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COMPARATIVE ANALYSIS OF CIRCULAR ECONOMY PRACTICES IN THE AGRI-FOOD SECTOR: A STUDY OF BRAZIL AND ITALY

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COMPARATIVE ANALYSIS OF CIRCULAR ECONOMY PRACTICES IN THE AGRI-FOOD SECTOR: A STUDY OF BRAZIL AND ITALY

Thesis presented to the Graduate in Regional Development and Agribusiness (PGDRA) at the Western Paraná State University – Unioeste Campus Toledo, as a requirement for obtaining the title of Doctor.
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This PhD dissertation results in the award of a double degree to Gabriela Daiana Christ. After the defense of the thesis in a single session, she was awarded the title of Doctor in Agricultural Sciences (UNIVPM) and the equivalent title of Doctor in Regional Development and Agribusiness (UNIOESTE).

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"*A fé na vitória tem que ser inabalável*"

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ABSTRACT (EN)

The integration of Circular Economy (CE) practices into the agri-food sector is central to addressing resource constraints, environmental challenges, and regional development. Yet, empirical evidence on how CE reshapes business models across regional contexts remains limited, particularly in cross-national comparisons. This study analyzes CE implementation through case studies in the Intermediate Geographic Region (RGInt) of Cascavel, Paraná State, Brazil, and the Marche Region, Italy. The objectives are to assess how national regulations address CE principles, identify practices adopted in the agri-food sector, and examine their role in transforming business models and fostering regional development. A qualitative approach was employed, combining semi-structured interviews and case study analysis. Findings reveal three main results. First, effective CE implementation requires balancing pragmatism, inclusiveness, governance, and socio-political contexts. Brazil emphasizes emergent initiatives linked to competitiveness, while Italy embeds CE within a fragmented but established framework. Second, aligning people's mindsets with a circularity-oriented culture over time required setting clear goals and targets, developing strategies for effective business innovation, and continually assessing progress through a sustainability lens (environmental, social and economic perspectives). Third, trajectories differ: RGInt Cascavel (Paraná) shows robust growth from livestock and diversification, whereas Marche reflects maturity and reorientation toward high-value niches. The research contributes by providing comparative evidence on the CE-regional development nexus, offering insights for businesses and policymakers.

Keywords: sustainable development; sustainable regional development; agri-food industry; sdg 12; symbiosis; cradle-to-cradle.

RESUMO (PT)

A integração das práticas de Economia Circular (EC) no setor agroalimentar é fundamental para enfrentar restrições de recursos, desafios ambientais e promover o desenvolvimento regional. No entanto, as evidências empíricas sobre como a EC transforma modelos de negócios em diferentes contextos regionais ainda são limitadas, especialmente em comparações internacionais. Este estudo analisa a implementação da EC por meio de estudos de caso na Região Geográfica Intermediária (RGInt) de Cascavel, no Estado do Paraná, Brasil, e na Região Marche, Itália. Os objetivos são avaliar como as regulamentações nacionais incorporam os princípios da EC, identificar práticas adotadas no setor agroalimentar e examinar seu papel na transformação de modelos de negócios e no fomento ao desenvolvimento regional. A pesquisa adotou uma abordagem qualitativa, combinando entrevistas semiestruturadas e análise de estudos de caso. Os resultados revelam três achados principais. Primeiro, a implementação eficaz da EC requer equilibrar pragmatismo, inclusão, arranjos de governança e contextos sociopolíticos. O Brasil enfatiza iniciativas emergentes vinculadas à competitividade, enquanto

a Itália incorpora a EC em um arcabouço mais estabelecido, embora fragmentado. Segundo, alinhar mentalidades a uma cultura orientada à circularidade ao longo do tempo exige a definição de metas claras, o desenvolvimento de estratégias de inovação empresarial e a avaliação contínua dos avanços sob a ótica da sustentabilidade (dimensões ambiental, social e econômica). Terceiro, as trajetórias regionais diferem: a RGInt Cascavel (Paraná) apresenta crescimento robusto impulsionado pela pecuária e pela diversificação, enquanto a Região Marche reflete uma estrutura madura em processo de reorientação para nichos de maior valor agregado. A pesquisa contribui ao fornecer evidências comparativas sobre a relação entre EC e desenvolvimento regional, oferecendo subsídios para empresas e formuladores de políticas públicas.

Palavras-chave: desenvolvimento sustentável; desenvolvimento regional sustentável; indústria agroalimentar; ods 12; simbiose; do berço ao berço.

ABSTRACT (IT)

L'integrazione delle pratiche di Economia Circolare (EC) nel settore agroalimentare è fondamentale per affrontare vincoli di risorse, sfide ambientali e promuovere lo sviluppo regionale. Tuttavia, le evidenze empiriche su come l'EC trasformi i modelli di business nei diversi contesti regionali sono ancora limitate, soprattutto nei confronti internazionali. Questo studio analizza l'implementazione dell'EC attraverso studi di caso nella Regione Geografica Intermedia (RGInt) di Cascavel, nello Stato del Paraná, Brasile, e nella Regione Marche, Italia. Gli obiettivi sono valutare come le normative nazionali incorporino i principi dell'EC, identificare le pratiche adottate nel settore agroalimentare ed esaminare il loro ruolo nella trasformazione dei modelli di business e nel promuovere lo sviluppo regionale. La ricerca ha adottato un approccio qualitativo, combinando interviste semistrutturate e analisi dei casi studio. I risultati rivelano tre principali evidenze. Primo, l'implementazione efficace dell'EC richiede un equilibrio tra pragmatismo, inclusività, governance e contesti socio-politici: il Brasile enfatizza iniziative emergenti legate alla competitività, mentre l'Italia integra l'EC in un quadro più consolidato ma frammentato. Secondo, allineare le mentalità a una cultura orientata alla circolarità richiede tempo, definizione di obiettivi chiari, strategie per l'innovazione aziendale e monitoraggio continuo dei progressi sotto la lente della sostenibilità (ambientale, sociale ed economica). Terzo, le traiettorie regionali differiscono: la RGInt di Cascavel mostra una crescita robusta trainata dal settore zootecnico e dalla diversificazione, mentre le Marche evidenziano una struttura matura in fase di riorientamento verso nicchie ad alto valore aggiunto. Lo studio contribuisce fornendo evidenze comparative sul nesso EC-sviluppo regionale, offrendo indicazioni per imprese e policy maker.

Parole chiave: sviluppo sostenibile; sviluppo regionale sostenibile; industria agroalimentare; SDG 12; simbiosi; cradle-to-cradle.

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"Then he told them to pick up the pieces that
were left over, so that nothing would be wasted" (Jonh, 6:12)
"Nothing is lost, nothing is created,
everything is transformed" (Antoine Lavoisier, 1789)

1 INTRODUCTION

No region is the same as another. A region is historically shaped by diverse elements and processes: its unique soil and climate conditions, its history of settlement and colonization, social and power dynamics, cultural and identity-based connections, the influence of political and administrative jurisdictions, economic and institutional practices and structures, among various other factors and characteristics (Alves, 2022b).

Literature recognizes that the concept of development goes beyond the strict notion of economic growth, incorporating social, institutional, and environmental dimensions associated with the expansion of human capabilities and the improvement of living conditions (Sachs, 2000). In the field of regional development, this understanding is territorialized, emphasizing the interaction between local productive structures, institutional arrangements, social capital, and public policies in reducing spatial inequalities and promoting endogenous development trajectories (Ferrera de Lima, 2020, 2022; Silva, 2022).

Despite this diversity, regions across the globe are facing common challenges brought on by unsustainable practices. The process of linear exploration production, usage, and waste generation – consumptions and production patterns – combined with demographic changes has been driving mankind towards the limits of the planet. The implementation of the **circular economy (CE)** has been growing as sustainable themes gain more attention at the municipal, regional, national and global levels (Dąbrowski *et al.*, 2024; Schroeder; Anggraeni; Weber, 2019; Silva; Franz, 2022).

That is, CE has been recognized as a potential paradigm that can balance environmental sustainability with the economic viability of sustainable development, particularly in the agri-food industry (Chiaraluce, 2024). A linear economic model of "take, make, and dispose" has so far contributed to the over-exploitation of natural resources, increase in pollution, and non-sustainable manners. By contrast, the CE, which is guided by the notion of closing the loops of resources by promoting recycling, reuse, and waste minimization, has contributed to diminished impacts on the environment while improving regional economies (Ellen MacArthur Foundation, 2015; Geissdoerfer *et al.*, 2020; Kirchherr; Reike; Hekkert, 2017; Klein; Nier; Tamásy, 2022a). Thus, the CE connects directly to sustainable regional development by

offering concrete mechanisms to align territorial competitiveness, institutional innovation, and sustainability, reinforcing the importance of contextual and territorially anchored approaches.

While recently several studies focused on circularity-related issues concerning different industries, sector-specific dynamics, such as those that occurred within the agri-food sector, were less discussed (Zucchella; Previtali, 2019). This happened mainly at regional levels. In fact, as D'Adamo et al. (2024) stressed, European countries are still very fragmented regarding performance toward Circular Economy outcomes, while Ghinoi et al. (2024) demonstrate that there is also a gap in the implementation of the CE at the municipal level. Similarly, Rocchi et al. (2021) applied the Material Circularity Indicator to the poultry sector, showing that intensive rearing does not necessarily achieve better circularity. All these works prove that sectoral and regional methods are necessary for understanding circularity in agri-food industry.

The CE can be an approach to intervene and moderate the impacts generated in the agri-food sector, proposing actions and solutions to readmit waste and by-products into the production chain (Chiaraluce; Bentivoglio; Finco, 2021). Furthermore, to develop innovative circular business models, managers and technicians must be aware of the possible solutions that can be adopted to recover and value their waste (Chiaraluce; Bentivoglio; Finco, 2023).

Initiatives to promote the CE are closely aligned with important European Union (EU) priorities such as industrial innovation, jobs and growth, investment agenda, climate and energy, social agenda, and worldwide efforts on sustainable development. Consumers and producers are important economic actors that propel this process, and industry must take the lead by pledging to source sustainably and collaborate across value chains (European Commission, 2015).

From this standpoint, the circularity in the agri-food system will be evaluated by examining its premises and units of analysis through a comparative approach in two distinct regions: Paraná State, Brazil (focusing on Intermediate Geographic Region of Cascavel), and Marche Region, Italy. This evaluation will provide insights into how circular economy practices are being implemented and their influence on the sustainable regional development in these areas, e.g., by localizing production, understanding the sustainable business model adopted by agri-food industries, and what CE practices are used.

1.1 THEME, CONTEXT AND RESEARCH PROBLEM

The agrifood sector encompasses the entire network of activities, processes, and actors involved in the production, processing, distribution, consumption, and disposal of food and

agricultural products (FAO, 2021). It integrates agricultural production with food supply chains, emphasizing the interconnectedness of farming, food processing, retail, and consumption.

Regarding the production process, every company generates some type of waste, reflecting how the environmental consequences of production and consumption patterns are closely intertwined with the broader trajectory of regional development. That is, studying only the "food and beverage industries" provides a focused lens to analyze how circular economy practices can be tailored to specific business models, enabling actionable insights for sustainable transformation within a critical and representative segment of the agri-food sector. Also, it enables the identification of business models capable of translating circular principles into actionable strategies.

The agri-food sector, in 2023, the Gross Production Value (GPV) of Brazil's agricultural sector was around R$ 1.3 trillion, with Paraná accounting for R$ 92 billion, or 11,5% of the national figure (IPARDES, 2024). Analyzing Paraná in detail is essential for understanding the broader dynamics and contributions of Brazil's agribusiness sector (Shikida; Galante; Cattelan, 2020). In that same year, Brazil had 71.866 active companies engaged in food and beverage manufacturing, of which 5.852 (8,14%) were in Paraná. Within the state, the Intermediate Geographic Region (RGInt) of Cascavel stood out with 1.189 companies, representing 20,23% of Paraná's total in this sector.

Similarly, in Italy, the agri-food system encompassing agricultural production through to food and beverage retail distribution – generated in 2020 an estimated turnover of €510 billion, corresponding to about 17% of the national economy. The food and beverage sector alone contributed roughly €141 billion, or 27% of that value (Chiaraluce, 2024). According to regional data from the Statistical Information System (SIS), in 2023, Italy counted 59.154 companies in food and beverage manufacturing, with 1.664 (2,81%) located in the Marche Region. Within Marche, the province of Ancona was particularly prominent, concentrating 402 firms, equivalent to 24,2% of the regional total (Camera di Commercio delle Marche, 2024).

The selection of the RGInt of Cascavel (Paraná, Brazil) and the Marche region (Italy) as case studies is grounded in their contrasting yet complementary profiles. While they differ in terms of scale, institutional frameworks, and stages of agri-food system development, both regions share a strong productive specialization in the food and beverage industry and a growing engagement with sustainability-oriented initiatives. This combination provides a robust empirical basis for examining how circular economy principles are operationalized within distinct socio-economic and regional contexts.

