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Social Sustainability in Circular Bioeconomy Business Models: Insights From Argentina

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ABSTRACT

Research on circular bioeconomy business models (CBEBM) has largely prioritised environmental and economic aspects, leaving out the social pillar. To address this gap, this paper analyses to what extent and in what ways social sustainability is integrated into CBEBM, based on 12 cases from northern Argentina, a region with high potential for circular bioeconomy, but also important social concerns. Our findings indicate a selective integration of social sustainability categories into CBEBM. Employment, labour law compliance, and certifications are widely present, while gender inclusion, participatory governance, and ancestral knowledge remain marginal. The degree of integration is shaped by organisational forms, institutional frameworks, and territorial embeddedness. Based on novel empirical evidence from a marginalised region, the study shows that social sustainability cannot be assumed as a by-product of circularity and proposes practical strategies for strengthening its role in CBEBM.

1 | Introduction

Despite widespread agreement that the three pillars of sustainability—economic, environmental, and social—are equally important, the social dimension remains comparatively underdeveloped in both research and practice (Boström 2012; Cuthill 2010; Vallance et al. 2011). Its significance became more pronounced with the adoption of the 17 United Nations Sustainable Development Goals in 2015, 11 of which explicitly address social sustainability (Schroeder et al. 2019). Nevertheless, social sustainability continues to be treated as a rather vague and secondary concept, lacking the definitional clarity and practical orientation afforded to its environmental and economic counterparts (Afshari et al. 2022; Boström 2012; Cuthill 2010; Nilsson et al. 2024; Schroeder et al. 2019).

Many businesses strive to make their practices more sustainable, developing strategies and business models accordingly (Donner et al. 2022). However, research on the development of strategies for implementing social sustainability in particular remains limited (Boström 2012; Hartmann 2025). Decision-makers in business and industry frequently prioritise economic and environmental objectives, further marginalising social considerations (Govindan et al. 2021). This imbalance is particularly evident in emerging sustainability frameworks such as the circular economy, where environmental and economic priorities dominate the agenda and the social dimension receives comparatively little attention (Geissdoerfer et al. 2017). Several scholars have argued that more meaningful integration of the social dimension is essential for achieving a holistic and equitable model of sustainability (Boström 2012; Missimer et al. 2017; Murphy 2012).

A similar pattern is visible in studies on circular bioeconomy business models (CBEBM). These models encompass diverse production systems that transform biological residues into high value-added products and use cascading approaches to optimise resource use and minimise environmental impacts

(Carus and Dammer 2018; Salvador et al. 2023; Salvador and De Francisco 2025). In principle, CBEBM can contribute simultaneously to all three pillars of sustainability (Stegmann et al. 2020). However, most empirical and theoretical analyses concentrate on the economic and environmental pillars, leaving the potential for social value creation implicit or secondary (Eid et al. 2025). Geissdoerfer et al. (2017) point out that the social dimension is the least developed aspect of the circular business model literature, and Salvador et al. (2023) similarly highlight that CBEBM research pays limited attention to social issues.

Therefore, because the social pillar of sustainability remains imbalanced in both research and business practice, and because it is fundamental for achieving sustainable and more equitable business models, the following question is central: To what extent, and in what ways, is social sustainability integrated into circular bioeconomy business models? We address this question from two angles. First, by examining and connecting the theoretical frameworks of CBEBM and social sustainability, we develop an analytical lens for empirical exploration. Second, by analysing CBEBM cases empirically, we develop a better understanding of how social sustainability is already integrated. In the conclusions, we further propose strategies for implementing social sustainability in practice, based on the empirical insights gathered in this study.

We focus on Argentina, a Global South country and major biomass producer (Food and Agriculture Organisation 2020), with a highly competitive agricultural, livestock, and agro-industrial sector that generates substantial amounts of biomass residues. Nevertheless, CBEBM in Argentina remain underexplored. To address this gap, we selected 12 CBEBM cases located in northern Argentina—a region that has received little attention in bioeconomy research and is often marginalised in national economic and political debates. At the same time, this region is characterised by a diversity of alternative organisational forms, including cooperatives, social enterprises, and family farming initiatives. These business models have considerable potential to strengthen the social sustainability dimension of the circular bioeconomy, yet they are rarely included in dominant bioeconomy narratives.

Existing studies indicate that Argentina's bioeconomy is largely driven by large-scale agribusiness and biotechnology sectors, focused on low value-added production (e.g., soybean, maize, wheat, and related biofuels) with limited local benefits (Deciancio and Siegel 2022; Puder and Tittor 2023; Siegel et al. 2022; Sili and Dürr 2025; Tittor 2021). Although the bioeconomy is frequently promoted as a sustainable development strategy capable of reducing resource dependency, critics argue that this promise remains largely unfulfilled (Puder and Tittor 2023). Dominant bioeconomy activities are based on large-scale agricultural production, and soybean in particular, and they are often associated with significant social and environmental impacts, including land concentration, health risks from agrochemicals, and biodiversity loss (Siegel et al. 2022; Staricco and Buraschi 2022). Much less attention has been paid to other forms of agricultural production, some of which are connected to alternative models of bioeconomy and circular economy (Deciancio and Siegel 2023).

Advancing our understanding of the social dimension of sustainability is particularly urgent for many countries in the Global South, where social concerns are often more pressing and institutional capacities more limited. Because most existing research focuses predominantly on countries in the Global North, there is a substantial empirical and geographical gap. In practical terms, this means that countries in the Global South often lack the necessary guidance to address their distinct social challenges (Anisul Huq et al. 2014; Govindan et al. 2021). This highlights the need to prioritise research on social sustainability in the Global South, ensuring that sustainability policies and practices are not only effective but also inclusive, just, and contextually relevant. In relation to CBEBM, Salvador et al. (2022, 2023) highlighted the limitations of current research, noting that some regions, such as Latin America and the Caribbean, remain under-researched. Khan and Ali (2022) reached similar conclusions for developing countries. Likewise, Donner et al. (2020) reviewed 39 cases of CBEBM but found that only two came from Global South countries (Brazil and Vietnam).

The contributions of this paper to sustainability and management studies are threefold. Theoretically, it addresses a gap in the CBEBM literature by focusing on the social pillar of sustainability and contributes to the social sustainability literature by developing strategies for implementing the concept. Empirically, it introduces novel case studies in a region and in sectors of the bioeconomy that have so far received little scholarly attention. Practically, it proposes actionable strategies for decision-makers to support the implementation and design of CBEBM.

In the next section, we review recent literature on CBEBM and social sustainability frameworks to propose an analytical framework for our study. We then outline our methodological approach. Afterwards, we present the results by analysing three aspects: (1) mapping the diversity of CBEBM and their archetypes across cases, including key social features; (2) identifying patterns and gaps in the presence of social sustainability categories; and (3) exploring cross-case dynamics and tensions. Finally, we conclude by proposing practical strategies and recommendations for integrating the social pillar into CBEBM and outline avenues for future research.

2 | Theoretical Framework

This section examines and connects the theoretical frameworks of CBEBM and social sustainability to develop an analytical lens for the subsequent empirical analysis. Sub-Section 2.1 reviews the CBEBM literature, highlighting the need to give due consideration to the social pillar of sustainability. Section 2.2 examines the social sustainability approach, and Section 2.3 presents the analytical framework guiding our study.

2.1 | Circular Bioeconomy Business Models: Principles and Archetypes

The distinction between traditional and alternative business models is crucial for understanding CBEBM. Traditional models were rooted in the linear economy of extract-produce-use-dispose materials and energy (Korhonen et al. 2018), where the

environment was treated as a waste reservoir (Rosa et al. 2019). The emergence of the circular economy and sustainable development approaches has challenged this paradigm, prompting the transformation of production systems and the adoption of business models that consider value creation not only in economic terms, but also in environmental and social ones (Centobelli et al. 2020; Woldeyes et al. 2025). Alternative models, such as sustainable, circular, and circular bioeconomy business models, have been widely discussed in the literature (e.g., Bocken et al. 2014; D'Amato, Veijonaho & Toppinen, 2020; Näyhä 2019; Klein et al. 2022; Mukherjee et al. 2023; Schagen et al. 2023).

Business models are generally understood as representations of how firms create, deliver, and capture value (Osterwalder and Pigneur 2010; Teece 2010). While traditional models focus on revenues, costs, and profits (Teece 2010), alternative ones extend the value proposition to include environmental and social outcomes (Bocken et al. 2014; Centobelli et al. 2020; Klein et al. 2022). CBEBM, in particular, are production and consumption systems based on the use of biological resources. Their main aim is to create value by transforming biological waste into high value-added products, establishing cascading systems to make the best use of resources and minimize the impact on the environment (Carus and Dammer 2018; Salvador et al. 2023; Stegmann et al. 2020). They differ from traditional bioeconomy models because of their emphasis on the cascading use of resources and the valorisation of waste (Stegmann et al. 2020), which requires the coordination of actors and innovations across the value chain.

To classify business models, researchers and practitioners have proposed several archetypes of alternative business models (e.g., Bocken et al. 2014; Lüdeke-Freund et al. 2019; Salvador et al. 2023). Archetypes are defined as "groupings of mechanisms or solutions (i.e., elements) to design or transform business models according to a specific purpose (e.g., circular economy, sustainability)" (Pieroni et al. 2020, 2). Salvador et al. (2023) conducted a comprehensive literature review on CBEBM to define and illustrate seven archetypes, exemplifying each with circular economy strategies that address economic and environmental issues. Table 1 summarises these archetypes, which we use both to categorise our empirical cases and to construct our analytical framework.

While CBEBM are often praised for their potential to create value across the three pillars of sustainability, most empirical and theoretical work has concentrated on economic performance and environmental efficiency. The social pillar, in contrast, is frequently treated as a by-product of circularity or left implicit in discussions of business models (Geissdoerfer et al. 2017; Salvador et al. 2023). Recent contributions have begun to address this gap: Donner et al. (2020) partially integrate the social dimension through stakeholder analysis, Klein et al. (2022) incorporate socio-economic perspectives into CBEBM analysis, and Salvador et al. (2023) link their archetypes to Sustainable Development Goals. Nonetheless, these efforts remain fragmented and lack a comprehensive analytical framework connecting CBEBM to social sustainability in a systematic way.

