectares of cultivated land and

annual sales exceeding USD 15 million. These projections illustrate the potential for NG-Seeds to evolve from an emerging agricultural innovation venture into a significant regional player in the development and commercialization of high-value crops.

CONCLUSIONS

Partnerships play a crucial role in innovation, as firms need to interact with different partners to acquire knowledge and develop new capabilities. This is particularly relevant in the agribusiness sector and supports the findings of Ardito et al. (2020), FAO (2016), and Van de Vrande et al. (2009) regarding the importance of learning from external sources of knowledge.

This paper presents a case study in which partnerships with a research centre (CGNA) and suppliers (farmers) enabled NG-Seeds to enter the animal feed market initially and later overcome a crisis through strategic reorientation toward the human food industry.

The NG-Seeds case illustrates how a company can struggle to succeed in a commodity market when relying on conventional agribusiness practices based on transactional relationships and economies of scale. To overcome this crisis, the company changed its strategy by adopting an open innovation approach that involved collaboration with partners upstream and downstream in the value chain, as well as a shift in its target market.
The partnership with CGNA enabled NG-Seeds to access and adopt a new technology: AluProt-CGNA®, a new lupin variety developed to provide plant-based protein to the growing animal feed and food industries. The company initially focused on the animal feed market and later entered the human food market. Although the feed market offered a large potential customer base, relatively easy market entry, and limited requirements for complementary technologies, the company failed to achieve commercial success in this segment due to several challenges inherent in the innovation process.

The development of complementary technologies was also essential to the company's strategic reorientation. These technologies enabled the production of protein isolates, concentrates, textured proteins, and protein flours from AluProt-CGNA®, allowing the company to move toward higher-value-added plant-based protein products. Entering the human food market was particularly important because it offered higher profitability

and greater flexibility in terms of production scale. Moreover, ingredients derived from AluProt-CGNA® displayed outstanding nutritional and techno-functional properties, making them suitable for a wide range of food applications.

The strategic partnerships between NG-Seeds and CGNA was essential for two main reasons. First, it provided NG-Seeds with a license to commercially exploit the lupin variety, which had significant business potential. Second, CGNA offered technological support to improve and adapt both agricultural production practices and industrial processing. This collaboration also helped address potential intellectual property conflicts, an issue discussed in the literature by Holgersson and Aaboen (2019).

However, a decisive factor was the joint development of new technologies specifically tailored to NG-Seeds' needs. This deeper level of collaboration enabled the company to enter higher-value markets while adapting production processes to its operational capabilities.

Partnerships with farmer-suppliers also helped reduce the risks associated with adopting the new technology. Looking ahead, the company could resume scaling up production by establishing an appropriate balance between small-scale farmers, who may face difficulties in adopting new technologies, and medium- and large-scale farmers, who generally have greater technological capabilities and higher crop productivity. This combination could strengthen the reliability of the grain supply while maintaining the company's commitment to small-scale farmers.

Overall, the NG-Seeds case provides an example of good partnership practices for innovation in the agribusiness sector. It highlights the importance of combining technology development and adoption, collaboration with research institutions and suppliers, support for small-scale farmers, and strategic business reorientation to create new opportunities for innovation and growth.

The findings confirm previous research on open innovation and interorganizational collaboration. Consistent with Ardito et al. (2020), Van de Vrande et al. (2009), and Bertello et al. (2024), the case demonstrates that access to external knowledge through partnerships can strengthen innovation capabilities and create new business opportunities. It also reinforces the interactive and multidirectional perspective of innovation proposed by Kline and Rosenberg (1986) and Caraca et al. (2009), showing that collaboration with research institutions can extend beyond

technology transfer to include joint development and adaptation. Furthermore, the involvement of farmer cooperatives supports the arguments of FAO (2016), Vellema et al. (2020), and Vlachopoulou et al. (2021) regarding the contribution of inclusive partnerships to agricultural value creation and the integration of smallholder farmers into competitive value chains.

Nevertheless, the findings also show that partnerships alone do not guarantee successful innovation or sustained commercial growth. Consistent with Müller-Seitz (2012) and Ogink et al. (2023), the case highlights the importance of absorptive capacity and effective knowledge management. It extends these arguments by showing that such capabilities must be developed not only within the firm but also across its production network, particularly among agricultural suppliers. As illustrated by the challenges faced by NG-Seeds, technical assistance and collaborative networks may be insufficient when farmers lack the technological and productive conditions needed to implement new practices. Overall, the case suggests that successful open innovation in agribusiness depends on the complementarity between external partnerships, firms' internal capabilities, farmers' absorptive capacity, and the adaptation of technological solutions to local production conditions.

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