The focus here is exploring **how circular economy practices influence the agri-food sector, aiming to uncover the connections between sustainability strategies, business models, and regional development**. Different territories approach circularity in unique ways, shaped by their institutional frameworks, production systems, and cultural values. This raises a key question: **What are the implications of circular economy practices in the agri-food sector for business models and regional development, considering the similarities and differences between RGInt Cascavel (Paraná), Brazil, and Marche, Italy?** By examining this, I aim to understand how circular strategies are embedded in distinct regional contexts and how they contribute to advancing sustainable development pathways, focusing on innovation and governance.

My thesis is that the adoption of circular economy practices in the agri-food sector is a significant driver of sustainable regional development, where business strategies, cooperative models, and policy frameworks interact with local social, cultural, and environmental dynamics to shape how circular transitions unfold across territories such as Italy and Brazil, and specially in regions like Marche and Intermediate Geographic Region of Cascavel.

Within the concepts of CE, it is recognized that the pursuit of sustainability by companies should be both spontaneous and strategically directed. Spontaneous, in that companies perceive sustainability as the most advantageous and profitable approach; and strategically directed, as it is increasingly mandated by national and international institutions and regulatory bodies. However, contrary to what some definitions and theories may suggest, this process is not linear. It often requires adaptations and concessions that companies may be reluctant to undertake unless such actions are demonstrably profitable or lead to cost reductions.

These strategies play an important role in fostering regional development by enhancing resource efficiency, creating new economic opportunities, and strengthening local economies through innovation, thereby contributing to more sustainable communities. The theoretical justification for this research lies in its contribution to deepening the debate on sustainable regional development (focus on economic, social, and environmental issues), and circular economy through empirical analysis. By using a comparative case study between two territories, this research, with its practical nature, aims to contribute to the strategic management of sustainability in the context of the studied areas. The combination of quantitative models (such as regional analysis/locational quotient) with qualitative approaches (primary research), along with the comparative analysis between the two territories, lends a novel and significant dimension to this research.

1.2 OBJECTIVES

The general objective is **to analyze the implementation of circular economy practices in the agri-food sector with case studies from Paraná State, Brazil, and Marche Region, Italy.**

The specific objectives are:

- To analyze how Brazilian and Italian regulations address the principles of the circular economy through their policies. (Regulation and policies).
- To identify and analyze circular economy practices implemented in the agri-food sector globally. (Global practices).
- To investigate how circular economy practices transform agri-food business models and contribute to regional development, comparing experiences from Italy and Brazil. (Business models and regional development).

1.3 JUSTIFICATION AND GAP

This research is timely, engaging with themes of growing importance in both academic debate and policy agendas, particularly in the context of sustainability transitions and food systems. Although the CE has become a central reference in international strategies, its application to the agri-food sector is often fragmented, with studies focusing on specific practices rather than systemic transformations (Agnusdei *et al.*, 2022; Barros *et al.*, 2023; Chiaraluce, 2024; Dąbrowski; Wandl, 2024; Donner; Gohier; de Vries, 2020).

A comparative perspective between Italy and Paraná (Brazil) addresses a gap in the literature, as most analyses are either global in scope or limited to single national contexts. Exploring how CE principles are embedded in distinct territorial and institutional settings enables a deeper understanding of the opportunities and barriers to circular transitions. For businesses, this research highlights pathways to innovation and competitiveness through resource recovery and collaboration. For policymakers, it highlights the role of governance and regulation in facilitating inclusive and place-based strategies. By linking regional development and circular economy, this research contributes to advancing integrated approaches that connect environmental goals with social and economic outcomes across diverse contexts. This research is socially, scientifically, economically, and regionally relevant.

Socially, by contributing to the improvement of public policies, propose solutions to social problems and favor the reduction of inequalities. In other words, the social relevance of

this research is linked to the promotion of sustainable practices that benefit communities, stimulate inclusive economic development, and contribute to the construction of a more equitable and environmentally healthy environment.

Scientifically, the scientific relevance of this research lies in the possibility of contributing to existing knowledge, filling knowledge gaps around knowledge, and practices related to the circular economy and business model considering regional development.

Economically, as it examines the implications of CE implementation from a regional perspective, with a particular focus on the agri-food industry. It also contributes by identifying practical pathways for companies to optimize resource use, minimize waste, and strengthen their circularity potential at the organizational level.

Regionally, focusing on regional contexts, such as Paraná State, Brazil, and Marche Region, Italy, this research addresses how localized CE strategies can promote sustainable economic growth while adapting to each region's unique socio-economic, environmental, and institutional conditions.

All these perspectives are intrinsically connected to the United Nations Sustainable Development Goals (SDGs), particularly decent work and economic growth (SDG 8), industry, innovation, and infrastructure (SDG 9), and, most prominently, responsible consumption and production (SDG 12).

1.4 ETHICAL ASPECTS

In Brazil, this study received ethical approval from the Human Research Ethics Committee of Western Paraná State University (*Comitê de Ética em Pesquisa com Seres Humanos* – CEP), under the Certificate of Submission for Ethical Appraisal (CAAE/Plataforma Brasil) No. 85558124.5.0000.0107 (Report No. 7.417.037). This approval ensured compliance with ethical standards, transparency, and the protection of all participants.

In Italy, data confidentiality was guaranteed in accordance with Regulation (EU) 2016/679 (General Data Protection Regulation – GDPR) and Legislative Decree 196/2003, as subsequently amended. All information collected through the questionnaires was used exclusively for scientific research purposes. The data are protected by statistical confidentiality and may only be disclosed in aggregated form. No individual-level information can be identified, ensuring that the data serve solely for scientific analysis.

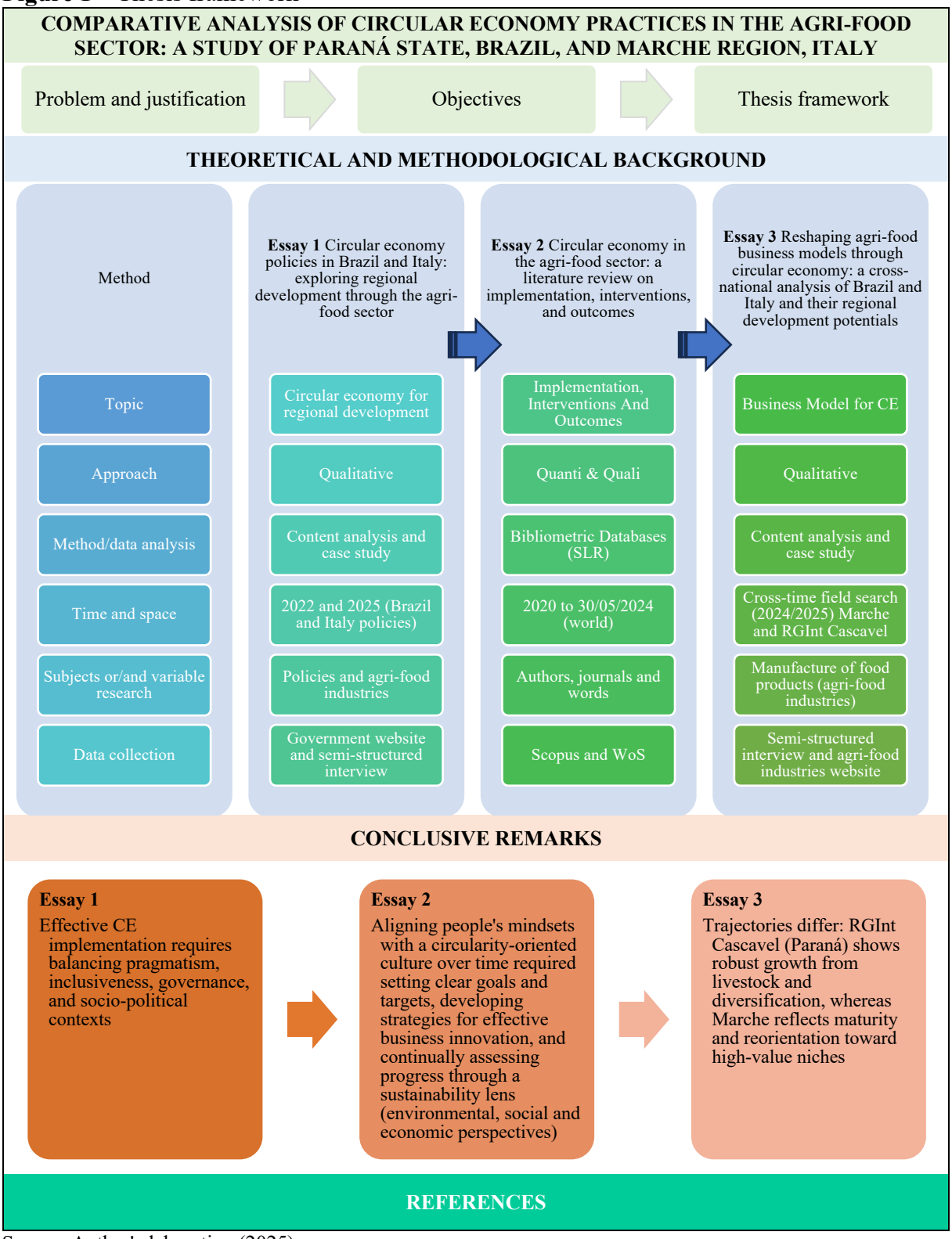
All research practices were conducted in accordance with the ethical principles outlined in the United Nations Educational, Scientific and Cultural Organization (UNESCO) guide

named “Guidance for generative AI in education and research” (UNESCO, 2023). Furthermore, as a non-native English speaker, I used Artificial Intelligence (AI) tools to enhance the clarity and coherence of my writing while ensuring the originality of my work. Specifically, ChatGPT and DeepSeek were employed exclusively as language-support tools, assisting with phrasing, transitions, and structure, but never generating original content. Their role was limited to refining expression and improving readability, whereas all theoretical choices, data analysis, and arguments remained entirely my responsibility. Moreover, every AI-assisted output was critically reviewed and finalized by me, ensuring that authorship and academic integrity were fully preserved. A summary of the plagiarism-check report, conducted by the researcher using Turnitin software, is provided in Appendix D.

1.5 THESIS FRAMEWORK

In addition to this introduction, this research project is structured into six other sections (see Figure 1). Essay 1 will analyze how Brazilian and Italian regulations address the principles of the circular economy through their policies. Essay 2 will discuss the implementation, intervention, and outcomes of CE practices. Essay 3 will analyze business models for a CE in the agri-food industry. Section 4 outlines the conclusive remarks. Finally, the references are provided. The PhD project schedule is available in Appendix A.

Figure 1 – Thesis framework



Source: Author' elaboration (2025).

ESSAY 1

2 CIRCULAR ECONOMY POLICIES IN BRAZIL AND ITALY: EXPLORING REGIONAL DEVELOPMENT THROUGH THE AGRI-FOOD SECTOR

Abstract: While Circular Economy (CE) is inherently tied to regional contexts and offers potential for sustainability transitions, policy and academic discussions often overlook the regional scale's role in driving resource management and ecological regeneration. This essay examines how Brazil and Italy address CE principles in their policies, highlighting their distinct approaches. A particular focus is placed on the agri-food sector, drawing on interviews with industry representatives to explore how CE intersects with regional development. Using a comparative framework, the study analyses CE strategies in both countries, focusing on what kind of CE is pursued, how it is implemented, where governance occurs, and for whom it is designed. The findings underline the importance of bridging practicality and inclusivity to enhance CE implementation. By critiquing these strategies, the essay contributes to understanding how different governance structures and socio-political contexts influence CE policy outcomes, offering insights for designing more coherent and regionally adaptive frameworks for CE transitions.

Keywords: Circular Economy Policies; Regional Sustainability; Comparative Governance.

"Development, in reality, concerns life's goals.
Developing to create a better world that responds to human
aspirations and broadens the horizons of expectations.
Development only exists when humankind develops"[1]
Celso Furtado

2.1 Essay introduction

Circular economy (CE) is inherently linked to territories, as economic activities are deeply rooted in their spatial context, functioning across multiple scales and shaped by their geographic setting (Dąbrowski *et al.*, 2024). Yet the CE academic literature and policy frameworks on CE often overlook this aspect. Because they tend to be more flexible and experimental with their policies than the federal government, regions and cities are better able to develop novel policy instruments and strategies and organize efforts among many stakeholders to promote sustainability transitions (Dąbrowski *et al.*, 2024).

This territorial embeddedness of CE resonates with broader theories of regional development. For instance, Brazilian economist Celso Furtado (1967), economic development originates in specific locations and then gradually diffuses outward. The pace and extent of this expansion are significantly influenced by the physical environment, particularly through the impact of transportation costs. In other words, space matters for regional development. As Furtado emphasized, "the practical problem will always be to reconcile general goals of development, defined in terms of the nation as a whole, with the objectives of social welfare directed towards certain sections of the population" (Furtado, 1967, p. 11).

Building on this perspective, regional development offers a valuable lens for understanding and advancing the CE. By emphasizing the spatial dimensions of economic activity, it highlights how regions can leverage their unique resources, industrial structures, and institutional frameworks to implement CE principles effectively. This approach not only stimulates regional innovation but also aligns CE transitions with local contexts, thereby promoting sustainable and inclusive growth.