To address this limitation, the next section reviews the concept of social sustainability and its operationalization challenges, which will serve as the basis for developing an integrative framework capable of capturing how social aspects are embedded within CBEBM.

2.2 | Social Sustainability: Conceptual Challenges and Analytical Approaches

Since the publication of the Brundtland Report in 1987, which promoted the concept of sustainable development, sustainability has become central to research and policy, initially focusing on environmental and economic concerns. The social dimension has gained increasing relevance since the 1990s, especially in recent years (Afshari et al. 2022; Nilsson et al. 2024), but is often described as the most elusive of the three sustainability pillars (Boström 2012; Vallance et al. 2011). While economic and environmental aspects have well-defined indicators and frameworks, the social dimension remains contested and difficult to operationalize (Cuthill 2010; Nilsson et al. 2024). Several authors have highlighted the vagueness of the concept, which can lead to its sidelining in decision-making processes (Schroeder et al. 2019).

In broad terms, social sustainability is defined as the capacity of societies to ensure equitable, inclusive, and enduring well-being for current and future generations. It addresses aspects such as social equity, access to resources, quality of life, and participatory governance, among others (Nilsson et al. 2024). Despite its growing visibility, it is a multi-dimensional concept that remains open and evolving (Afshari et al. 2022; Boström 2012), highly dynamic and context-dependent, with significant variation across temporal and geographical settings (Dempsey et al. 2011). In the business context, some frameworks have attempted to translate these ideas into corporate social responsibility (CSR) practices, stakeholder engagement, or social impact assessments (Boström 2012; Missimer et al. 2017).

The absence of a universally accepted definition has contributed to questions about the legitimacy and applicability of social sustainability, with divergent interpretations rooted in varying academic disciplines, cultural contexts, and professional perspectives (Åhman 2013; Nilsson et al. 2024; Rasouli and Kumarasuriyar 2016; Weingaertner and Moberg 2011). Boström (2012) identifies two key barriers that hinder the development of social sustainability: first, defining its substantive goals, and second, understanding how to implement those goals effectively. While academic research has focused predominantly on the former, the development of strategies for the implementation of the concept remains a critical area for future research (Nilsson et al. 2024). Our paper seeks to address this gap.

Beyond definitional ambiguity, social sustainability is also deeply shaped by socio-political histories and epistemological traditions (Åhman 2013; Rasouli and Kumarasuriyar 2016), a point that becomes crucial in Latin American contexts. Approaches grounded in indigenous territoriality, post-extractivist critiques, or collective forms of land stewardship may not align with institutionalised or northern-derived sustainability frameworks. For instance, Dam et al. (2025) demonstrate in their analysis of biomass value chains on marginal lands that mechanisms of inclusion are often embedded

TABLE 1 | Archetypes of circular bioeconomy business models.

Archetype	Core	Example of strategies
1. Optimising resource efficiency and use	Resources are used at the highest possible efficiency; thus, resource consumption is minimised both by requiring less input and generating less waste.	Reduce or eliminate waste; Design out waste; Lean manufacturing; Offering refilling; Cascaded systems; Offering upgrade options; Offering durable and modular products; Offering repair and maintenance options.
2. Value recovery from waste	Waste is at the core of the value proposition, which is the recovery of the maximum value from waste.	Algae for wastewater treatment; Producing bioenergy or biofuels from bio-waste; Composting; Upcycling; Reconditioning; Remanufacturing; Refurbishing; Reusing; Recycling.
3. Innovation towards bio- and renewable resources	Innovation is used to find novel solutions to societal concerns or to meet societal needs and desires by using bio-based resources.	Biofuels or bioenergy from novel or harmful sources; Circular procurement; Biomimicry-inspired innovation; Replacing non-renewable resources
4. Establishing biorefineries	Sharing facilities or resources between firms.	Sharing facilities or resources; Forming clusters or networks; Forming cooperatives and bioproduction parks; Vertical or horizontal integration of production.
5. Resource exchange	Resources are exchanged, thus there is a change in ownership.	Industrial symbiosis; Buying or receiving resource flows from others; Selling or giving away resource flows to others
6. Valuing the local economy	Prioritising local resources as feedstock to meet local needs.	Prioritising local suppliers and local customers; Valuing the local economy
7. Service- and result-oriented value offers	Providing a result or a service instead of solely delivering a physical product and holding stewardship of the physical means through which the result or service is produced.	Product-service systems; Extended producer responsibility; Service provision (waste treatment with upcycling purposes).

Note: Based on a comprehensive literature review, the authors defined and illustrated these archetypes, providing examples of circular economy strategies linked to economic and environmental issues. Their framework informed the classification of the empirical cases in this study and the construction of the analytical framework presented in Section 2.
Source: Own elaboration based on tables 1 to 7 in Salvador et al. (2023, 354–357).

in asymmetric power relations and governance trade-offs that exceed formal stakeholder participation. These insights underscore that social sustainability cannot be treated as a neutral or universally transferable set of principles, but rather as a historically situated and relational concept shaped by inequalities, contestation, and situated notions of well-being (Nilsson et al. 2024; Weingaertner and Moberg 2011).

This broader perspective challenges the idea that the social dimension is simply an 'add-on' to existing business models. Instead of merely softening or complementing economic and environmental objectives, social sustainability may in some cases hold the potential to reconfigure core business model logics by redefining value creation, governance arrangements, or relationships with territories and communities (Åhman 2013; Cuthill 2010; Rasouli and Kumarasuriyar 2016; Vallance et al. 2011). This distinction between additive and transformative understandings is particularly relevant for CBEBM, where local knowledge systems, cultural meanings, and social relations can both enable or constrain circular practices. Conceptually incorporating these dynamics allows us to understand social sustainability as both a category of analysis and a potential driver of organisational and territorial transformation.

To clarify and operationalize the social sustainability concept, several frameworks and typologies have been proposed over the past two decades (e.g., Afshari et al. 2022; Boström 2012; Nilsson et al. 2024) and several literature reviews on social sustainability have been published (e.g., Murphy 2012; Weingaertner and Moberg 2011). Among them, Nilsson et al. (2024) offer a particularly comprehensive approach, combining a systematic literature review with content analysis, and synthesising both academic and practical perspectives. Their framework proposes more than 20 social sustainability categories, with four 'core categories' that appear most frequently across definitions: inequality reduction, well-being, participation and influence, and social relationships and networks.

This framework is particularly suitable for our study, as it provides a multifaceted and integrative analytical tool that aligns with our holistic perspective. We employed all of Nilsson et al.'s categories to guide the coding of interview data and to assess how social dimensions are manifested or absent across the CBEBM cases (see in Table A1 the list of categories and their descriptions, and in Table A4 categories and sub-categories used for coding).

Having clarified the conceptual landscape of social sustainability, we now turn to its connection with CBEBM. This connection is essential to construct an analytical lens capable of capturing how the social dimension can be embedded into CBEBM.

2.3 | Analytical Framework

To bridge the literature on CBEBM and social sustainability, we developed an analytical framework that allows us to identify not only whether social aspects are present but also how they shape business model dynamics in practice. While CBEBM scholarship has primarily emphasised environmental and economic mechanisms of value creation (Salvador et al. 2023; Stegmann et al. 2020), insights from social sustainability research show that social dimensions may support, constrain, or even reconfigure business models—particularly in contexts marked by inequality, informality, or strong territorial identities.

In this study, we use Nilsson et al.'s (2024) framework as our main analytical tool. Grounded in a systematic review and content analysis of academic and practical definitions, its breadth provides a comprehensive set of categories that allow for systematic comparison across cases. These categories help to identify instances of social sustainability within CBEBM, whether it is present, weakly integrated, or absent. However, we supplement this framework with additional conceptual considerations that are particularly pertinent in Latin American contexts.

As discussed in Section 2.2, social sustainability cannot be considered as a mere additional layer placed on top of existing business model logics. In some contexts, local knowledge systems, community governance arrangements and culturally embedded notions of well-being can reshape how value is defined, produced and distributed. Distinguishing between additive and transformative social dynamics is crucial for understanding how CBEBM operates in peripheral or marginalised regions, where integrating social considerations may reflect strategies of autonomy, resistance, or community empowerment, as well as compliance with institutional norms. We use the term compliance to denote adherence to externally imposed standards—particularly labour regulations, certification schemes, and buyer-driven requirements—rather than internally defined practices. Within CBEBM, compliance typically reflects asymmetric relations with actors who control market access.

Our analytical framework integrates the CBEBM framework with three complementary dimensions: (1) systematic identification of social sustainability categories, as defined by Nilsson et al. (2024); (2) contextual interpretation of these categories, recognising that social meanings, priorities and tensions may differ from institutionalised or Northern-derived definitions; (3) assessment of the potential for transformation, examining whether social dimensions merely support other aspects of the business model (e.g., compliance with certification and labour regulation), or whether they can reconfigure it.

By combining these perspectives, the analytical framework allows us to capture not only what social categories are present in CBEBM, but also how and why they take shape in particular ways across the cases studied. This integrated approach aligns with the paper's aim of evaluating the extent to which social sustainability is embedded in CBEBM and identifying the patterns, absences, and underlying tensions that emerge in practice. Figure 1 presents the analytical framework, which then guide our empirical analysis and informs the strategies proposed in the conclusions.

3 | Methods

Due to the exploratory nature of this study and our aim to generate empirically grounded insights into the complex phenomenon of CBEBM and social sustainability, we adopted a qualitative research design (Farrukh and Sajjad 2024; Maxwell 2013). To foster familiarity with the field while maintaining the broader perspective required for informed theorising, the research team comprised members both from the country under study and from outside it (Gioia et al. 2013). Throughout the fieldwork, the long-standing professional experience of the two Argentinean co-authors working with agricultural producers and institutions in northern Argentina facilitated access and trust-building—particularly in peripheral regions where external research often encounters more suspicion. This positionality strengthened rapport but required continuous reflexivity to avoid introducing assumptions.