Circular economy policies, embedded within broader environmental, social, and economic objectives, need to be interpreted considering distinct regional contexts. Regional development offers a complementary perspective, providing a spatial and contextual framework

[1] "O desenvolvimento, na realidade, diz respeito às metas da vida. Desenvolver para criar um mundo melhor, que responda às aspirações do homem e amplie os horizontes de expectativas. Só há desenvolvimento quando o homem se desenvolve" (Celso Furtado).

for understanding how policies related to CE are shaped by local resources, industrial structures, and governance systems, factors that differ markedly between Brazil and Italy.

By integrating these perspectives, we can analyze how both countries design and implement CE policies, considering their unique regional challenges and opportunities. The interviews were conducted in Paraná State (Brazil) and the Marche Region (Italy), two regions selected for their strong agri-food traditions and ongoing efforts to integrate circular economy principles into regional development strategies (Chiaraluce, 2024; Shikida; Galante; Cattelan, 2020). This approach allows for a comprehensive evaluation of how Brazil and Italy translate CE principles into actionable policies, fostering sustainable transitions at both national and regional levels.

In addition, the adoption of a circular economy framework has the potential to unlock real economic prospects, enhance the availability of raw materials for industry through waste recovery, generate employment opportunities, and facilitate the shift towards a sustainable green technology sector (Chiaraluce; Bentivoglio; Finco, 2023). Given these benefits, the agri-food sector warrants particular attention, as its high natural resource consumption, significant waste generation, and critical role in ensuring food security make it a strategic arena for CE implementation.

However, the literature and policy practice do not adequately address the challenges and key drivers of implementing a localized circular economy in a region. Yet, this is important due the regional level offers greater opportunities for public participation in resource management and ecological regeneration, as the positive impacts are more directly observable (Van Den Berghe *et al.*, 2024).

In this essay, we take stock of the current debates and policies on CE, proposing an investigation into how Brazil and Italy address the Circular Economy in their policies, with empirical insights from interviews with agri-food firms to assess practical implementation. That is: what kind of CE has been pursued, how, where and for whom. By employing a methodological approach that analyzes the circular economy policies in both countries, the study seeks to provide a comparative framework. This framework will highlight how Brazil and Italy implement circular economy principles in their regulatory landscapes.

2.2 Theoretical background

2.2.1 Conceptual foundations of the circular economy

Although the concept of a circular economy originated in industrial ecology in the 1990s (Pearce; Turner, 1990), tied to the idea of symbiosis among industries where one sector's waste serves as a resource for another and remains closely linked to waste management, it has quickly expanded its application across numerous disciplines.

Circular Economy has long been a topic of discussion within academic and scientific circles, and its significance is increasingly recognized in the contemporary context. This paradigm entails the reduction of resource consumption, with a particular emphasis on natural resources, and the mitigation of waste and effluent generation, except in cases where negative externalities are produced (APDR, 2018).

The majority of experts focus on the following fundamental ideas: the waste hierarchy, the systemic approach (micro, meso, and macro), sustainable development, and the 4Rs framework (Kirchherr *et al.*, 2023). Table 1 presents some definitions of the circular economy provided by different scholars and institutions over time.

Table 1 – Circular economy definition

Circular Economy is	**Source**
the circular flow as an alternative for the reuse of materials in production processes. As a result, recycling began to be considered an alternative to contain the high emission of toxic waste into the environment	(Pearce; Turner, 1990)
an economy that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times	(Ellen MacArthur Foundation, 2015, p. 46)
a model for production and consumption (with heavy emphasis on production), whose ultimate goal is to achieve the decoupling of economic growth from natural resource depletion and environmental degradation	(Williams, 2019, p. 2749)
(an) economic system that uses a systemic approach to maintain the circular flow of resources, through the recovery, retention or addition of their value, while contributing to sustainable development[2]	(ABNT, 2022, p. 4)
The circular economy is a regenerative economic system which necessitates a paradigm shift to replace the 'end of life ' concept with reducing, alternatively reusing, recycling, and recovering materials throughout the supply chain, with the aim to promote value maintenance and sustainable development, creating environmental quality, economic development, and social equity, to the benefit of current and future generations. It is enabled by an alliance of stakeholders (industry, consumers, policymakers, academia) and their technological innovations and capabilities	(Kirchherr *et al.*, 2023, p. 7)
an alternative paradigm to the dominant linear model of production and consumption that aims to reduce waste, reuse resources and regenerate natural systems	(Van Den Berghe *et al.*, 2024, p. 101)

Source: own design (2025).

[2] "sistema econômico que utiliza uma abordagem sistêmica para manter o fluxo circular dos recursos, por meio da recuperação, retenção ou adição de seu valor, enquanto contribui para o desenvolvimento sustentável"

These definitions (Table 1) highlight the core principles of circularity, including resource regeneration, material reuse, and the decoupling of economic growth from environmental degradation. Each definition underscores the systemic and restorative nature of the circular economy, aligning with sustainable development.

Notably consumption has received relatively little investigation up to this point, given that popular definitions of the CE, such as those provided by the Ellen MacArthur Foundation (2015), concentrate more on the flows of materials and energy than on the activities of consuming. It is noteworthy, therefore, that Kirchherr and colleagues (Kirchherr *et al.*, 2023) included consumption in their above-cited definition of CE (Dagevos; Lauwere, 2021).

The city benefits from circular systems in many ways, including increased economic productivity, revenue opportunities, the promotion of urban, social, and environmental health, and support for local production (Williams, 2019). The circular city model is centered on territorializing the ideas of the circular economy, whereby everything that is wasted becomes a resource for inexpensive, regenerative urban systems that combine social fairness, economic productivity, and environmental sustainability to lessen social inequality (Fusco Girard; Nocca, 2019).

Because it aims to match its activities with the natural cycle, the circular economy model has the potential to support sustainable development on a local, regional, and global scale. The outcomes might not contribute to the sustainable development of the region if circular processes are projected and put into practice without placing people at the center of their decisions (Silva; Franz, 2022). Silva and Franz (2022) pointed that the opportunity to make changes and to find vital solutions to the planet's sustainability emerge in the cities due to its relevance on population growth, production and consumption. Also, the circular economy can be applied to large and small enterprises, collectively and individually, worldwide and locally, and it facilitates the development of economic, natural, and social capital.

Nevertheless, only Van Den Berghe et al. (2024) explicitly underscore the relationship of CE and regional development. That is, the concept has garnered growing interest among policymakers, practitioners, and scholars as a prospective strategy to address the multifaceted challenges of environmental deterioration, resource depletion, social inequity, and economic stagnation.

Concepts of CE offer a comprehensive means of preventing resource depletion, valorization of by-products, and enhancing regenerative action, thus aligning economic profitability and environmental sustainability. While the CE offers a set of principles for sustainable production and consumption, its practical application depends heavily on the

specific conditions of each region. This makes regional development an essential lens for understanding how CE policies are shaped and implemented, especially on agri-food sector.

2.2.2 Circular economy for regional development

To Alves (2022a, p. 12) the idea of development is linked to "the ability, not only to improve the living standards of its population, but also to make the region more competitive and innovative, maintaining its dynamism/growth over time."[3] That is, development is a multidisciplinary concept with the ultimate objective of the well-being of certain populations. For example, the coordination of projects with a view to a virtuous cycle to promote education, health, employment, social protection, respect for diversity (Ferrera de Lima; Alves, 2012).

Development extends beyond incentive policies or income growth, encompassing primarily the objective of enhancing the well-being of specific populations. There is a close relationship between regional development and regional science. The latter emerged in the 1950s to rethink new theories and approaches to regional phenomena, including the development process. Notably, the term "Regional Science" was coined by Walter Isard (1960), who aimed to create a framework that would bring together researchers focused on regional development under a unified analytical perspective (Theis *et al.*, 2022).

The quest to understand regional development can be traced back to theories that emerged in the 1960s as a counterpoint to earlier location theories, which dominated until the mid-20th century. These classical theories were developed by scholars such as Johan-Heinriche Von Thünen (The Isolated State, 1826), August Lösch (The Spatial Order of the Economy, 1940), Walter Christaller (Central Place Theory, 1933), and Alfred Weber (Theory of the Location of Industries, 1909) (Ferrera de Lima, 2022, 2024).

These early theorists focused on issues such as the location of productive activities, centrality, and the hierarchy of places. Their work laid the foundation for understanding the locational dynamics of production, which is essential for addressing intra and inter-regional inequalities.

According to Ferrera de Lima (2020, p. 132), "the theory of regional development seeks to understand the role of space, public policy, and territories in improving the quality of life and economic progress of regions." The author argues that promoting regional development is

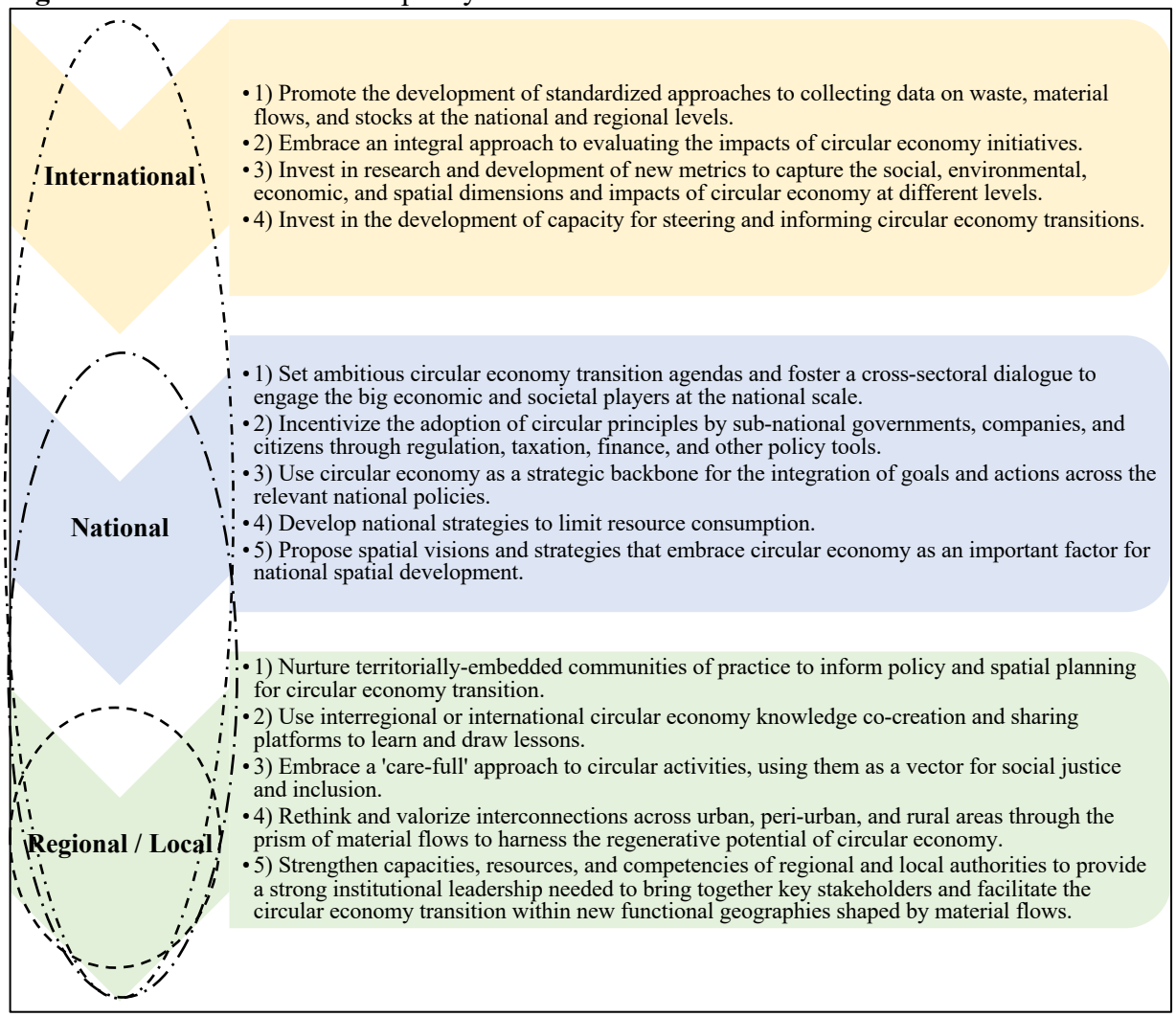
[3] Tradução da autora, texto original: "capacidade, não somente de melhorar os níveis de vida de sua população, mas também de tornar a região mais competitiva e inovadora, mantendo o seu dinamismo/crescimento ao longo do tempo."

intrinsically linked to the construction of citizenship within regions, with human development being the primary focus of public policy in regional development.

Also, local actors' actions form the basis of the endogenous regional development theory, and a region's social capital is formed by the interaction of territorial cooperative links (Silva, 2022). The integration of human capital, infrastructure, governance, and agglomeration economies can drive environmentally responsible practices and resource efficiency, aligning regional growth with CE principles.