3.1 | Case Selection and Sampling Strategy

This study follows a qualitative multiple-case study design (Yin 2009) aimed at exploring how social sustainability is integrated into CBEBM. We adopted a purposive sampling strategy, selecting cases that combined bio-based production with circularity principles, represented diverse organisational forms, and were embedded in a socio-economically peripheral region of Argentina. Purposive sampling ensured that participants who could provide comprehensive insights into each case were included (Farrukh and Sajjad 2024; Yin 2009).

Case selection followed a three-step process. First, we conducted preliminary interviews with stakeholders linked to the bioeconomy sector in Argentina. These interviews helped identify northern Argentina as a strategically relevant region due to its concentration of non-dominant agricultural activities, historical marginalisation in national debates, and the presence of alternative organisational forms such as cooperatives and family farming initiatives. Second, we used the 2018 National Agricultural Census of Argentina (Instituto Nacional de Estadísticas y Censos 2018) to identify non-dominant agricultural activities in relation to national figures, but which are highly representative at the provincial level, in order to move beyond well-studied cases of staple crops and biofuels. For example, jojoba represents

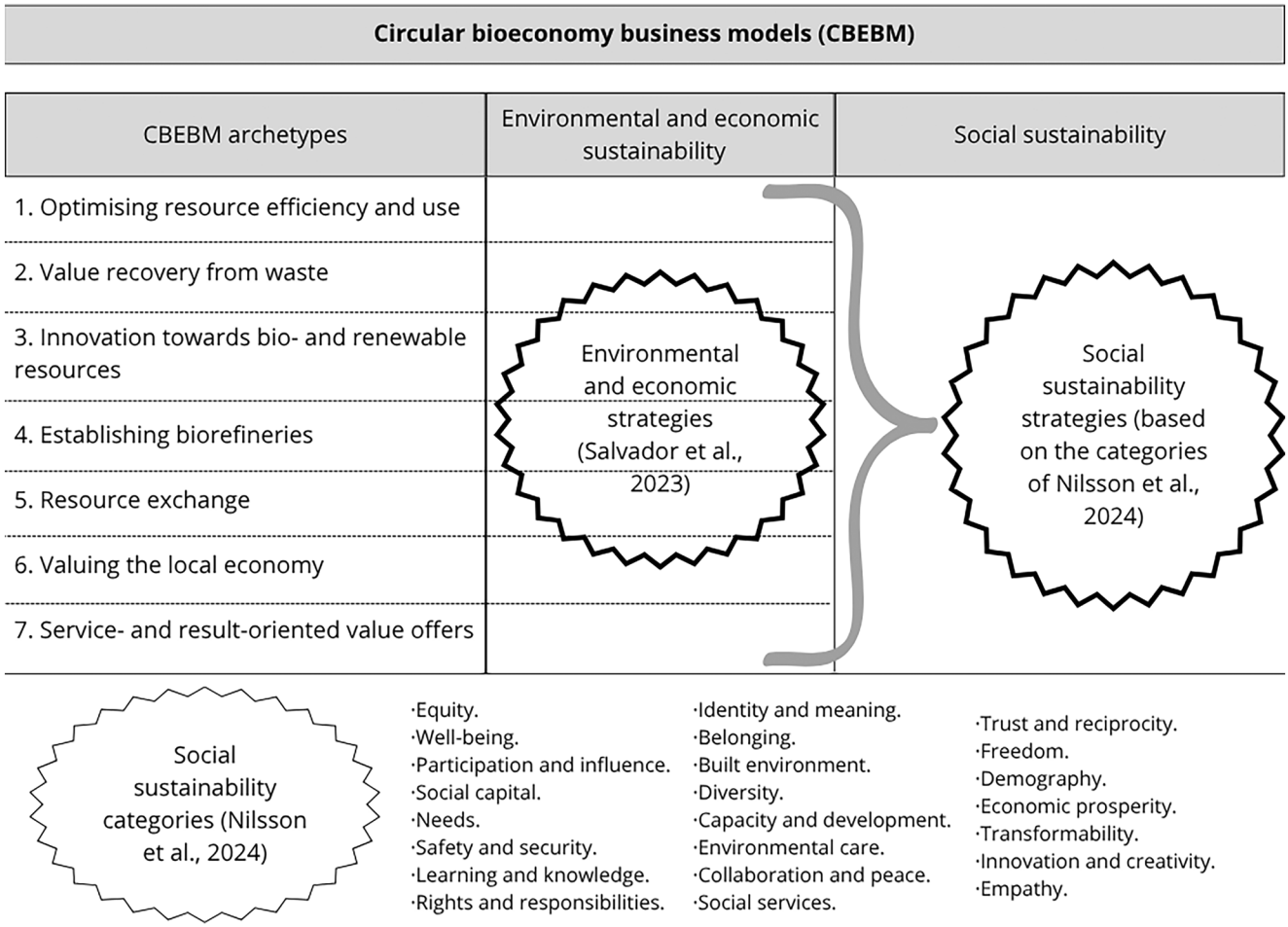

FIGURE 1 | Analytical lens for analysing social sustainability in Circular Bioeconomy Business Models (CBEBM). This framework connects the seven archetypes of CBEBM proposed by Salvador et al. (2023) with the social sustainability categories developed by Nilsson et al. (2024), enabling the analysis of how social aspects are integrated alongside environmental and economic dimensions.

only 0.3% of industrial crops nationally but is one of the main crops in La Rioja province (Instituto Nacional de Estadísticas y Censos 2018, 212). This approach ensured the inclusion of sectors typically overlooked in mainstream bioeconomy research. Third, we conducted exploratory interviews with technical experts, producer organisations, researchers, and institutional actors to validate the relevance of these activities and make the final selection of cases.

Following this process, we selected twelve cases relevant to the circular bioeconomy because of the combination of circularity principles with bio-based resources. This included a variety of organisational forms: two cooperatives, two family businesses, five medium-sized and large companies, two vertically integrated firms and one start-up, operating in various sectors of the bioeconomy (including agriculture, livestock, food, biotechnology, and services). This diversity allows for a meaningful comparison of how social sustainability is integrated—or neglected—across different types of business models.

Most of the cases are located in northern Argentina, a region that is far from the economic and political centre of the country and faces important socio-economic challenges such as inequality, informality and limited infrastructure. This area is particularly important for studying the social dimensions of CBEBM as it offers opportunities for developing bioeconomy business models while also presenting important social and economic constraints. Figure 2 shows the geographical distribution of the cases.

3.2 | Data Collection

Data collection was conducted between 2022 and 2023 using semi-structured interviews and secondary sources. Semi-structured interviews were chosen because they allow for in-depth exploration of multiple dimensions of social sustainability while enabling participants to introduce issues not anticipated by the researchers. The interview guide was organised around four main topics: (1) business models with a focus on value creation, (2) the bio-resources value chain and biomass waste generation and uses (useful for archetyping each case), (3) environmental and economic issues related to the business model, and (4) specific social issues using Nilsson et al.'s (2024) categorisation as a compass. This structure ensured comparability across cases while providing flexibility for probing emerging themes.

We interviewed owners, managers, cooperative leaders, technical staff, and institutional actors (researchers, extension agents,