Nonetheless, the CE does not represent a ‘one-size-fits-all approach’; instead, it constitutes a context-dependent and geographically situated process that necessitates a comprehensive and systemic framework. Figure 2 shows policy recommendations for facilitating an urban and regional CE.

Figure 2 – Overview of the CE policy recommendations in three scale



Source: own design (2025), adapted from: (Van Den Berghe *et al.*, 2024, p. 100).

Effective transition to a CE requires coordinated policy efforts across international, national, and local levels (Figure 2). Each governance scale has a distinct role in advancing and applying CE principles within regions, disciplines, economic sectors, institutional and administrative boundaries.

The circular process is already being used in agriculture, as seen in the digestate and biogas generation processes. However, much more focus and investigation are needed in the food industry (Chiaraluce, 2021). Understanding and transforming the agri-food system is critical in the context of sustainable development, particularly considering the pressing issues of food loss and food waste (Chiaraluce; Bentivoglio; Finco, 2023).

Since successful international, national, and local policies are essential for promoting systemic shifts toward circularity, the CE and regulatory frameworks are closely related. Regulations are essential for encouraging resource recovery, material reuse, and waste reduction while making sure that CE programs support social justice and sustainable development objectives. Examples of laws that assist businesses and localities in incorporating CE concepts into their operations include tax incentives for circular processes and waste valorization norms, such as those found in the food waste hierarchy (Klein; Nier; Tamásy, 2022b).

Hence, “integrating a circular perspective into spatial planning and territorial policies can generate a wealth of synergies in the transition to circular futures” (Dąbrowski *et al.*, 2024, p. 20). To achieve this and avoid one-size-fits-all approaches, CE policies must be context-specific. Moreover, regulations not only enable CE implementation but also ensure its alignment with broader economic, environmental, and social objectives.

As stressed in this section, we understand circular economies as an important pillar of sustainable production and consumption. While CE seeks to improve productivity by minimizing, reusing, and recycling the outputs of the productive process to the greatest extent feasible, regional development emphasizes the strategic use of regional resources to enhance economic performance and social well-being. Together, these perspectives foster resource efficiency, stimulate local innovation, and strengthen the socio-economic development of regions.

Given this context, **in what ways do Brazil and Italy differ in addressing the Circular Economy through policies, and how are these approaches implemented in the agri-food sector?** The next section will delve into materials and methods to answer this question.

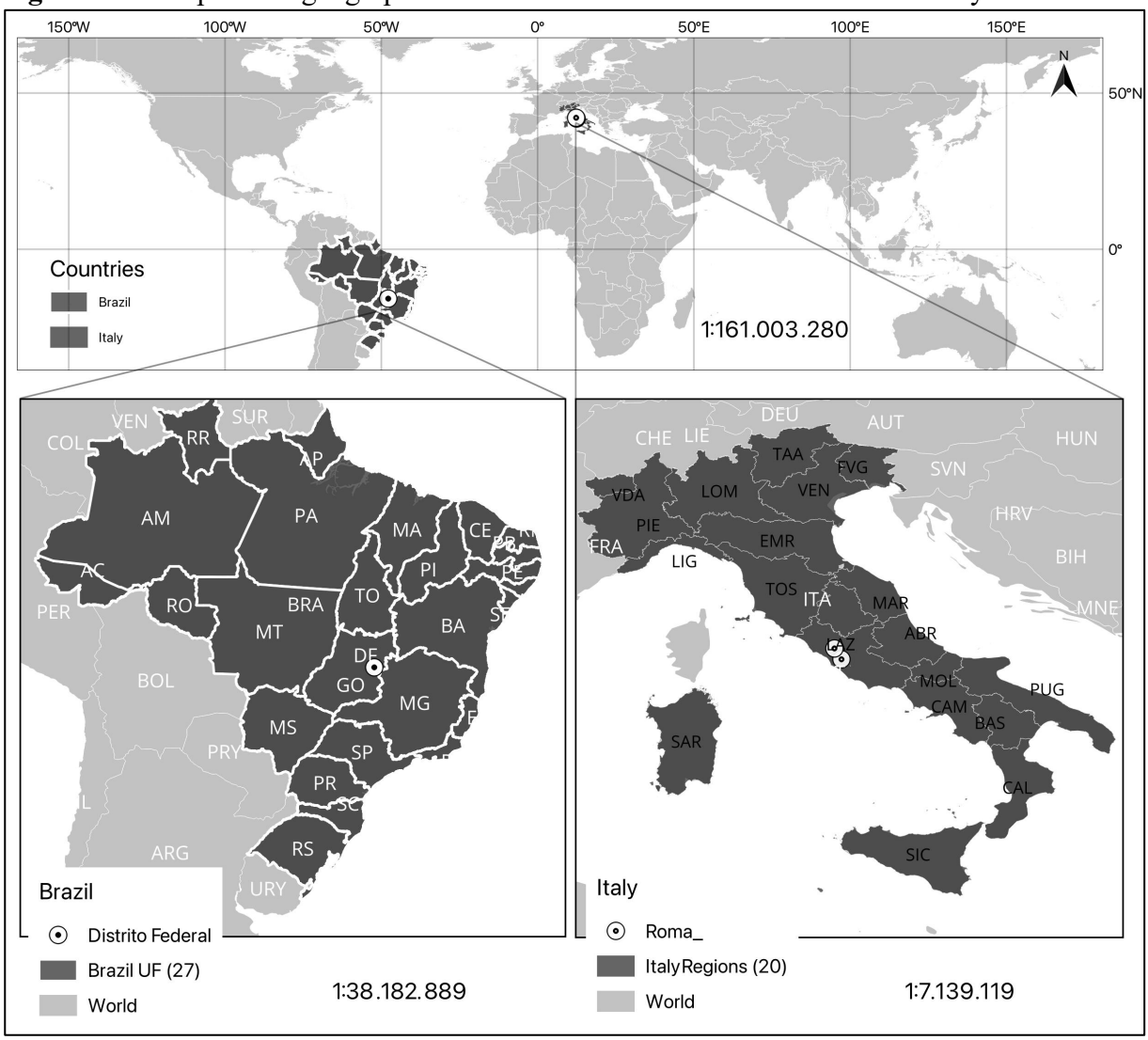
2.3 Materials and methods

This study employs a qualitative and comparative research design to investigate the status of the circular economy (CE) in Brazil and Italy. The methodological approach is structured to enable a systematic comparison of the regulatory frameworks and policies associated with CE in both contexts.

Case selection

The investigation involves a cross-comparison between Brazil and Italy. Both countries are ideal case studies for examining CE policies due to their contrasting yet complementary contexts. Figure 3 shows a comparative geographic and administrative divisions.

Figure 3 – Comparative geographic and administrative divisions: Brazil and Italy



Source: own design (2025).

Brazil is a federative republic composed of 26 states and one Federal District, which houses the capital, Brasília. This administrative structure reflects the country's vast geographic and cultural diversity, spanning over 8.5 million square kilometers. The states are further divided into municipalities, totaling 5.570, which exercise significant autonomy in local governance (IBGE, 2024). This decentralized system allows for tailored regional policies, particularly in areas such as environmental management and economic development, while maintaining a unified national framework. The geographic and administrative divisions of Brazil play a critical role in addressing the country's complex socio-economic and environmental challenges. Paraná represents one of Brazil's most dynamic agricultural hubs, with a diversified production system and a growing emphasis on cooperative structures (Shikida; Galante; Cattelan, 2020).

Italy is a parliamentary democratic republic characterized by a multi-tiered administrative structure, comprising 20 regions, which are further divided into provinces and municipalities. Covering approximately 301.340 square kilometers, Italy's geographic and administrative divisions reflect its diverse cultural, historical, and economic landscapes. The country's regions are granted varying degrees of autonomy, with five regions – Sicily, Sardinia, Trentino-Alto Adige/Südtirol, Friuli-Venezia Giulia, and Valle d'Aosta/Vallée d'Aoste – having special statutes that confer greater legislative and administrative powers. This decentralized governance model allows regions to address local socio-economic and environmental issues while aligning with national policies. Italy's geographic and administrative divisions play a pivotal role in implementing tailored strategies, particularly in areas such as environmental sustainability and regional development (EUROSTAT, 2023). Marche Region stands out in Italy for its medium-sized enterprises and innovation-oriented agri-food sector (Chiaraluce, 2024)

Data gathering and analysis[4]

The research adopts a qualitative comparative methodology, focusing on an in-depth analysis of regulatory documents. This design is particularly suitable for exploring the particulars of CE implementation across diverse socio-economic and cultural contexts. The comparative dimension enables the identification of commonalities, differences, and unique

[4] Ethics committee approval and informed consent obtained: Certificate of Submission for Ethical Appraisal (CAAE/Plataforma Brasil) N. 85558124.5.0000.0107 (Report number: 7.417.037).

approaches in Brazil and Italy, offering a nuanced understanding of how these nations address CE principles.

Secondary data sources include national and regional laws, policies, and guidelines that govern CE in both countries. In Brazil the study reviews key regulatory instruments such as the PLANEC (Brasil, 2025), in Italy, data includes national policies like the Strategia nazionale per l'economia circolare (MITE, 2022). Regional regulations are also analyzed to capture subnational variations.

To enhance the reliability and robustness of the findings, a multiple case studies (Yin, 2018) with a qualitative approach, using semi-structured interviews and document analysis to triangulate the collected information, was employed (see Appendix B). This approach ensures that the conclusions are well-grounded and reflect the complex realities of CE in both contexts.

A sampling methodology was established based on the research interest: The case companies should belong to the most relevant sectors of the Brazilian and Italian agri-food industries according to the statistical analysis (locational quotient > 1, see C); the case companies should have a solid brand reputation; the case companies should run a mature and profitable business, able to support investment for the circular transition; the case companies produce by-products with a potential circular use.

Data collection was carried out by questionnaire and direct interviews with entrepreneurs and technicians of the different companies from November 2024 to June 2025. In total, six agri-food companies were interviewed: three from Brazil and three from Italy. In each selected case study, at least two people were interviewed (more than 12), generally the owner and the technician in charge of the production processes. Although the number of interviews was small, the focus on in-depth qualitative insights ensures the richness of the data. Moreover, using multiple cases supports analytical generalization, as findings can be replicated in similar contexts (Chiaraluce; Bentivoglio; Finco, 2023). Interviews were conducted face-to-face and remotely via Teams or Meet, recorded, and transcribed. Details of the interviews are provided in Frame 1.

Frame 1 – Interviews conducted over the research (n. 7)

Code	Country	Date	Agri-food sector	Position	Format	Language	Length	+ Visiting duration	Pages
2	Italy	21/11/2024	Meat and production of meat products	Research and Development Manager	In-person	EN	00:35:27	01:13:00	8
4	Italy	26/11/2024	Manufacture of grain mill products	President and member	In-person	IT	01:04:32	00:30:00	12
6	Italy	29/11/2024	Processing and preserving of fish	Quality Control team	In-person	IT	01:00:52	01:15:01	14
7	Italy	29/11/2024		CEO			01:02:07		10
8	Brazil	12/05/2025	Meat and production of meat products	President and member; and Accountant	In-person	PT	00:41:45	00:00:00	8
9	Brazil	15/05/2025	Meat and production of meat products	Research, development and innovation manager; and Environmental analyst team	Google Meet	PT	00:23:55	00:00:00	6
12	Brazil	12/06/2025	Processing and preserving of fish	Environmental analyst and ESG Analyst	Microsoft Teams	PT	00:33:22	00:00:00	7
						Total	05:22:00	02:58:01	65

Source: own design (2025).

Each case (agri-food firm) was coded separately using the same coding framework. Following this, a cross-comparison analysis was conducted to compare the cases. The data were analyzed using deductive content analysis with the support of ATLAS.ti software (version 24), allowing for systematic coding based on pre-defined analytical categories. To be more specific, the analysis used pre-specified first-order coding based on Regional Development and Circular Economy, while an inductive approach considered the theoretical framework established in the literature.

2.4 Results

2.4.1 Circular economy in Brazil

With the introduction of the National Solid Waste Policy (PNRS)[5], established by Law No. 12.305 in 2010, the Brazilian regulatory framework encompassed the main guidelines for sustainability. Among the principles and instruments of this law, the shared responsibility for the product's life cycle and reverse logistics stand out, essential links for enabling the reintegration of waste into a new economic cycle (Brasil, 2010).

[5] Política Nacional dos Resíduos Sólidos (PNRS)

Based on the regulation, solid waste management in Brazil adopted waste generation reduction and pollution mitigation as its main guidelines to promote sustainability. In addition to the National Environmental Education Policy (PNEA)[6], established in 1999, the National Solid Waste Policy is integrated with the Water Resources Policy (PNRH)[7] of 1997, the National Climate Change Policy (PNMC)[8] of 2009, and the National Basic Sanitation Plan (PLANSAB)[9]. The latter, enacted by Federal Law No. 11.445, dated January 5, 2007, establishes the national guidelines for basic sanitation and, in its Article 7, determines that the activities of public services for urban solid waste management include the treatment of domestic waste and the management of solid waste resulting from the cleaning of streets and public roads.