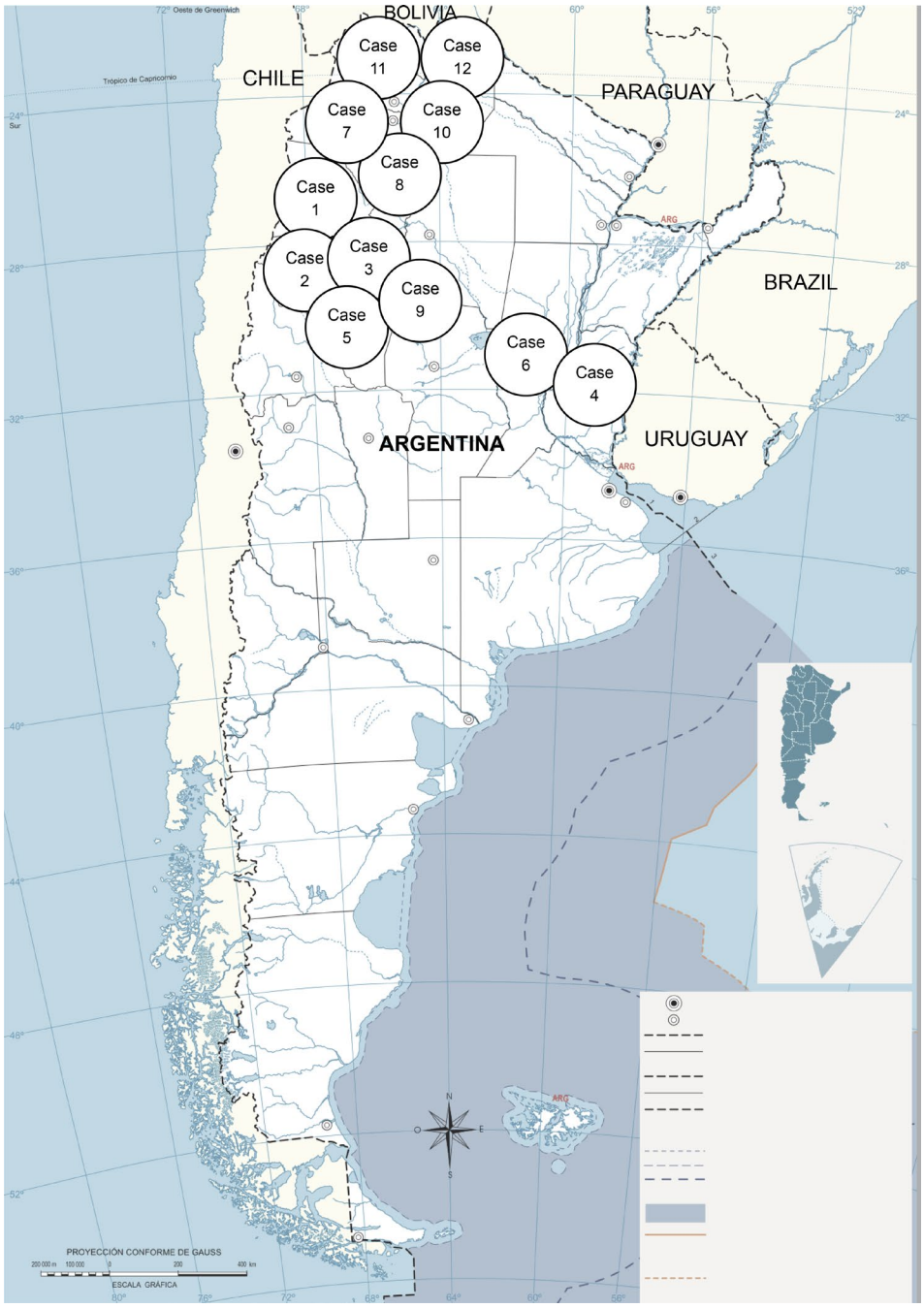

FIGURE 2 | Location of the cases in Argentina. Source: own elaboration. The map highlights the concentration of cases in northern Argentina, a peripheral region where socio-economic challenges such as inequality, informality, and limited infrastructure intersect with opportunities for developing circular bioeconomy business models. This territorial focus underscores how location and context shape both the opportunities and the constraints for integrating social sustainability into CBEBM. *Source*: Instituto Geográfico Nacional (w.d.) (2025).

and public officials). We selected participants through purposive sampling, based on their direct involvement in the organisation's circular bioeconomy activities or their relevant technical expertise. Snowball sampling (Kirchherr and Charles 2018) was also used to identify additional knowledgeable participants within each value chain.

A total of 24 interviews were conducted, lasting between 30 and 80 min either in person or virtual depending on logistical feasibility. All participants were informed about the aims of the study and gave consent for participation and recording. Interviews were conducted and transcribed in Spanish. Direct quotations were translated into English by the authors (see Table A2 for interview details). We used both structured and open non-leading questions in the interviews, and field notes captured interactional dynamics and potential biases, ensuring that participants' perspectives guided the narratives collected.

To enhance the robustness of the data, we complemented interviews with secondary sources, including technical reports, internal organisational documents (when available), producer

association materials, company websites, and media publications (see Table A3 for secondary sources details). These sources supported triangulation and allowed cross-validation of information about organisational history, certifications, and production processes. In addition, field visits were carried out in selected cases—particularly cooperatives and agricultural organisations—enabling direct observation of production processes, organisational facilities, and local socio-environmental conditions. These observations were systematically documented in field notes and later incorporated into the analysis.

Together, these multiple sources of evidence strengthened the credibility of the empirical material and allowed for a comprehensive understanding of how social sustainability is interpreted and enacted across the studied CBEBM.

3.3 | Data Analysis

Data analysis involved systematically coding interview transcripts and document contents manually to transform them into a structured dataset for in-depth analysis (Farrukh and Sajjad 2024; Gioia et al. 2013). Coding was performed manually using structured spreadsheets due to the manageable size of the dataset and the need to remain close to the narrative depth of interview material. We followed a qualitative content analysis approach combining deductive and inductive strategies. Deductive codes were based on the CBEBM framework of Salvador et al. (2023) and the social sustainability categories proposed by Nilsson et al. (2024). Inductive codes emerged from the empirical material, capturing territorial dynamics, organisational practices, and power relations. See the Table A4 for the data analysis categories and codes.

The analysis proceeded in three iterative stages. First, all interview transcripts were read in full to gain an overall understanding of each case and to identify preliminary patterns. Second, a coding matrix was developed based on the main theoretical framework, complemented by additional inductive codes that captured context-specific elements particularly relevant in the Global South (e.g., ancestral knowledge, informal labour practices, dependence on external actors). Third, coded segments were compared within and across cases to identify similarities, divergences and salient absences in the integration of social sustainability.

To enhance the credibility of the analysis, we used several strategies. The coding scheme was refined through repeated cycles of comparison between cases and categories. Analytical memos were generated throughout the process to document decisions and reflections. In addition, interpretations were cross-checked with field notes and secondary sources, strengthening internal consistency through triangulation. We also conducted intercoder reliability checks to ensure consistency and minimize interpretative discrepancies (Cole 2023; Khan et al. 2024).

This combined deductive–inductive approach made it possible to evaluate how social sustainability categories were manifested, partially integrated or absent across the cases, while also allowing context-specific dynamics to emerge beyond the formal categories of the framework.

4 | Results and Discussion

In this section we examine to which extent and in which ways social sustainability is integrated into CBEBM. We present the empirical findings of the 12 CBEBM cases studied in northern Argentina and discuss them in relation to the analytical framework introduced earlier. The section is organised into three interrelated parts. Section 3.1 maps the diversity of CBEBM and their archetypes, their territorial context, and key social features. Section 3.2 analyses patterns and absences in the presence of social sustainability categories across cases. Finally, Section 3.3 reflects on the cross-case dynamics and tensions that have emerged from the analysis.

4.1 | Mapping the Cases: Diversity of Circular Bioeconomy Business Models and Integration of Social Sustainability

The 12 cases encompass a broad range of organisational forms—cooperatives, family businesses, start-ups, and vertically integrated firms—across agriculture, livestock, food, biotechnology, and services. Applying Salvador et al.'s (2023) archetypes, in most cases each organisation aligns primarily with one archetype, although overlaps are frequent, as the authors also noted. For instance, cooperatives often combine social mission-oriented models with circular resource recovery, while some private firms adopt inclusive practices such as local employment schemes. For analytical purposes, we classified each case according to the archetype that best captured its dominant circular bioeconomy activities, while acknowledging hybrid features.

The cases are summarised in Table 2, including organisational characteristics, CBEBM archetypes, and the social features identified through interview analysis. These features, grounded in Nilsson et al.'s (2024) categories, provide an initial indication of how social sustainability is incorporated in each business model.

Although interviewees and organisational documents did not explicitly employ the term circular bioeconomy, all cases exhibited practices consistent with CBEBM principles. Through our analytical lens, we classified each case into one of the seven CBEBM archetypes (Salvador et al. 2023). This confirms the relevance of the archetype framework in contexts where terminology is absent but circular practices are present. The mapped cases include resource optimisation and waste recovery (e.g., olive and poultry companies), biotechnological innovation based on agro-industrial residues, resource exchange platforms, cooperatives mobilising ancestral knowledge (quinoa and Andean crops), and ecosystem services such as carbon sequestration.

Beyond this categorisation, the cases reveal context-specific adaptations to peripheral and marginalised settings in northern Argentina. Many of them diverge from conventional narratives of the bioeconomy, instead reflecting context-specific adaptations based on local resources, social networks, and historical trajectories. This territorial embeddedness highlights both opportunities and constraints, which are further discussed in the following section.

TABLE 2 | Overview of circular bioeconomy business models (CBEBM) and key social features.

Case #	Organisation type	Sector/activity	Location	CBEBM core	CBEBM archetype	Key social features[a]
1.	Economic group	Agriculture, food. Olive and jojoba farming, olive oil.	La Rioja	Biomass waste is reused efficiently to minimise resource consumption and reduce waste.	1	Local manual labour; compliance with labour laws and union rights; pride in La Rioja's uniqueness; limited producer collaboration; basic occupational safety.
2.	Biodynamic farm	Agriculture. Jojoba farming and oil.	La Rioja	Production emphasises efficient use of bio-waste and minimising inputs.	1	Local hiring with fair contracts and participation; biodiversity protection and animal welfare; biodynamic certification; association with national biodynamic agriculture network; long-term partnerships with international company; recognition of indigenous knowledge.
3.	Agro-industrial firm	Agriculture, food, beverage. Nut, olive, vine, wine and olive oil.	La Rioja	Biomass recovery and waste valorisation is a core business activity.	2	Strong stakeholder engagement (clusters, chambers, universities); multiple certifications (organic, vegan, ISO, carbon footprint); internships and skilled labour; biomass pellets for circularity; territorial identity as competitive asset.
4.	Vertically integrated company	Food. Meat processing and by-products (poultry).	Entre Rios	Comprehensive waste recovery underpins its business model.	2	High automation with limited direct jobs; foreign technical support; multiple certifications (HACCP, ISO, BMP, Halal); member of poultry chamber; rendering plant for zero-waste philosophy and by-product valorisation; vertical integration with global ties.
5.	Economic group	Agriculture. Jojoba farming and oil.	La Rioja	Innovative efforts to address environmental concerns through bio-waste valorisation.	3	Labour-intensive farms; strong compliance with rural union; organic certification (declining); Fair for Life in process; informal producer collaboration; occasional R&D links; state absence perceived; economically driven culture.
6.	Start-up	Biotechnology. Fungal biofactory for food colours and flavours.	Santa Fe	Innovation based on bio-based resources for sustainable products.	3	Highly skilled scientific team; strong collaborations with research institutions and biotech networks; mission aligned with SDGs; crowdfunding and global investors; health- and sustainability-oriented innovation.
7.	Agricultural and livestock company	Agriculture and livestock. Chia, livestock, processing.	Salta	Integrates multiple production streams for resource efficiency.	4	Big workforce, few women; hiring challenges due to social plans; BRCGS certification; strict food safety and traceability; weak R&D on chia seeds; links with producer associations; biomass efficiency via proximity; interest in bioethanol projects.

(Continues)

TABLE 2 | (Continued)

Case #	Organisation type	Sector/activity	Location	CBEBM core	CBEBM archetype	Key social features[a]
8.	Seed processing company	Agriculture services. Specialty seed processing.	Salta	Biomass waste is exchanged, changing ownership.	5	Small workforce, few women; strong local community ties; certifications (HACCP, ISO, organic); traceability as advantage; weak state support; collaboration with R&D organisations; open but under-resourced attempts to valorise scrap.
9.	Vertical integrated company	Agriculture. Jojoba farming and oil, chia oil and pharmaceutical related-products.	La Rioja (farms)	Exchanges bio-waste externally.	5	Small workforce, local employment; food certifications (chia, vegan); labour law compliance demanded; collaboration with R&D organisations; member of International Jojoba Export Council; by-products sold (cement industry, livestock); awareness of regional economy impact; lack of local government support.
10.	Farmer cooperative	Agriculture and food. Quinoa.	Salta	Full integration of local resources and traditional knowledge.	6	Shift from camelids to quinoa (ancestral recovery); family farming with strong women's role; organic certification 2013 (not renewed); mining company support the cooperative (business model, finance, infrastructure); municipal/provincial backing; international exposure; weak cooperative functioning; project ended with mining leadership change.
11.	Farmer cooperative	Agriculture and food. Andean crops (potatoes, quinoa, maize).	Jujuy	Prioritises local, circular practices and traditional resource use.	6	Over 100 members; family farming; strong role of women in agroecology; emphasis on ancestral practices; organic in some products, but focus on agroecology and participatory guarantee systems; resilient culture (adapted crops and value-added foods); National Cooperative Food Network member; IDB and EU financial support; direct-to-consumer niche strategies.
12.	Carbon credit service company	Services. Carbon credit project, seed production.	Salta	Offers a service rather than a product, grounded in ecological stewardship.	7	Local job creation; alternative income in conservation areas; education and training community benefits; stakeholder feedback mechanism; REDD+ programme; multiple SDG contributions; commercial advantage linking seeds and conservation; alignment with sustainability philosophy.

Note: This table is the descriptive summary of the 12 cases analysed, including organisational characteristics, CBEBM core and archetype, and the key social features identified through interview content analysis and secondary data. These features, linked to the social sustainability categories proposed by Nilsson et al. (2024), provide the basis for assessing the extent to which the social dimension is integrated into CBEBM.
Abbreviations: BMP, best manufacturing practices; BRCGS, British Retail Consortium Global Standards; EU, European Union; HACCP, hazard analysis critical control points; IDB, Inter-American Development Bank; ISO, International Organisation for Standardisation; R&D, research and development; REDD+, reducing emissions from deforestation and forest degradation; SDG, sustainable development goals.
[a]Key social features are related to Nilsson et al.'s (2024) social sustainability categories.
Source: Own elaboration.

Furthermore, the emergence of CBEBM in areas officially classified as 'non-productive', such as protected zones or biodiversity reserves, is especially noteworthy. In these areas, new forms of value generation are beginning to take root, such as carbon sequestration for international markets. This underscores the strategic potential for CBEBM in the region analysed, where large tracts of ecologically valuable land may offer opportunities to align conservation and development goals.

The findings in Table 2 suggest that social sustainability is present in all CBEBM studied, though in highly variable ways. Practices relate not only to the four core categories of Nilsson et al. (2024) but also to several additional categories, confirming the usefulness of employing a comprehensive framework rather than a narrow set of indicators.

Additionally, cooperatives stand out for mobilising collective action, strengthening community ties, and enabling more equitable distributions of value. This echoes findings from broader global South literature, where cooperatives often mitigate exclusion from formal markets (Dash 2021). In our cases, they correspond to Salvador et al.'s (2023) Archetype 6, which emphasises local employment and shorter supply chains; our findings extend this by showing their capacity to generate culturally embedded and territorially grounded forms of social value. The next section examines the specific social sustainability categories present—and absent—across cases.

4.2 | Social Sustainability Patterns and Absences

Applying Nilsson et al.'s (2024) we found that social sustainability is integrated in a partial, selective and context-dependent manner. While some dimensions are addressed systematically, others are marginal or absent.

Employment and decent work emerge as the most consistent category across the cases, although in different ways. In several labour-intensive activities such as jojoba, quinoa and Andean crops, organisations provide local jobs and emphasise formal compliance (Interviews #23 and #24). In cooperatives, a predominance of manual, family-based labour was underlined. One interviewee explained "The work was manual and required human effort [...] the whole family usually work for the farm" (Interview #8). While such organisations provide opportunities for actors with limited resources or capacities, they also reveal structural challenges such as dependence on family labour and limited mechanisation. In contrast, industrial models demonstrate the opposite trend, with automation reducing employment opportunities (Secondary data #38). These examples highlight how employment and decent work, though widely present, are unevenly distributed across organisational forms. While cooperatives and small producers often sustain local livelihoods, industrial firms prioritise efficiency and compliance, creating a tension between job creation and technological modernisation.

Broader aspects of well-being beyond livelihoods, such as health, dignity, or social services, are almost absent, with well-being equated mainly to income stability. Health and safety concerns are generally better addressed in larger firms, where compliance with international certifications and standards ensures more systematic controls. A CEO of a medium-size company highlighted "All incoming goods are analysed [...] the European Union is very strict. In fact, there are parameters which, if detected, you have to take all the goods back" (Interview #5). This reliance on external audits and certification systems contrasts with the more limited resources of smaller organisations. In cooperatives and among small producers, safety measures are largely informal and embedded in everyday practices. The quinoa cooperative, for instance, highlighted that mechanisation was only introduced when supported by the CSR programme of a mining company (Interview #8). Similarly, training and knowledge transmission often take place through practical, community-based processes rather than formalised standards, underscoring how learning and safety are linked to social dynamics and experiential knowledge. This contrast reflects broader inequalities between resource-endowed and resource-constrained organisations. Larger firms tend to address health and safety through formal certifications aligned with global market demands, while cooperatives rely on informal learning and community practices, which may be effective locally but lack external recognition.

Inclusion across the CBEBM cases is uneven. Issues of inequality reduction, gender equity, or fairness across generations are rarely explicit, with inclusion largely limited to compliance. Women's leadership is most visible in cooperatives and small-scale farming, where production practices allow for stronger participation of families and communities. A private consultant for social projects noted "[quinoa] is a crop that allows them to be very close to the people, to the women [...] The woman can raise animals, her children and take care of the quinoa" (Interview #8); and related to the same topic, a technical assistant in an EU project pointed out "Women farmers are more receptive to adopt agro-ecology techniques" (Interview #7). These examples indicate that cooperatives provide spaces where gender inclusion is both necessary and valued. By contrast, in private firms, the notion of inclusion is less developed. While some interviewees stressed compliance with formal labour regulations, there were no explicit references to women's participation or indigenous identity. This would suggest that in market-oriented firms, inclusion is limited to fulfilling legal requirements, leaving other dimensions of social sustainability marginal or absent.

Participation and governance mechanisms vary significantly across the CBEBM studied. Cooperatives generally embody democratic forms of governance and have progressively consolidated participatory structures, allowing members to influence decision-making and shape organisational strategies. The representative of a cooperative pointed out "We are more than 150 members, including associations and indigenous communities. Through cooperative commercialization we can finally bring all sectors to the same table, allowing everyone to participate in decision-making" (Interview #15). In contrast, most private firms display more hierarchical governance arrangements, where participation is limited to compliance with formal norms rather than inclusive decision-making (Interview #21). However, hybrid models demonstrate that more participatory approaches are possible even in corporate settings, as it is in the example of the biodynamic jojoba case that highlighted "[the company] give you the chance to participate and it's very nice that you have an idea and they say come on, let's go" (Secondary data #31). This example illustrates

how alternative governance mechanisms can emerge in private organisations when broader social and environmental commitments shape their business practices.

Cultural identity and territorial embeddedness appear as strong drivers in the cases of jojoba, quinoa, and other Andean crops, where territorial pride and ancestral knowledge are central to social value creation. Land was not only valued for its productive potential, but also for its natural, cultural, and historical attributes, including biodiversity, climate conditions, ancestral knowledge, and traditional land-use practices (Interview #15, #24, and #8). These narratives reveal how indigenous and ancestral perspectives contribute to defining what 'social value' means in CBEBM, especially in cooperative and community-based organisations. In contrast, industrial and technology-driven firms prioritise global certifications and innovation over local cultural ties. This divergence underscores that embedding in local socio-cultural contexts is not automatic but must be intentionally cultivated.

Community development and education are more common in cooperatives, which often run training and awareness programs (Interview #15). They also foster community engagement by organising local fairs (Interview #15). Furthermore, some private jojoba farms created really community development as it was depicted by a jojoba researcher "*Bañado de los Pantanos* is a small village with 20 houses, you take out jojoba and you have killed the village" (Interview #19).

Partnerships with universities and other technical and research institutions for education and research purposes are also relevant in some private firms, as well as in cooperatives (Interview #7). Moreover, learning and knowledge feature prominently. Producers stress the support of the National Institute of Agricultural and Livestock Technology, universities, or research institutions in sustaining innovation (Interview #18). Jojoba producers also underline genetic selection as a form of socio-technical empowerment. Furthermore, participation, networks, and collaboration appear as crucial enablers, particularly in cooperatives and producer associations. One producer told us, "We are few, we all know each other and every year we visit each farm to share results and problems" (Interview #22).

Finally, fair trade and certifications show a dual pattern across the CBEBM studied. On the one hand, certifications are widespread in market-oriented firms, responding directly to international client requirements. One interviewee of a big firm emphasised "The main reason [for certifications] was because their international customers ask for it" (Interview #4). These compliance-driven approaches highlight how certification often functions as a market entry condition rather than a proactive social commitment. On the other hand, cooperatives and alternative initiatives pursue different forms of legitimacy; they emphasise ancestral practices or solidarity-based systems (Interview #15). Local legitimacy and social trust can thus be mobilised as alternatives or complements to global certification schemes. These local initiatives resonate with Participatory Guarantee Systems (PGS), which were also mentioned during interviews. PGS[1] focus on democratising knowledge, with oversight systems for compliance with standards being created by producers, experts, and consumers, who then collectively ensure that organic agricultural techniques are adopted (Loconto and Hatanaka 2018).