Bianco (2018) suggest the implementation of a new urban solid waste management model using advanced methods and technologies has demonstrated its technical and economic viability, transforming urban solid waste from a cost factor into an investment opportunity. This approach not only provides economic incentives but also delivers positive environmental and societal impacts (externality), turning waste into a resource for new business models and industrial processes. It supports sustainable and innovative development in the Western Paraná region of Brazil by generating income, fostering technological advancements, extending landfill lifespan, reducing the need for additional landfill space, and ensuring compliance with Federal Law No. 12.305/2010 (PNRS).

However, in addition to federal legislation, states and municipalities act autonomously to enact their own regulations to govern waste management and reverse logistics within the limits established by the National Solid Waste Policy. Thus, the development of integrated solid waste management plans (Brasil, 2010) follows a priority order of action: (i) non-generation; (ii) reduction; (iii) reuse; (iv) recycling and treatment of solid waste; (v) environmentally appropriate final disposal of waste, which is the residue for which all utilization possibilities have been exhausted, being considered unsuitable for any type of use. Therefore, from the perspective of moving towards a sustainable economy, waste must be reused in some way, according to its characteristics and specificities, meaning it should be reintegrated into production processes or reused for other purposes.

The first National Regional Development Policy (PNDR)[10] (2007) focuses on territorial equity and environmental sustainability in a generic way, without explicitly addressing the

[6] Política Nacional de Educação Ambiental (PNEA)
[7] Política Nacional de Resíduos Sólidos está integrada à Política de Recursos Hídricos (PNRH)
[8] Política Nacional sobre Mudança do Clima (PNMC)
[9] Plano Nacional de Saneamento Básico (PLANSAB)
[10] Política Nacional de Desenvolvimento Regional (PNDR)

transformation of production models. PNDR II (2019) represents the greatest advance in this regard, by incorporating principles such as sustainability of production processes, integrated planning, federative cooperation and appreciation of territorial diversity, central elements for circular strategies on a regional scale. And the PNDR III (Brasil, 2024b), while maintaining some of these principles, omits mention of productive sustainability, indicating a possible weakening of the commitment to the ecological restructuring of regional economic chains. No version explicitly mentions the concept of CE.

On the 17th June 2024, a decree was published creating the country's first National Circular Economy Strategy (ENEC)[11] (Brasil, 2024a). The strategy aims to promote the economic transition from the current linear model to a circular economy, to create lasting and more conscious economic growth. The drafting of the ENEC was inspired by circular economy principles and reports published by the Ellen MacArthur Foundation.

The Strategy is based on the seven guidelines of the circular economy, especially the elimination of waste and pollution, circulation of materials and products at their highest values, and regeneration of nature. The following points of focus stand out in the ENEC: I) Create a regulatory and institutional environment favorable to the circular economy; II) Promote innovation, culture, education and skills generation to reduce, reuse and redesign how products are made, with the circular economy in mind; III) Reduce the use of resources and the generation of waste, in order to preserve the value of materials; IV) Propose financial instruments to support the circular economy; and V) Promote inter-federative coordination and the involvement of workers in the circular economy.

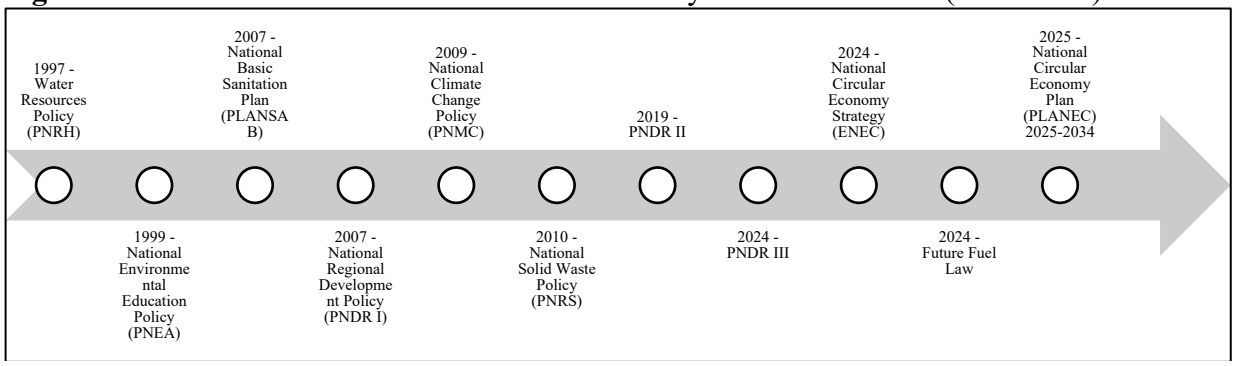
Finally, on May 8, 2025, during the meeting of the National Circular Economy Forum organized by the Ministry of Development, Industry, Trade and Services (MDIC), Brazil's National Circular Economy Plan (PLANEC) was approved. The document outlines 18 objectives and more than 70 actions, and it will serve as the foundation for establishing circularity policies over the next ten years (Brasil, 2025).

The document details the governance and five priority axes of the National Circular Economy Strategy (ENEC), which include creating a favorable regulatory environment, fostering innovation and education, reducing resource use and waste generation, proposing financial support instruments, and promoting inter-federative coordination with the participation of workers. The plan emphasizes collaboration between different sectors and the importance of a fair and inclusive transition.

[11] Estratégia Nacional de Economia Circular (ENEC)

Figure 4 presents a timeline highlights Brazil's progressive environmental and sustainability policies from 1997 to 2025, marking significant steps toward integrating environmental management, from water resources to solid waste, and culminating in the recent focus on a circular economy.

Figure 4 – Brazilian Environmental and Sustainability Policies Timeline (1997/2025)



Source: own design (2025).

The timeline in Figure 4 highlights policy development's fragmented and reactive nature in addressing complex environmental challenges. Although no PNDR explicitly mentions the term “circular economy”, the evolution shows a transition from a specific mention of environmental sustainability as an objective to be converged in 2007, to the inclusion of sustainable development and the sustainability of production processes as fundamental principles of the policy in 2019, culminating in the explicit incorporation of sustainable economic growth in the purpose of the policy and the creation of a strategic axis dedicated to “environment and sustainability” in 2024, evidencing an increasing integration and focus on the theme over time.

Especially in the PLANEC, change is seen as an economic opportunity that can increase efficiency, reduce costs, create business, generate jobs and promote competitiveness and social well-being, with public policies that promote financial incentives being essential. The timeline underscores Brazil's incremental approach to sustainability, revealing progress and persistent structural and governance challenges hindering comprehensive environmental transformation.

2.4.2 Circular economy in European Union (Italy)

Focusing on Italy, which is part of the European Union, it falls under the most integrated stage of Forms of Country Integration: the “Economic Community.” This level involves not only tariff-free trade within the bloc but also a common external tariff, free movement of goods,

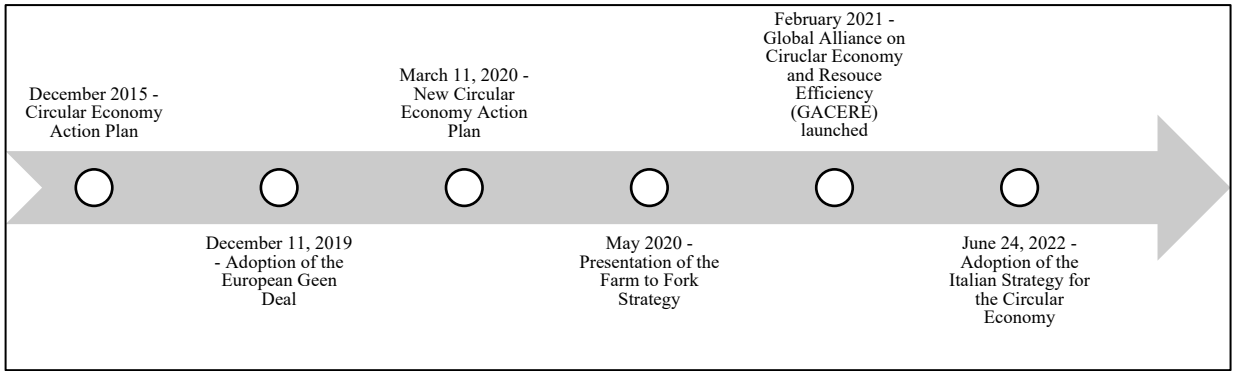
services, capital, and labor, as well as harmonization and joint coordination of socioeconomic policies (Jank; Nassar, 2000).

Furthermore, the European Union, at this level, also introduces institutional unification, such as the adoption of a common currency (Euro in 1999) and fiscal regulations across its member states. This reflects Italy's deep integration with other EU members, highlighting benefits like streamlined trade and labor mobility but also the challenge of aligning national policies with broader EU frameworks.

Every action taken by the EU is founded on the treaties. These binding agreements between EU member countries set out EU objectives, rules for EU institutions, how decisions are made and the relationship between the EU and its members. Treaties are the starting point for EU law and are known in the EU as primary law. The body of law that comes from the principles and objectives of the treaties is known as secondary law; and includes regulations, directives, decisions, recommendations and opinions. The legislation system of the EC uses the follow instruments (EU Legislation): Regulation, Directive, Decision, Communication (COM), Staff and joint staff working documents (SWD or SEC), Recommendation, Opinions (European Union, 2024).

European policy framework focusses on circular economy (Figure 5) began with the adoption of the Circular Economy Action Plan in December 2015, followed by the European Green Deal in December 2019, which laid a comprehensive foundation for environmental policies. In March 2020, a new Circular Economy Action Plan was introduced, further advancing the agenda. The Farm to Fork Strategy, presented in May 2020, focused on sustainable food systems. In February 2021, the Global Alliance on Circular Economy and Resource Efficiency (GACERE) was launched, emphasizing global cooperation. Finally, in 2022 was the adoption of the Italian Strategy for the Circular Economy 2021-2022, showcasing Italia's commitment to transitioning towards a circular economy. Figure 5 highlights key milestones in advancing sustainability initiatives.

Figure 5 – European policy framework focus on Italian circular economy (2015/2022)



Source: own design (2025).

The Circular Economy Action Plan (European Commission, 2015) also known as "Closing the Loop – An EU Action Plan for the Circular Economy," emphasizes the potential of the circular economy to enhance the EU's competitiveness by mitigating resource scarcity and price volatility, fostering innovative business models, and promoting efficient production and consumption practices. It is projected to generate local employment across various skill levels while contributing to social integration and cohesion. The plan focuses on key aspects such as sustainable production through improved design and processes, responsible consumption, effective waste management, and the development of markets for secondary raw materials. It also highlights the importance of driving innovation and investments in priority sectors, including plastics, food waste, critical raw materials, construction and demolition, and biomass and bio-based products.

The European Green Deal (European Commission, 2019) sets out how to make Europe the first climate-neutral continent by 2050. It provides a framework to accelerate the transition towards a circular economy, fostering a more sustainable bioeconomy and enhancing the competitiveness of European industries. Key priorities include mobilizing industry for clean and circular practices, increasing the EU's climate ambitions for 2030 and 2050, and ensuring affordable, secure, and clean energy supply. It also emphasizes the shift to sustainable and smart mobility, building energy-efficient infrastructure, and preserving biodiversity. Central to the Green Deal is the Farm-to-Fork Strategy, which promotes fair, healthy, and environmentally sustainable food systems, contributing to a holistic transformation of the EU's economy for a sustainable future. 2019 also was the year that the Circular Economy Action Plan was considered completed. The 54 actions under the action plan have been completed or are being implemented.

A New Circular Economy Action Plan for a cleaner and more competitive Europe (European Commission, 2020), outlines a forward-looking agenda to create a cleaner and more

competitive Europe through collaboration with economic stakeholders, consumers, citizens, and civil society organizations. Its key priorities include empowering consumers, reducing waste, ensuring that circularity benefits people, regions, and cities, and positioning Europe as a global leader in circular economy efforts. The plan focuses on transforming critical product value chains, including electronics and Information and Communications Technology (ICT), batteries and vehicles, plastics and packaging, textiles, construction and buildings, as well as food, water, and nutrients, to drive sustainable and inclusive growth.

The new Circular Economy Action Plan under the European Green Deal (European Commission, 2020) includes programs targeting the whole life cycle of products, including as their design, the development of circular economy procedures, the encouragement of sustainable consumption, and the goal of ensuring that the materials utilized are retained for as long as feasible in the EU economy (Amanatidis; Curmei, 2023).

On 24 June 2022, Italy adopted its National Strategy for the Circular Economy (MITE, 2022), marking a significant step toward sustainable development. Key measures include the establishment of a chrono program to guide the implementation of the strategy's actions and the creation of the Observatory for the Circular Economy within the Sustainable Development Department of the Ministry of Ecological Transition. Additionally, the Directorate-General for Circular Economy (MASE) was introduced to oversee and coordinate circular economy initiatives, reinforcing Italy's commitment to ecological transition and resource efficiency.

Operationally, initiatives supporting the transition to a circular economy are being implemented across Europe through dedicated platforms and networks. The Circular Economy Network (https://circulareconomynetwork.it/), the European Circular Economy Stakeholder Platform (https://circulareconomy.europa.eu/platform/en), and the Italian Circular Economy Stakeholder Platform (https://www.icesp.it/) serve as key mechanisms for promoting circularity by facilitating knowledge exchange, policy development, and industry engagement. These initiatives provide strategic frameworks, best practices, and collaborative opportunities to enhance circular business models, resource efficiency, and sustainable innovation at regional and national levels.

The evolution of the European Union's Environmental Action Programmes (EAP) demonstrates the European Union's increasing sophistication in environmental policymaking. From foundational principles to the incorporation of sustainable development and circular economy concepts, the EAPs have progressively expanded their scope and specificity. The integration of detailed waste management policies, particularly concerning agroecosystems, indicates a comprehensive approach to addressing both broad environmental goals and specific

sectoral challenges (Duquennoi; Martinez, 2022).

According to Chiaraluce (2021) although Italy is well positioned in terms of circularity and has adopted European directives through its legislative decrees, specific European and Italian policies are still lacking to guide the circular economy transition in the agri-food sector. Future efforts are needed to develop innovative circular business models and overcome technological, political and legal barriers.

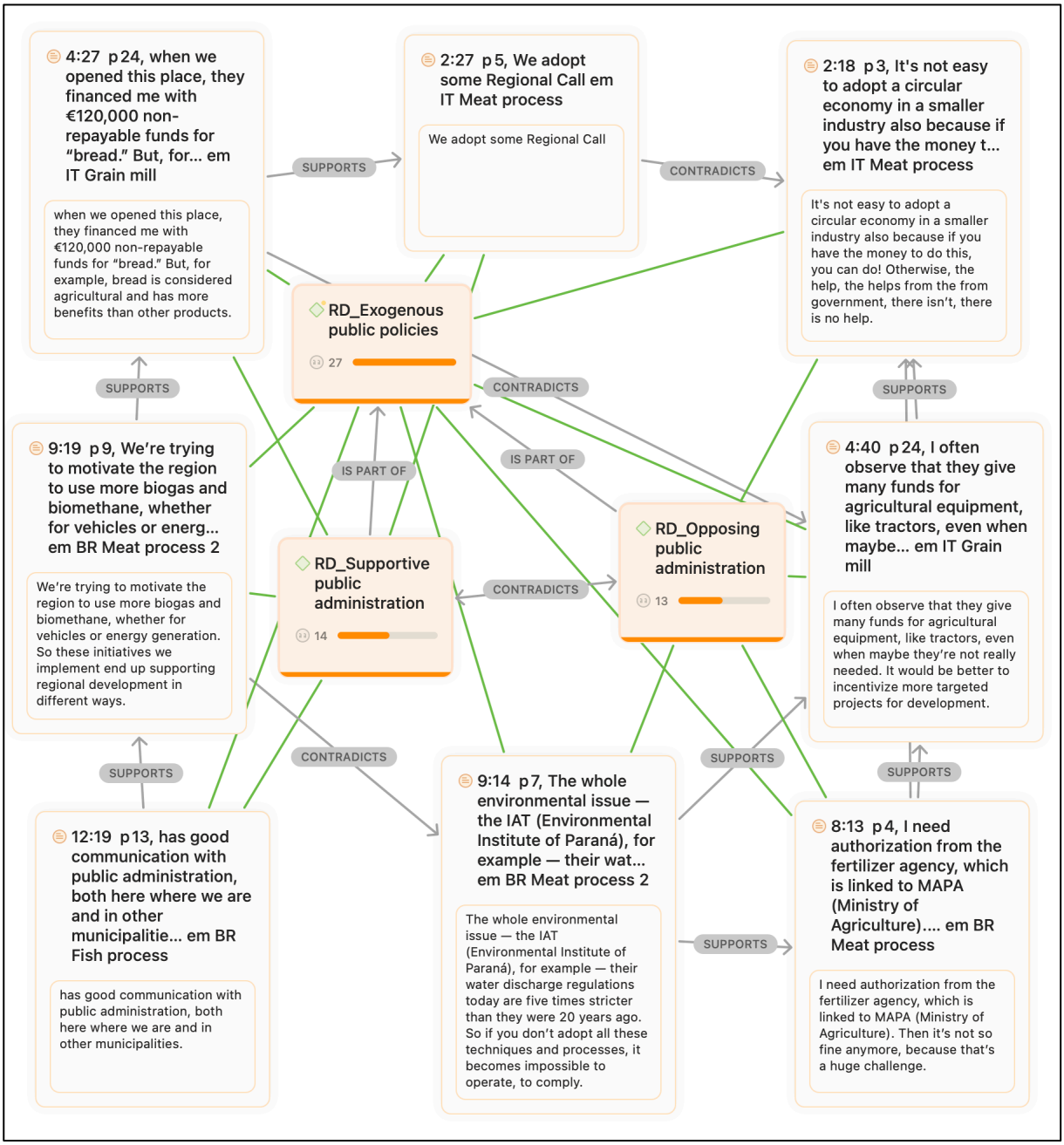
Moreover, the policies related to agroecosystems and waste management exhibit a trend towards specificity and rigor. Directives and regulations increasingly addressed particular waste streams such as sewage sludge, animal waste, and fertilizers, reflecting the EU's focus on mitigating the environmental impacts of agriculture and ensuring the safe management of bio-waste. Notably, the amendments and regulations during the 6th EAP further refined these policies, introducing new classifications and management strategies for animal by-products and other agricultural waste.

2.4.3 Evidence from the Brazilian and Italian agri-food firms

When asked, "How could public administration contribute to implementing circular economy practices in agri-food companies?", Brazilian and Italian interview responses revealed diverse perspectives. Despite these differences, a unifying theme emerged: the importance of local belonging and the need to "work regionally." This emphasis resonates strongly with current policy recommendations, which highlight that regions are not only passive recipients of national strategies, but key actors and arenas for the circular transition. As such, a "place-based and critical approach" to circular economy policy is advocated – one that accounts for the specific spatial settings, cultural values, and socio-economic conditions in which agri-food systems are embedded.

Figure 6 illustrates the complex relationship between public policies and the practical implementation of circular economy practices within agri-food firms. Empirical insights reveal that while certain instruments, such as regional calls and collaborative communication with local administrations – serve as enabling mechanisms, facilitating the adoption of biogas initiatives and other sustainable processes, firms also encounter significant regulatory and bureaucratic obstacles.

Figure 6 – Concept map of "exogenous public policies" code (Brazil and Italy)



Source: own design (2025).

Also, we can see from the Figure 6 that excessive administrative requirements, overlapping institutional mandates, and uneven allocation of public funds, often favouring traditional agricultural activities, emerge as recurrent challenges. These contradictions underscore the coexistence of supportive and opposing dimensions within the same policy environment. Consequently, the effectiveness of CE implementation depends not only on firms' internal strategies but also on their ability to navigate an inconsistent and sometimes fragmented policy framework. The findings thus expose a structural gap between policy design and on-the-

ground application, highlighting the need for more coherent and sector-specific public interventions to foster a genuinely enabling environment for circular transitions in the agri-food sector.

An interview with a Brazilian agro-industrial cooperative highlights significant barriers and aspirations in advancing circular economy practices. A central issue raised concerns the regulatory ambiguity surrounding techniques such as fertigation, particularly regarding permissible fertilizer application. As underline by a Brazilian meat producer (8):

> Oh, I'll do fertigation. But wait – what are the regulations around that? It's not very clear how much fertilizer I can apply here or can't. We don't have this kind of applicability, not even for chemical fertilizers. (Brazilian firm, 8).
>
> But before expanding, we need help to overcome these basic licensing challenges in order to commercialize. (Brazilian firm, 8).

This lack of regulatory clarity hampers innovation and discourages the broader adoption of sustainable practices, even when projects are technically and economically viable. According to the respondent, the primary challenge is not the lack of financial support but rather bureaucratic inefficiencies and institutional inertia, which generate delays and jeopardize the continuity of circular initiatives:

> When we ask for help, it's not even about financial subsidies – it's just about truly wanting this to succeed. This project stands on its own. It's viable. But we face delays and red tape. If we were a company relying solely on this plant, we would've gone bankrupt already. (Brazilian firm, 8).

Despite these challenges, the interviewee adopts a forward-looking perspective, emphasizing Brazil's potential as a global food production leader and advocating for a broader mindset:

> …Brazil is increasingly becoming a global food production leader. We must stop thinking regionally and start thinking globally – act locally but think globally. (Brazilian firm, 8).

This highlights the critical role of governance, regulatory frameworks, and strategic positioning in enabling circular transformations within the Brazilian agri-food sector.

> The whole environmental issue – the IAT (Environmental Institute of Paraná), for example – their water discharge regulations today are five times stricter than they were 20 years ago. So, if you don't adopt all these techniques and processes, it becomes impossible to operate, to comply. (Brazilian firm, 9).
>
> With the biogas work we're doing, we're working alongside OCEPAR and OCB to develop new programs in the region, encouraging broader adoption. We're trying to motivate the region to use more biogas and biomethane, whether for vehicles or energy generation. So, these initiatives we implement end up supporting regional development in different ways. (Brazilian firm, 9).

> I think the main resistance – and it still exists – is the question of funding. Sometimes they get excited: "Wow, this is great!" But then – oops – where's the money to make it happen? So, yes, financing is still a problem. (Brazilian firm, 9).

> I don't think it's about making the rules more flexible just to make things easier for us – and in fact, they've been raising the bar. But they've done it gradually. So, in a way, they've given us enough time to adapt. Yes, the requirements have increased – a lot – but always with a reasonable timeframe. I don't see that as a problem. (Brazilian firm, 9).

> [The firm] has good communication with public administration, both here where we are and in other municipalities. Also, with the federal government. […] (Brazilian firm, 12).

In contrast, an interview with a representative from a meat industry located in the Marche Region, Italy, reflects a different institutional context. The respondent emphasizes the autonomy of private initiatives in the absence of government support:

> It's not easy to adopt a circular economy in a smaller industry also because if you have the money to do this, you can do! Otherwise, the help, the helps from the from government, there isn't, there is no help. (Italian firm, 2).

These statements illustrate a self-reliant approach to sustainability, where the implementation of circular practices depends predominantly on the financial capacity of individual firms rather than public incentives or coordinated policy support.

On the other hand, some Italian agri-food firms recognize the strategic importance of their sector and sustainability concerns, but market dynamics and short-term pressures limit their engagement with regional development. As one firm observed:

> The relationship with the territory is important, but it is not the goal that the market demands at the moment. (Italian Firm, 6).

Another highlighted concerns about food security, warning that:

> I'm convinced that in the future food will be missing. If we continue like this, necessarily. (Italian Firm, 4).

> But for the future, I am the only one who has always believed in nutrition. Without nutrition, you can't move forward. […] people need to eat, so it's a sector worth believing in. It matters today and will still matter in fifty years. […] We cannot afford to be noncompliant with food regulations. (Italian Firm, 7).

Taken together, these perspectives reveal a tension between firms' recognition of the sector's essential role and their limited capacity to prioritize regional embeddedness under current market conditions. In this context, the CE emerges as a framework with the potential to reconcile market demands with long-term sustainability, but its implementation requires

supportive institutional arrangements that incentivize local resource circularity, strengthen territorial linkages, and promote regulatory compliance beyond minimal standards.

2.5 Discussion

In Brazil, although initiatives like the National Solid Waste Policy (PNRS) and the recent National Circular Economy Strategy (ENEC) set strong intentions for waste reduction and resource reuse, they largely lack binding regulations with concrete enforcement mechanisms. The decree that established the first national circular economy strategy was later detailed in an action plan. The plan establishes guidelines for the production and consumption of goods within Brazilian territory (Brasil, 2025).

Italy, on the other hand, operates within the EU's well-defined regulatory environment, where directives and regulations – such as those stemming from the EU's Circular Economy Action Plan – create legally binding rules that member states, including Italy, must incorporate into national law. In practice, this leaves much of Italy's circular economy policy as aspirational rather than concrete. Rather than driving real systemic change, these initiatives often serve as well-publicized commitments without the legislative backbone to ensure measurable impacts on resource usage and waste management.

Both policies (Brasil, 2025; MITE, 2022) recognize the urgent need for a transition from a linear to a circular model of production and consumption. Both see this transition as essential to address environmental crises (such as climate change and biodiversity loss) and ensure security of resource supply. Frame 2 highlights a comparative analysis of Brazil and Italy's strategies for implementing CE policies.