In summary, the analysis reveals that social sustainability in the CBEBM cases studied is integrated selectively. Strong patterns emerge in categories such as employment and livelihoods, participation and networks, learning and knowledge, cultural identity and territorial embeddedness, and community development and education. Certifications also emerge as a recurring mechanism, particularly in market-oriented firms, although these tend to respond more to the requirements of international clients than to proactive social commitments. At the same time, however, notable absences persist. Inequality reduction and gender equality are rarely addressed beyond legal compliance. Well-being is narrowly equated with job and income stability, with little reference to broader aspects such as dignity, health or social services. Finally, environmental care is rarely linked to social well-being, reflecting the fragmented and compartmentalised integration of the sustainability pillars. Overall, these findings suggest that CBEBM do not automatically incorporate social sustainability, but rather through selective, context-dependent choices shaped by market logics, institutional frameworks and local knowledge.

4.3 | Cross-Case Reflections: Contextual Dynamics and Tensions

The cross-case comparison indicates three aspects that stand out across the cases: organisational form, institutional frameworks, and territorial embeddedness. These aspects confirm that social sustainability in CBEBM cannot be assumed as a by-product of circularity, unlike environmental or economic outcomes. Its integration requires deliberate organisational choices, supportive institutions, and recognition of territorial specificities.

Organisational form matters, but does not determine social outcomes. As shown in the previous section, cooperatives tend to emphasise inclusion, participatory governance, and cultural identity, while private firms often focus on certifications and formal compliance. However, exceptions analysed in the paper blur this distinction: some firms adopt inclusive practices, such as the biodynamic farm, while some cooperatives exhibit limitations with weak governance, as is the example of the quinoa cooperative. This suggests that values, governance arrangements, and stakeholder relationships, rather than ownership structure alone, are important in shaping social sustainability.

Institutional frameworks condition which social dimensions are prioritised. International clients demand certifications and compliance, pushing firms toward standardised practices. Public institutions and research agencies provide support in some cases, but overall state engagement is weak and inconsistent. This fosters dependency on external factors such as NGOs, mining companies or global buyers, reproducing power asymmetries that privilege compliance over locally embedded forms of social value (Loconto and Hatanaka 2018).

Territorial embeddedness creates both opportunities and vulnerabilities. Many cases draw on local assets, such as La Rioja's uniqueness for jojoba or the ancestral value of Andean crops in Jujuy, to create cultural identity and distinctiveness in markets. At the same time, the location and weak institutional support constrain innovation and scaling. Interviewees recurrently highlighted frustration with limited or inconsistent state support and dependence on

external actors (as is the example of one cooperative to the mining company or to international clients in other cases). This reflects the broader challenge of embedding CBEBM in contexts where institutional frameworks are weak or inconsistent.

The tension between compliance-driven approaches and context-sensitive practices is central: while certifications ensure market access, they often overlook local priorities such as inclusion, participation, or cultural identity. Conversely, cooperatives and small producers mobilise these dimensions but face limitations in scaling them without institutional support.

In sum, social sustainability in CBEBM emerges from the interplay of market logics, institutional asymmetries, and territorial dynamics. Addressing these tensions is essential for designing strategies that bridge global requirements with local realities, ensuring that the circular bioeconomy contributes to more equitable and contextually relevant forms of sustainable development. These findings align with broader scholarship on how governance and institutional arrangements shape the possibilities and limitations of sustainable business models (Boons & Lüdeke-Freund, 2013; Loconto and Hatanaka 2018).

While our findings reveal tensions surrounding dependence on certifications, external actors, and asymmetric access to resources, these frictions also reflect broader power structures that shape who is able to define value, set standards, and control market access. In several cases, compliance-oriented models consolidate the authority of external institutions, whereas cooperatives and community-based organisations mobilise forms of agency—such as territorial identity, collective organisation, or ancestral knowledge—to negotiate, reinterpret, or resist these pressures. Although these dynamics are not explored in depth here, they suggest that social sustainability in CBEBM is inseparable from questions of power, autonomy, and the capacity of actors to shape business model trajectories.

5 | Conclusion

This study contributes to a more balanced understanding of CBEBM by explicitly integrating the social pillar of sustainability, which remains the least developed in both research and practice. Drawing on 12 cases from northern Argentina and applying an analytical framework that integrates both bodies of literature, our findings indicate that the social dimension is integrated selectively and contextually: employment, compliance with labour regulations and certifications are categories systematically present, whereas gender inclusion, participatory governance, and ancestral knowledge remain marginal or unevenly addressed. These results show that the social pillar cannot be assumed as an inherent outcome of circularity, but depends on organisational forms, institutional frameworks, and territorial embeddedness.

Based on these insights, we propose four interrelated strategies to strengthen the integration of social sustainability in CBEBM: (1) organisations should actively recognise and valorise local and ancestral knowledge as sources of social value creation. Territorial identity, indigenous practices, and cultural values are not peripheral add-ons but can provide legitimacy, foster innovation, and create differentiation in markets. (2) Participatory governance and inclusion mechanisms must be strengthened. Moving beyond mere compliance requires creating spaces where workers, women, and other socially disadvantaged actors can participate meaningfully in decision-making and benefit distribution. (3) Hybrid forms of value recognition should be developed by combining external certification with participatory or community-based schemes. Such approaches can bridge the gap between global market requirements and local realities, mitigating the risk that global standards overlook local contexts. (4) Institutional support and cross-sector partnerships are essential to create an enabling environment for socially sustainable CBEBM. Public policies, research institutions, and producer networks play a decisive role in ensuring fair market access and fostering innovation.

This study has some limitations. The geographical and sectoral focus restricts the generalisability of the findings, and analytical challenges remain regarding how the social pillar can be operationalised in practice. Moreover, although we highlighted several important tensions, due to space constraints we were not able to examine dynamics of power, agency and resistance in depth. This is a crucial area for further research, exploring how actors negotiate, contest or reinterpret these pressures and to what extent such forms of agency may reconfigure business model logics rather than merely adapting to them. Additionally, further research could expand the empirical base by examining CBEBM in other countries of the Global South or by conducting more detailed analyses of specific organisational types, such as cooperatives, which stood out in our cases. There is also a need for more robust conceptual frameworks linking CBEBM and social sustainability, as well as for developing objective or quantifiable indicators grounded in social sustainability categories. Finally, the use of qualitative data analysis software (such as NVivo or Atlas.ti) could be valuable in future research with larger samples, enabling additional analytical techniques such as word-frequency or co-occurrence analysis.

Ultimately, recognizing the diversity of pathways through which social sustainability emerges—and deliberately embedding these dimensions into CBEBM—is essential for ensuring that circular bioeconomy transitions contribute to more equitable, contextually grounded, and resilient forms of sustainable development.

Author Contributions

Celina N. Amato: conceptualisation, data curation, funding acquisition, investigation, methodology, project administration, resources, visualisation, writing-original draft, writing-review and editing. **Mónica Buraschi:** conceptualisation, funding acquisition, investigation, methodology, writing-review and editing. **Karen M. Siegel:** conceptualisation, funding acquisition, project administration, supervision, writing-review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Endnotes

[1] Formalised by the International Federation of Organic Agriculture Movements in 2004, PGS allocate oversight authority to third-party certifiers or standards-setters (International Forum for Organic Agriculture Movements 2013; Loconto and Hatanaka 2018).

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Appendix A

TABLE A1 | Categories of social sustainability and their descriptions.

Categories of social sustainability	Description
Inequality reduction[a]	Equitable distribution of resources, opportunities, and costs among individuals, in society, and through generations.
Well-being[a]	Includes both physical and mental well-being, and aspect that can create well-being.
Participation and influence[a]	The processes and actions of providing the members of society the opportunity to actively take part in the society, access the decision-making processes and influence planning, policy, and politics.
Social relationships and network[a]	The connection to other individuals and to the society, such as fostering relationships, networks, inclusion, interaction, and social capital.
Needs	The basic needs to live and survive, like having access to food, water, shelter, livelihood, and recovery.
Safety and security	The aspects of feeling and to being safe. This category also includes economic and environmental security.
Learning and knowledge	The process of learning and gaining knowledge and skills, both at an individual and a societal level.
Rights and responsibilities	The aspects of responsibility for powerholders, governance, social order, human rights, and tolerance and respect in society.
Identity and meaning	The feeling of meaning and purpose both within oneself and within the community
Belonging	The sense of feeling as a part of a group and/or society and be proud of a place.
Built environment	Physical settings' effect and potential on the societal structures, the individuals', or groups' well-being.
Diversity	A variety of perspectives and functions in society.
Capacity and development	The capacity to evolve and develop on a societal level and the institutional capacity for self-organisation.
Environmental care	The importance of a healthy environment to nurture social life.
Collaboration and peace	Peaceful collaboration and co-existence between stakeholders.
Social services	Functions that occur within the physical structure connected to social needs, for example, schools and public services.
Trust and reciprocity	Faith to and in the society and its members, and reciprocity of cooperation.
Freedom	The freedom of choice and expression and the power to change one's own life.
Demography	The change or stabilisation in the demographic structure.
Economic prosperity	Economic development and prosperity.
Transformability	Resilience, flexibility, and adaptability to change. The capacity to handle change and raise awareness about risks and threats.
Innovation and creativity	A society that fosters innovative thinking and creativity.
Empathy	No explications.

[a]Four core categories, these appeared in 75% or more of the definitions that the authors considered for the analysis.
Source: Own elaboration based on table 1 of Nilsson et al. (2024, 5933–5936).

TABLE A2 | List of interviews.