Frame 2 – Circular Economy Strategies in Brazil and Italy

	Brazil	Italy
What	the economic system of production that maintains the circular flow of resources and associates economic activity with the circular management of resources, through the addition, retention or recovery of their values, and which is based on the principles of non-generation of waste, circulation of products and materials and regeneration.	a new model of production and consumption aimed at the minimization of the waste through an efficient use of the resources as well as the circular maintenance of their flow in Italy, is an epochal challenge with the purpose to prevent the production of the waste, maximize its recovery, reuse and recycling through the eco-design of durable and repairable products and create a new supply chain of secondary row materials instead of raw materials
How	I) elimination of pollution and the reduction of waste and residue generation; II) maintenance of the value of materials; III) regeneration of the environment; IV) reduction of dependence on natural resources; V) sustainable production and consumption; VI) increase in the life cycle of each and every material; and VII) guarantee of a fair, inclusive and equitable transition, which addresses gender, racial, ethnic and socioeconomic disparities.	I) reuse and repair II) industrial symbiosis III) extended producer responsibility IV) minimum environmental criteria V) ecodesign VI) end of waste VII) digitalization VIII) soil IX) water resources X) environmental finance and taxation XI) urban areas and territories XII) environmental education
Where	Brasília, May 5, 2025	Roma, June 2022
Whom	National Circular Economy Forum is an advisory board established by Ordinance GM/MDIC No. 309, of September 13, 2024, with the mission of advising, monitoring and evaluating the implementation of ENEC (Brasil, 2025)	Ministero della Transizione Ecologica (MITE, 2022)

Source: own design (2025).

The articulation of objectives and methodologies (Frame 2) reflects contrasting perspectives shaped by their socioeconomic and institutional contexts. However, a critical examination of these strategies raises important questions about the depth and practical applicability of these approaches. Both seek to create a favorable environment, stimulate investments, optimize resource and waste management and use technology for the transition, recognizing that it is a complex process that requires the articulation of multiple actors.

Brazil defines CE through the lens of maintaining the circular flow of resources while linking economic activity to resource management. The emphasis on the “principles of non-generation of waste, circulation of products, and regeneration” suggests a holistic approach. However, this definition remains broad and lacks specificity in operationalizing these principles across industries. Conversely, Italy’s framing emphasizes a “new model of production and consumption” with a focus on minimizing waste and maximizing resource efficiency. The explicit mention of eco-design, reuse, and secondary materials demonstrates a more pragmatic and industry-oriented approach. However, the Italian definition appears to focus more on

technological solutions, potentially sidelining systemic socio-environmental dimensions.

Regarding implementation strategies (how), Brazil's strategies revolve around pollution elimination, value maintenance, environmental regeneration, and sustainable production. The inclusion of goals such as equitable transitions addressing gender, racial, and socioeconomic disparities is commendable. However, these objectives risk being overly aspirational without measurable targets or clear implementation frameworks. Italy, on the other hand, lists 12 actionable areas, such as "reuse and repair," "industrial symbiosis," and "ecodesign." These strategies are well-aligned with established CE practices and EU directives. However, some areas, such as "environmental education" and "urban areas and territories," lack clear connections to operational CE practices.

About the Geographical and Institutional Context (Where and Whom), in Brazil, the CE strategy is anchored in the establishment of a National Forum for Circular Economy, indicating the intent for participatory governance. However, the centralized location (Brasília) might limit regional adaptation, especially in a country with significant socioeconomic and environmental disparities. In Italy, the Ministry for Ecological Transition is the driving force, reflecting alignment with EU environmental policies. However, the absence of explicit mechanisms for regional and local implementation may hinder context-specific adaptation, particularly in economically diverse regions of the country.

The circular economy strategies of Brazil and Italy illustrate the potential of CE to drive regional and sustainable development. By aligning CE principles with regional development theories and sustainable development goals, both countries can address their unique challenges and opportunities. The focus on space, public policy, and regions, as emphasized by Ferrera de Lima (2022, 2024), ensures that CE transitions are context-specific and inclusive. As both countries continue to refine their strategies, they can serve as models for other regions seeking to integrate CE principles into their development agendas.

When asked, "How could public administration contribute to implementing circular economy practices in agri-food companies?", Brazilian and Italian interview responses revealed diverse perspectives. While Italian interviewees emphasized structural and institutional barriers to circular economy adoption, particularly the lack of governmental support and financial incentives. Brazilian perspectives revealed a more varied and, at times, collaborative experience with public administration.

Italian firms pointed to an absence of concrete assistance from the government, especially for smaller industries that lack the financial capacity to independently invest in circular practices. The relationship with local territories was seen as secondary to market

demands, and although the long-term relevance of the agri-food sector was recognized, strict food regulations were viewed as non-negotiable constraints rather than enablers.

These results align with the findings of Chiaraluce, Bentivoglio, and Finco (2023), who interviewed six Italian firms in the Marche Region and observed a consistent perception of institutional barriers to circular economy implementation. In their study, all interviewees identified public administration and bureaucratic procedures as significant obstacles, emphasizing how such factors delay progress and add complexity to circular initiatives. Furthermore, the Italian legislative framework was perceived as unclear and unsupportive, contributing to a regulatory confusion.

In contrast, Brazilian firms reported both frustrations and strengths in their institutional interactions. While some cited excessive bureaucracy and delays as barriers that could threaten the viability of circular initiatives, others appreciated the predictability of gradually evolving regulations and maintained constructive relationships with municipal and federal agencies.

This comparison suggests that although both countries face regulatory and financial challenges, Brazilian firms may experience more flexibility and institutional dialogue, whereas Italian firms perceive a more rigid, unsupported environment, particularly among smaller enterprises lacking access to capital. Evidence from Brazilian and Italian companies indicates that CE can foster regional development through value-added activities, local supply chain strengthening, and the creation of resource-efficient regions.

2.6 Essay final remarks and conclusion

This essay has critically examined the current policies surrounding the Circular Economy (CE) in Brazil and Italy, highlighting their distinct priorities and challenges. Brazil’s approach stands out for its emphasis on inclusivity and equity, aligning with broader social justice goals. Both countries, despite their progress, must address the critical challenge of bridging the gaps between ambition, practicality, and inclusivity to achieve truly transformative outcomes in Circular Economy policy.

The interview findings highlight the place of respondents' local belonging, and the need to “work regionally” resonates with the policy view that regions are not only critical arenas for CE implementation but also drivers of place-based and context-sensitive approaches. While the Italian representative's remark that “a relationship with the territory is not the goal that the market demands at the moment” reveals a disconnect between market incentives and territorial regeneration, policy frameworks advocate for a reorientation of market logics through

supportive instruments and circular business model innovation. Furthermore, one particularly Brazilian interviewee expressed uncertainty about the pace of transition, mirroring policy concerns about the challenges of scaling local CE initiatives and the frequent delays in policy implementation, reinforcing the urgency for robust governmental leadership and compelling narratives to accelerate change.

Regarding the conceptual framing of CE (what kind), while Brazil's approach appears more inclusive in theory, its lack of concrete mechanisms makes it less actionable. Italy's model, although detailed, risks perpetuating a technocratic approach that may not fully address broader societal inequities.

In terms of implementation strategies (how), the implementation strategies, Brazil's emphasis on equity is noteworthy but insufficiently operationalized, reflecting a gap between ambition and feasibility. Italy's focus on technical measures is strong but risks neglecting social inclusivity and transformative change beyond the industrial sector.

As for governance and beneficiaries (where and for whom), both strategies demonstrate centralized governance models, which may limit their adaptability to regional needs. Brazil's focus on inclusivity should be mirrored in decentralized policy implementation, while Italy's strong institutional alignment needs complementary mechanisms for local engagement. Brazil's acknowledgment of equity concerns is progressive but requires actionable policies. Italy's approach, while efficient, risks marginalizing vulnerable populations by overlooking the social dimensions of CE.

Moving forward, both countries could benefit from integrating the strengths of each approach – Brazil from Italy's actionable focus, and Italy from Brazil's emphasis on equity – to develop holistic and transformative CE policies. What is suggested is not creating a managerial panacea for implementing the circular economy but recognizing realistic and context-appropriate channels towards its implementation.

Moreover, long-term change does not only depend on technology solutions but on the action of local communities, cooperatives, and producers themselves. Integrating circular thinking into practice and policy, CE strategies can foster inclusive, place-based, and sustainable regional development. This is, however, a two-way process: while CE strategies may promote regional development, regional development also creates the conditions that enable CE strategies and their effective implementation

In this sense, the agri-food sector emerges as a strategic direction, not only because of its essential role in food security and supplying populations, but also because of its specific characteristics – such as strong dependence on natural resources, intensive generation of

organic waste, seasonality of production, and significant presence of small producers. These particularities make the sector especially sensitive to the principles of circularity, while at the same time offering concrete opportunities to rethink production models from the perspective of ecosystem regeneration, regional valorization, and social innovation.

The added value of this work lies in drawing an unprecedented parallel between Brazil, represented by Paraná State, and Italy, represented by the Marche Region, through a qualitative analysis based on interviews with comparable agri-food companies in both contexts. By integrating political and business perspectives, this study provides original insights into how circular economy practices are shaped by institutional frameworks, regional policies, and entrepreneurial strategies across two distinct yet complementary agri-food systems. This comparative approach not only advances the academic debate but also offers practical implications for policymakers and industry leaders seeking to foster sustainable transitions in diverse regions and territories.

ESSAY 2

3 CIRCULAR ECONOMY IN THE AGRI-FOOD SECTOR: A LITERATURE REVIEW ON IMPLEMENTATION, INTERVENTIONS, AND OUTCOMES

Paper information

- **Title**: Circular economy in the agri-food sector: a literature review on implementation, interventions, and outcomes
- **Authors**: **Gabriela Daiana Christ**, Giulia Chiaraluce, Deborah Bentivoglio, Crislaine Colla, and Adele Finco
- **Journal**: Revista de Administração Mackenzie (Mackenzie Management Review)
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Abstract: This study examines circular economy practices in the agri-food sector, addressing the need for sustainable solutions in food production and consumption. Using a systematic literature review, bibliometric mapping with R software (Bibliometrix package, version 4.2.3), and deductive content analysis with ATLAS.ti (version 24), the research identifies trends, gaps, and detailed interventions. From an initial dataset of 1,067 articles (2020-2024), a rigorous screening process refined the sample to 70 studies, with 13 analyzed qualitatively. Motor themes included food waste, composting and food security. Reduction emerged as the most common strategy, while impacts were primarily environmental (42.73%), followed by economic (34.68%) and social (22.59%). The findings emphasize the interdisciplinary nature of circular economy research, integrating technological innovation with sustainability principles. By applying the 9R model to diagnose interventions and assess outcomes, the study provides actionable insights to guide policymakers and practitioners. This study uniquely links 9R interventions to tangible outcomes in agri-food systems, offering policymakers an evidence-based toolkit for regional CE transitions.

Keywords: Systematic Literature Review – SLR; sustainability; strategy.

"For every expert there is an equal and opposite expert."
Old scientific joke draws on Newton's Third Law of Motion
(Petticrew; Roberts, 2006, p. 4)

3.1 Essay introduction

The demographic and climate changes are putting stress on the food system. The circular economy is a topic of great discussion in both research and policy, and its practical application is seen as the answer to many of the contemporary sustainability issues. The agri-food sector has traditionally been a significant source of waste, especially in the industrial stages of raw material transformation and processing (Chiaraluce; Bentivoglio; Finco, 2023).

In this sense, understanding the mismatches and potential synergies in the implementation of the circular economy will help to identify new opportunities to optimize circularity in food production systems (Tait *et al.*, 2023). How effectively implement such a transition is however still debated (Cagno *et al.*, 2023; Hamam *et al.*, 2021).

Although there is already a trend toward circular economy and sustainability, there is a lack of systematic academic research that rethinks management models based on circularity, especially in the context of agri-food. A methodical, transparent, and repeatable review procedure based on the statistical assessment of science, scientists, or scientific activities could be implemented through bibliometrics (Aria; Cuccurullo, 2017).

Employing a mixed-method approach that combines a quantitative bibliometric review with qualitative content analysis (Bardin, 2011; Petticrew; Roberts, 2006), this study seeks to identify and critically examine circular economy practices adopted in the global agri-food sector. The empirical investigation is structured around three key research questions:

RQ1: What is the current state of research on circular economy in agri-food sector?

RQ2: What theoretical frameworks underpin this field of study?

RQ3: What are the key interventions and measurable outcomes associated with implementing circular economy principles in the agri-food sector?

To achieve these objectives, we conducted a Systematic Literature Review (SLR) of 70 publications on the circular economy in the agri-food sector, covering research published up to May 30, 2024. The earliest study meeting the criteria dates back to 2020. According to Petticrew and Roberts (2006) a systematic review is of value specialty to inform policy and to support practice. The authors argue that a systematic review is desirable when developing new techniques requires a clear image of previous research, including methodological research. Also, a content analysis was conducted in 13 studies to further enhance the study's scope.

While prior research has mapped CE trends bibliometrically (Chiaraluce; Bentivoglio; Finco, 2021) or explored case studies in isolation (Donner; De Vries, 2023; Klein; Nier; Tamásy, 2022a; Morea *et al.*, 2023), our study's novelty lies in its integrated mixed-methods pipeline: Bibliometrix quantifies research clusters and theoretical frameworks, revealing dominance of the 9R model over the traditional 3R (RQ1-RQ2). Content analysis of 13 case studies qualitatively links interventions to contextual factors (e.g., policy → Rethink), addressing Tait et al.'s (2023) call for granular implementation insights (RQ3). Triangulation via a Sankey diagram bridges macro/meso/micro levels, visually demonstrating how context shapes outcomes – a gap in Corral et al. (2022). Our PRISMA-compliant SLR and public codebook enhance reproducibility, advancing Petticrew and Roberts' (2006) standards for systematic reviews.