Interview #	Date	Organisation they belong to	City, province	Position in the organisation	Duration of the interview (minutes)	Type of interview
1	August 25, 2022	State, Agro-industry Minister (province level)	La Rioja, La Rioja	Ex director of the office	30	In-person (in Rosario city)
2	September 29, 2022	Consultant in agribusiness	Ciudad Autónoma de Buenos Aires, Buenos Aires	Researcher in agro-economics	45	In-person (in Rosario city)
3	October 20, 2022	State, Production Minister (province level)	Salta, Salta	Director of agro-industry office	30	In-person (in Rosario city)
4	November 2, 2022	Poultry and animal feed company	Basavilbaso, Entre Ríos	Engineer in the quality control area	30	Virtual
5	June 6, 2023	Agriculture company (Pecan nut, chia, legumes)—Livestock company	Salta, Salta	Owner, CEO	60	In-person
6	June 6, 2023	State, Production Minister (province level) [Second interview]	Salta, Salta	Director of agro-industry office	50	In-person
7	June 7, 2023	State technical agency for family agriculture (national level)	Salta, Salta	Technical assistant in EU project (quinoa)	43	In-person
8	June 7, 2023	Private consultant in social projects in The Andes	Salta, Salta	Ex consultant of mining company	80	In-person
9	June 8, 2023	Seed processing company (chia, amaranto and another legumes)	Cerrillos, Salta	CEO	40	In-person
10	June 8, 2023	State technical agency and research agency (national level)	Cerrillos, Salta	Technical researcher (chia)	60	In-person
11	June 8, 2023	Processing company (legumes and spices)	Cerrillos, Salta	CEO	55	In-person
12	June 16, 2023	State research agency and university (national level)	Ciudad Autónoma de Buenos Aires, Buenos Aires	Researcher (quinoa)	47	Virtual
13	June 26, 2023	Carbon credits company—Seed producing company (chia, chickpea, bean)	Salta, Salta	Owner, CEO	36	Virtual
14	September 12, 2023	State (national level, research agency)	Ciudad Autónoma de Buenos Aires, Buenos Aires	Researcher (quinoa)	60	Virtual
15	September 14, 2023	Farmers' cooperative (Quinoa, Andean crops, vegetables)	Salta, Salta	Representative	80	Virtual

(Continues)

TABLE A2 | (Continued)

Interview #	Date	Organisation they belong to	City, province	Position in the organisation	Duration of the interview (minutes)	Type of interview
16	September 20, 2023	Seed producing company (Chia and legumes)	Salta, Salta and Córdoba, Córdoba	Owner	38	Virtual
17	September 21, 2023	State (national level, technical agency)	Faimallá, Tucumán	Technical researcher (economic and financial)	46	Virtual
18	September 26, 2023	State (national level, research agency) San Juan, San Juan	San Juan, San Juan	Researcher (quinoa)	70	Virtual
19	October 26, 2023	State technical agency (national level)	Aimogasta, La Rioja	Director, technical researcher (jojoba)	60	Virtual
20	October 27, 2023	State technical agency (national level)	Chilecito, La Rioja	Director, technical researcher (jojoba and quinoa)	63	Virtual
21	October 30, 2023	Economic group A: jojoba seed producing company, jojoba and chia oil producing company, and a pharmaceutical and cosmetic company.	Aimogasta, La Rioja	Engineer (production area)	35	Virtual
22	November 9, 2023	Economic group A: jojoba seed producing company, jojoba and chia oil producing company, and a pharmaceutical and cosmetic company.	Aimogasta, La Rioja	CEO	40	Virtual
23	November 9, 2023	Economic group B: jojoba and olive seed producing company, and olive oil producing company	Aimogasta, La Rioja	Engineer (production area)	52	Virtual
24	November 10, 2023	Economic group C: jojoba seed companies and jojoba oil producing company	Aimogasta, La Rioja	Shareholder	32	Virtual

Source: Own elaboration.

TABLE A3 | List of secondary data.

Secondary data #	Type of actor	Case related	Type of secondary data	Source
1	Private	Wine and olive company	Paper	D'Alessandro, M., Gonzalo, M., Filipetto, S., & Starobinsky, G. (2021). Valle de La Puerta: recursos, capacidades y vínculos para la internacionalización empresarial desde Chilecito, La Rioja, Argentina. *Pymes*, Innovación y Desarrollo, *9*(3), 3–25. https://revistas.unc.edu.ar/index.php/pid/article/view/36885
2	Private		Piece of news (private)	https://tageblatt.com.ar/valle-puerta-camino-produccion-sustentable/
3	Public		Piece of news (public)	https://www.argentina.gob.ar/inti/pymes-exportan/energia/edicion-8-enero-2021/valle-de-la-puerta-sa-produccion-de-pellets-partir
4	Public		Piece of news (public)	https://www.argentina.gob.ar/noticias/argentina-tendra-la-primera-planta-de-pellets-para-producir-energia-partir-de-residuos-de-?fbclid=IwY2xjawExYCtleHRuA2FlbQIxMAABHU4uURwVI2bZYPgMMVvA9OjO5e_bTlO_yQb3BxYOQNKyJlJTcMAlMz4u2w_aem_7-u9H6dpOXAHND158PZfHw
5	Public	Quinoa cooperative	Piece of news (public)	https://www.salta.gob.ar/prensa/noticias/comunidad-gobierno-y-empresa-celebran-la-consolidacion-del-proyecto-quewar-75853
6	Public		Piece of news (public)	https://www.salta.gob.ar/prensa/noticias/pequenios-productores-de-quinoa-de-san-antonio-de-los-cobres-formaron-una-cooperativa-agropecuaria-70391
7	Public		Piece of news (public)	https://www.salta.gob.ar/prensa/noticias/trabajadores-de-la-puna-saltenia-conformaron-una-cooperativa-para-el-procesamiento-de-quinoa-65651
8	Private		Piece of news (private)	https://agroempresario.com/publicacion/24461/quewar-la-cooperativa-de-productores-punenos-de-quinoa/?cat=2310003
9	Private		Piece of news (private)	https://mineriasustentable.com.ar/contenido/691/de-la-mano-de-la-mineria-se-potencia-el-desarrollo-comercial-de-la-quinoa-organi
10	Private		Piece of news (private)	https://cooperativas.com.ar/se-conformo-una-cooperativa-de-productores-de-quinoa/
11	Private		Piece of news (private)	https://www.eltribuno.com/nota/2019-8-9-23-26-0--quewar-la-cooperativa-de-productores-punenos-de-quinoa
12	Private		Piece of news (private)	https://www.eltribuno.com/nota/2021-1-11-0-0-0-producen-una-quinoa-organica-y-de-calidad-en-la-puna-saltena
13	Public-Private	Andean crops and quinoa cooperative	Document (Mesa nacional de cultivos andinos)	https://alimentosargentinos.magyp.gob.ar/HomeAlimentos/Cultivos%20Andinos/reuniones_y_eventos.php
14	Private		Webpage (Andean crops cooperative)	https://cauqueva.org.ar/
15	Public		Technical report	Roqueiro, G., Guillen, L. F., Barcena, N., Tornello, S., Ruiz Cortez, L. A., & Notario, L. (2020). Promoción del cultivo de quinua en los Valles Andinos y Centrales de San Juan como alternativa productiva y contribución a la seguridad alimentaria. Informe técnico. INTA. http://hdl.handle.net/20.500.12123/8238

(Continues)

TABLE A3 | (Continued)

Secondary data #	Type of actor	Case related	Type of secondary data	Source
16	Public		Report	Scalise, J. (2014). Caracterización y diagnóstico de la cadena de valor de la quinua en Argentina. Ciudad Autónoma de Buenos Aires: Ministerio de Agroindustria de la Nación Argentina. https://alimentosargentinos.magyp.gob.ar/HomeAlimentos/Cultivos%20Andinos/Quinua/Bibliografia%20Quinua/2%20AGREGADO%20de%20VALOR/Caracterizacion%20y%20Diagnostico%20de%20la%20cadena%20de%20valor%20de%20la%20quinoa%20en%20Argentina.pdf
17	Public		Report	Organización de Naciones Unidas para la Alimentación [FAO] y Asociación Latinoamericana de Integración [ALADI] (2014). Tendencias internacionales del comercio internacional de quinua. https://www.fao.org/3/i3583s/i3583s.pdf
18	Public		Report	Alarcón García, A. (2012). Mercado de la quínoa. Programa de Servicios Agrícolas Provinciales, Unidad para el Cambio Rural. Buenos Aires. https://alimentosargentinos.magyp.gob.ar/HomeAlimentos/Cultivos%20Andinos/Quinua/Bibliografia%20Quinua/3%20COMERCIALIZACION/COMERCIALIZACION/Mercado%20de%20la%20Quinua.pdf
19	Public		Paper	Curti, R., Costa Tártara, S., Vidueiros, S., Pallaro, A., & Bertero, D. (2017). La quinua en el noroeste argentino. Ciencia Hoy, 26(155), 49–54. https://cienciahoy.org.ar/wp-content/uploads/Revista_155.pdf
20	Public		Paper	Golsberg, C. (2013). Organización de la Agricultura Familiar en el Noroeste de Argentina para la producción de quinua. Ciencia y Tecnología de los Cultivos Industriales, 3(5), 85–92. https://ri.conicet.gov.ar/bitstream/handle/11336/7314/INTA-Revista-Ciencia-y-Tecnologia-de-los-Cultivos-Industriales-Ano-3-No-5-Quinua.pdf?sequence=5
21	Public		Paper	Kerssen, T. (2015). Food sovereignty and the quinoa boom: challenges to sustainable re-peasantisation in the southern Altiplano of Bolivia, Third World Quarterly, 36(3), 489–507. https://doi.org/10.1080/01436597.2015.1002992
22	Public		Paper	Li, F. (2023). Materiality and the politics of seeds in the global expansion of quinoa. Food, Culture & Society, 26(4), 867–885. https://doi.org/10.1080/15528014.2022.2152608
23	Private		Book	Daza, R., Burin, D., Pereyra, E., & Heras, A. (2015). Quinua, regalo ancestral: historia, contexto, tecnología, políticas. Jujuy: Fundación Nueva Gestión. https://www.aacademica.org/ana.ines.heras/278
24	Private		Video (Daniel Bertero talking about Quinoa for Chinese)	https://www.youtube.com/watch?v=HWvN3CUY-JQ
25	Private		Piece of news (private)	https://viapais.com.ar/salta/saltenos-de-la-puna-producen-una-quinoa-organica-de-alta-calidad/
26	Private		Piece of news (private)	https://correodelsur.com/capitales/20170711_la-maldicion-del-boom-drastica-caida-de-precios-de-la-quinua-de-exportacion.html
27	Private		Piece of news (private)	https://www.economist.com/business/2019/05/25/big-agribusiness-wants-to-make-quinoa-more-mainstream

(Continues)

TABLE A3 | (Continued)

Secondary data #	Type of actor	Case related	Type of secondary data	Source
28	Private		Piece of news (private)	https://www.laprensa.com.ar/473886-Quinua.note.aspx
29	Private		Piece of news (private)	https://www.lanacion.com.ar/economia/campo/regionales/quinoa-de-cultivo-ancestral-de-las-culturas-andinas-al-aprovechamiento-del-boom-de-la-demanda-nid09102021/
30	Private		Piece of news (private)	https://www.redaccion.com.ar/una-red-de-750-familias-distribuidas-por-la-argentina-transforma-el-consumo-en-un-acto-social/
31	Private	Jojoba	Video (Jojoba farm owner and Weleda partner)	https://www.youtube.com/watch?v=RgRc-9uYR1Q
32	Public		Book	Instituto Nacional de Estadística y Censos (1996). *El cultivo de la jojoba: provincia de La Rioja*. República Argentina: Ministerio de Economía y Obras y Servicios Públicos, Secretaría de Programación Económica, Instituto Nacional de Estadística y Censos.
33	Public		Webpage (International Jojoba Exports Council)	https://ijec.net/
34	Private	Bioeconomy start-up	Piece of news (private)	https://www.forbesargentina.com/negocios/una-start up-biotecnologica-creada-argentina-levanta-64-millones-dolares-n29437 https://www.forbes.com/sites/douglasyu/2023/02/01/fungi-powered-ingredients-startup-michroma-promising-to-remove-petroleum-from-food-colorings-raises-64-million-in-venture-funding/?sh=28038f7930d1
35	Private		Webpage (start-up Michroma)	https://www.michroma.co/home
36	Private		Piece of news (private)	https://www.lanacion.com.ar/tecnologia/michroma-la-biofabrica-argentina-de-colorantes-y-saborizantes-sustentables-nid01012021/
37	Private		Piece of news (private)	https://insights.figlobal.com/michroma/startup-success-michroma-interview
38	Public	Poultry	Conference paper	Ruhl, L. M., Hegglin, D. R., Pietroboni, R. A., Cettour, W. H., Lepratte, L., & Blanc, R. L. (2012). Estrategias competitivas desarrolladas por la industria avícola de la Costa del Río Uruguay (CRU), Entre Ríos, Argentina. VI Jornadas Nacionales de Investigadores en Economías Regionales: Economía Social y Solidaria: Experiencias, Saberes y Prácticas. Facultad de Ciencias Sociales, Universidad de Buenos Aires
39	Public		Master thesis	Palacios, E. (2003). El complejo agroindustrial avícola argentino. Reconversión y perspectiva de inserción en el mercado regional e internacional. Tesis de maestría. Magister en Integración Latinoamericana. Universidad Nacional de La Plata. https://doi.org/10.35537/10915/1783
40	Public	Chia	Paper	Coates, W. & Ayerza, R. (1998). Commercial Production of Chia in Northwestern Argentina. *Journal of the American Oil Chemists' Society*. https://doi.org/10.1007/s11746-998-0192-7
41	Public		Report	Scalise, J. (2015). Caracterización y diagnóstico de la cadena de valor de la chía en la Argentina. Ministerio de Agroindustria. https://www.argentina.gob.ar/sites/default/files/procanor-caracterizacion-diagnostico-de-la-cadena-de-valor-de-la-chia-en-argentina.pdf

(Continues)

TABLE A3 | (Continued)

Secondary data #	Type of actor	Case related	Type of secondary data	Source
42	Private		Piece of news (private)	https://infonegocios.info/conosur/un-imperio-fundado-en-una-semilla-los-planes-de-sturla-para-que-germine-un-gran-negocio
43	Private	Biodynamic mode of production	Webpage (Association for Biodynamic Agriculture in Argentina)	https://aabda.com.ar/
44	Public	General	Report	INDEC. Censo Nacional Agropecuario 2018. Resultados generales (1a ed. digital) https://www.indec.gob.ar/indec/web/Nivel4-Tema-3-8-87
45	Public	General-bioeconomy	Report	Bocchetto, R. M., Gauna, D. H., Bravo, G. C., Gonzalez, C. B., Rearte, M., Molina Tirado, L., Hilbert, J. A., Eisenberg, P., Lecuona, R. E., Taraborrelli, D. S., Papagno, S. G., & Vaudagna, S. R. (2020). Bioeconomía del Norte Argentino: situación actual, potencialidades y futuros posibles. Documento de Trabajo. Ciudad Autónoma de Buenos Aires: MINCyT. https://repositorio.inta.gob.ar/handle/20.500.12123/8662

Source: own elaboration.

TABLE A4 | Categories and codes for data analysis.

Categories	Codes (1st round)	Codes (2nd round)
CBEBM	BUSINESS MODEL	TRADITIONAL ALTERNATIVE
	BIOMASS WASTE	
	VALUE CREATION	
CBEBM Archetypes	ARCH 1 RESOURCE EFFICIENCY AND USE	
	ARCH 2 VALUE RECOVERY	ARCH 2 VALUE RECOVERY (POTENTIAL)
	ARCH 3 INNOVATION	ARCH 3 INNOVATION (POTENTIAL)
	ARCH 4 BIOREFINERIES	ARCH 4 BIOREFINERIES (POTENTIAL)
	ARCH 5 RESOURCE EXCHANGE	ARCH 5 RESOURCE EXCHANGE (POTENTIAL)
	ARCH 6 LOCAL ECONOMY	
	ARCH 7 SERVICE OFFER	ARCH 7 SERVICE OFFER (POTENTIAL)
Economic and environmental sustainability	ECONOMIC ISSUES	
	ENVIRONMENTAL ISSUES	

(Continues)

TABLE A4 | (Continued)

Categories	Codes (1st round)		Codes (2nd round)
Social sustainability categories and sub-categories	INEQUALITY REDUCTION	Accessibility	
		Affordability	
		Attention to minority and vulnerable groups	
		Distribution of income and/or resources	
		Environmental justice	
		Equality	
		Equity	
		Fairness	
		Gender equality	
		Generational-inter/intra/future	
		Impartiality	
		Inter-species equity	
		Justice	
		Life chances	
		Opportunities	
		Reduction of social stratification	
		Sharing	
		Social equity	
		Social justice	
	WELL-BEING	Dignity and pride	
		Health	
		Mental health	
		Quality of life	
		Satisfaction and happiness	
		Well-being	
	PARTICIPATION AND INFLUENCE	Civic engagement and collective action	
		Community involvement	
		Democracy	
		Empowerment	
		Participation and influence	
		Social engagement	
		Transparency	
	SOCIAL RELATIONSHIPS AND NETWORK	Community	
		Co-presence	
		Inclusiveness	
		Institutional thickness	
		Social capital	
		Social coherence	
		Social cohesion	
		Social inclusion	
		Social integration	
		Social interaction and relationships	
		Social network	
		Social recognition	
		Solidarity	
	NEEDS	Housing	
		Human needs	
		Intangible human needs	
		Leisure	
		Livelihood	
		Material living standards	
		Sanitation	
		Satisfaction of basic needs	
		Work and employment	
	SAFETY AND SECURITY	Economic security	
		Environmental security	
		Safety and security	

(Continues)

TABLE A4 | (Continued)

Categories	Codes (1st round)	Codes (2nd round)
	LEARNING AND KNOWLEDGE	Awareness
		Cultural capital
		Education
		Human capital
		Individual capacity
		Information about risk and sustainability
		Knowledge
		Learning and self-development
	RIGHTS AND RESPONSIBILITIES	Consumer/product responsibility
		Contribution to society
		Corporate social responsibility
		Ethics
		Human rights
		Labour rights
		Negotiation of the future
		Politics and governance
		Respect
		Respect for environmental, economic, and social conditions and boundaries
		Responsibility
		Social contract
		Social order
		Societal responsibility
		Tolerance
	IDENTITY AND MEANING	Common meaning and purpose
		Culture
		Cultural enrichment
		Cultural expression
		Cultural identity
		Identity
		Individual meaning and purpose
		Preservation of traditions/cultures/cultural heritage
		Sense of identity
		Spirituality
	BELONGING	Belonging
		Sense of attachment
		Sense of community
		Sense/Pride of place
	BUILT ENVIRONMENT	Attractive housing
		Connectivity
		Housing satisfaction
		Infrastructure
		Local environmental quality and amenity
		Mixed use and tenure
		Mobility
		Multimodality
		Neighbourhood satisfaction
		Quality of home and neighbourhood
		Recreation
		The impact of environmental settings on humans
		Urbanity
		Vitality
		Walkability
	DIVERSITY	Cultural diversity
		Diversity
		Social diversity

(Continues)

TABLE A4 | (Continued)

Categories	Codes (1st round)	Codes (2nd round)
	CAPACITY AND DEVELOPMENT	Capacity for self-organisation Human values and behaviours for social and community health Institutional stability Social/community capacity and development
	ENVIRONMENTAL CARE	Environmental protection Human values and behaviours for environmental health Human-nature relation Social institutions for environmental sustainability
	COLLABORATION AND PEACE	Collaboration/cooperation Conflict mitigation Peace Social stability
	SOCIAL SERVICES	Public realm and services Social infrastructure
	TRUST AND RECIPROCITY	Reciprocity Trust
	FREEDOM	Autonomy Freedom Privacy
	DEMOGRAPHY	Demography Demographic stability Population profile Residential/community stability
	ECONOMIC PROSPERITY	Economic prosperity Productivity Social institutions for economic sustainability
	TRANSFORMABILITY	Flexibility/adaptability Resilience
	INNOVATION AND CREATIVITY	Creativity Innovation Technology development
	EMPATHY	Empathy

Source: Own elaboration based on the theoretical framework (Nilsson et al. 2024; Salvador et al. 2023).