The findings of this study have both theoretical and practical contributions by offering a bibliometric mapping of the general state and current trends and useful evidence of the interventions and outcomes implemented by several countries around the world. It supports theoretical insights for the academic community and helps to guide circular practices in the agri-food sector. This review is both retrospective and forward-looking. We discuss what has been accomplished thus far and the likely future directions of research on the circular economy in agri-food.

3.2 Theoretical background

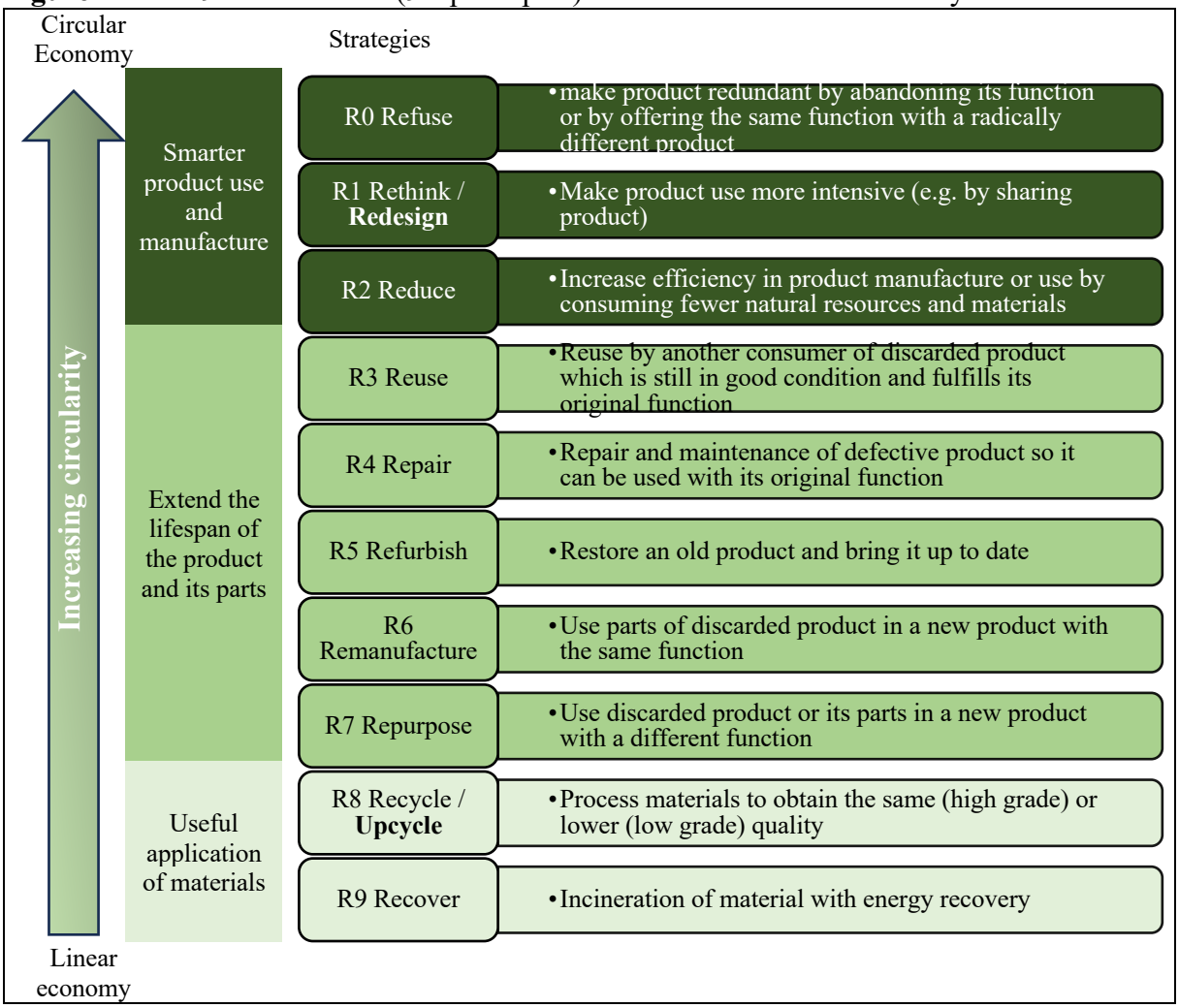
The circular economy is most often described as a combination of reduction, reuse and recycling activities, although it is often not highlighted that CE requires systemic change(Kirchherr *et al.*, 2023). After analyzing 221 definitions from CE, the authors provided the following synthetic definition:

> The circular economy is a regenerative economic system which necessitates a paradigm shift to replace the 'end of life ' concept with reducing, alternatively reusing, recycling, and recovering materials throughout the supply chain, with the aim to promote value maintenance and sustainable development, creating environmental quality, economic development, and social equity, to the benefit of current and future generations. It is enabled by an alliance of stakeholders (industry, consumers, policymakers, academia) and their technological innovations and capabilities (Kirchherr *et al.*, 2023, p. 7).

In the context of circular economy implementation, Kirchherr et al. (2023) adapted the model initially proposed by Potting et al. (2017). Many researchers view the various R

frameworks as the practical foundation of circular economy principles. These frameworks extend beyond the traditional 3R activities – Reduction, Reuse, and Recycling – to include more comprehensive models, such as the 4R framework (adding Renewing), the 6R framework (incorporating Redesign/Rethink and Remanufacturing), and the more detailed 9R framework (including Reject, Repair and Recover), as illustrated in Figure 7.

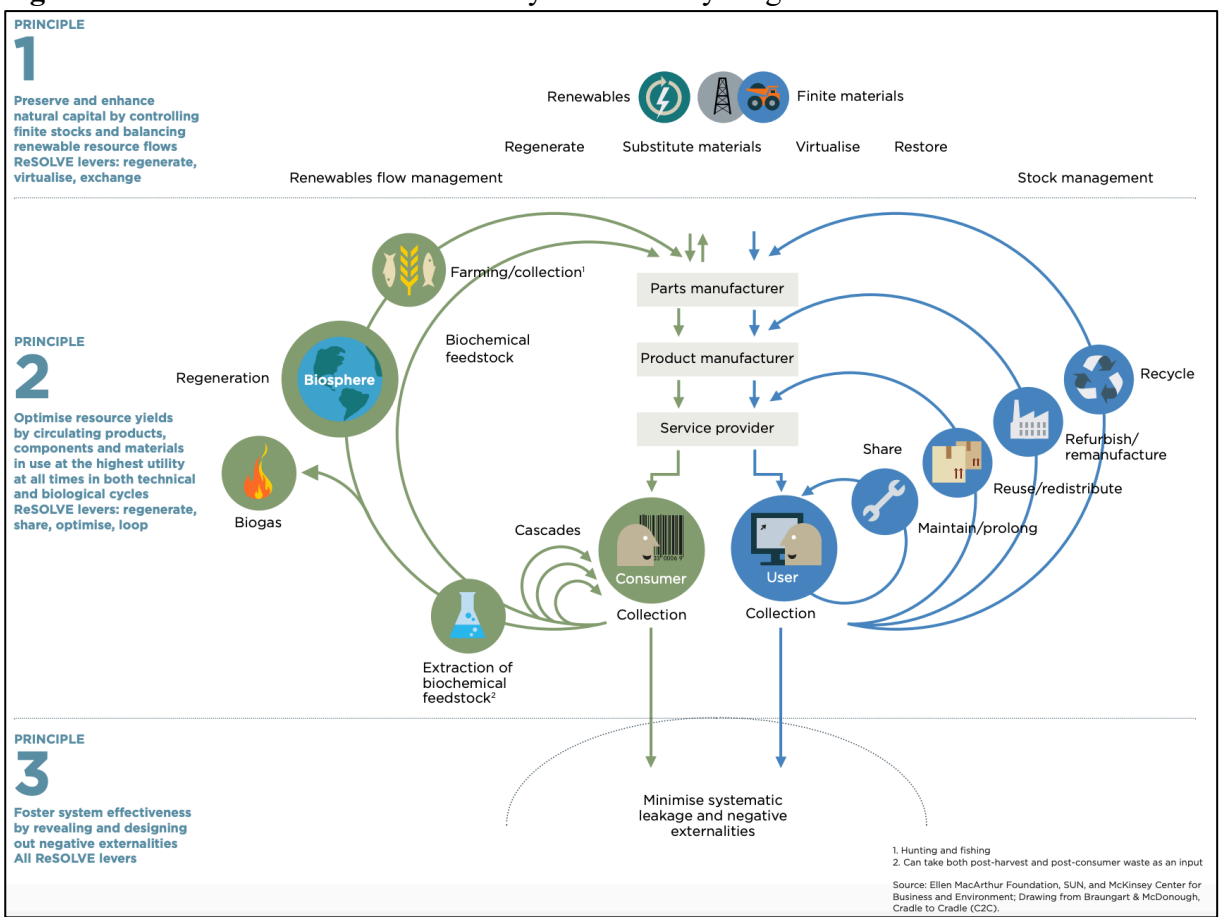
Figure 7 – The 9R Framework (9R principles): 'how-to' of circular economy



Source: (Potting *et al.*, 2017, p. 15).

Figure 8 offers a complementary perspective by illustrating specific strategies to enhance circularity across various business models. The figure provides concrete examples of interventions and/or strategies, enabling an understanding of how circular practices can be applied. Despite the widespread use of the "Butterfly Diagram: Visualizing the Circular Economy" (Ellen MacArthur Foundation, 2015) as the primary tool for understanding circular economy concepts (Figure 8).

Figure 8 – Outline of a Circular Economy: the butterfly diagram



Source: (Ellen MacArthur Foundation, 2015, p. 24).

On the other hand, the Butterfly Diagram (Figure 8) shows the continuous circulation of materials within two primary cycles: the technical and biological. In the technical cycle, products and materials are retained through reuse, repair, remanufacturing, and recycling. In the biological cycle, e.g. the Agri-Food sector, nutrients from biodegradable materials return to the Earth, supporting natural regeneration.

Regarding the circular economy in agriculture, Velasco-Muñoz et al. (2021) states that it involves a collection of actions aimed at ensuring biodiversity and the regeneration of agro-ecosystems, as well as the economic, environmental, and social sustainability of agriculture. These practices pursue the efficient and effective use of resources at all stages of the value chain.

To support a thorough implementation of the circular economy model within the agro-industrial sector, it is important to ensure food independence, economic security, and the attainment of sustainable development objectives. Crucial to this effort is the establishment of effective public policies that foster the advancement of innovative, resource-efficient technologies and the adoption of circular business practices. These initiatives will boost the

competitiveness of the domestic agricultural industry, enhance its investment appeal, and protect the environment (Litvak; Litvak, 2023).

Converting unsustainable business models into sustainable ones is the aim of CE. In this regard, performance evaluation seems to be essential for encouraging the adoption of better practices, benchmarking outcomes, and successfully communicating them to various stakeholders (Cagno *et al.*, 2023). Businesses may reduce resource consumption and environmental effects, boost customer value, and increase revenue by implementing CE practices (Dziedzic *et al.*, 2022).

With this in mind, companies must first determine the elements that support, impede, or facilitate the change before assessing the complexity of interactions related to the CE transition (Tumuyu; Marthalia, 2023). Also, develop a thorough understanding, get ready for any changes to policy, and concentrate on managing natural resources.

By interviewing seven experts from Consulting Firms, Falkenberg, Schneeberger and Pöchtrager (2023) emphasized that there is no guarantee for a concrete implementation in practice and, therefore, further obligations, such as a design guideline, are needed. Mandatory reporting is viewed as a crucial first step in promoting and implementing a circular economy on the corporate side, specifically regarding the two European Union legal acts (Corporate Sustainability Reporting Directive and Taxonomy Regulation).

3.3 Materials and methods

To meet the goal of conducting a bibliometric analysis and identifying the approaches used in research on the “circular economy in agri-food sector”, in this section, we will describe the methodological procedures of the systematic review. The systematic review was led using the PRISMA research protocol (Moher *et al.*, 2010) guided by the questions stipulated according to the researchers' prior knowledge of the topic. Thus, a search string was initially built by including terms related to the research topic.

The final search strings developed for both database the Scopus (Elsevier) journal and the Web of Science (Clarivate), which are presented in Frame 3. The initial search used the combination of terms related to circular economy, circularity, by-product, and the Boolean operators “AND” and “OR”. The best combination of terms was based on previous studies in the field (Chiaraluce; Bentivoglio; Finco, 2021; Hamam *et al.*, 2021; Salinas-Velandia *et al.*, 2022; Sánchez-Teba; Gemar; Soler, 2021; Yang *et al.*, 2021). Hence, the final search was held on May 30, 2024, with the following search strings: ("circular econom*" OR "circular*" OR

"by-product") AND ("agribusiness" OR "Agr*" OR "agricultural waste" OR “agri-food”) AND ("sustainab*" OR "business model" OR "circular business model") AND ("polic*" OR "practic*").

Frame 3 – Search String of the papers in the portfolio (30/05/2024)

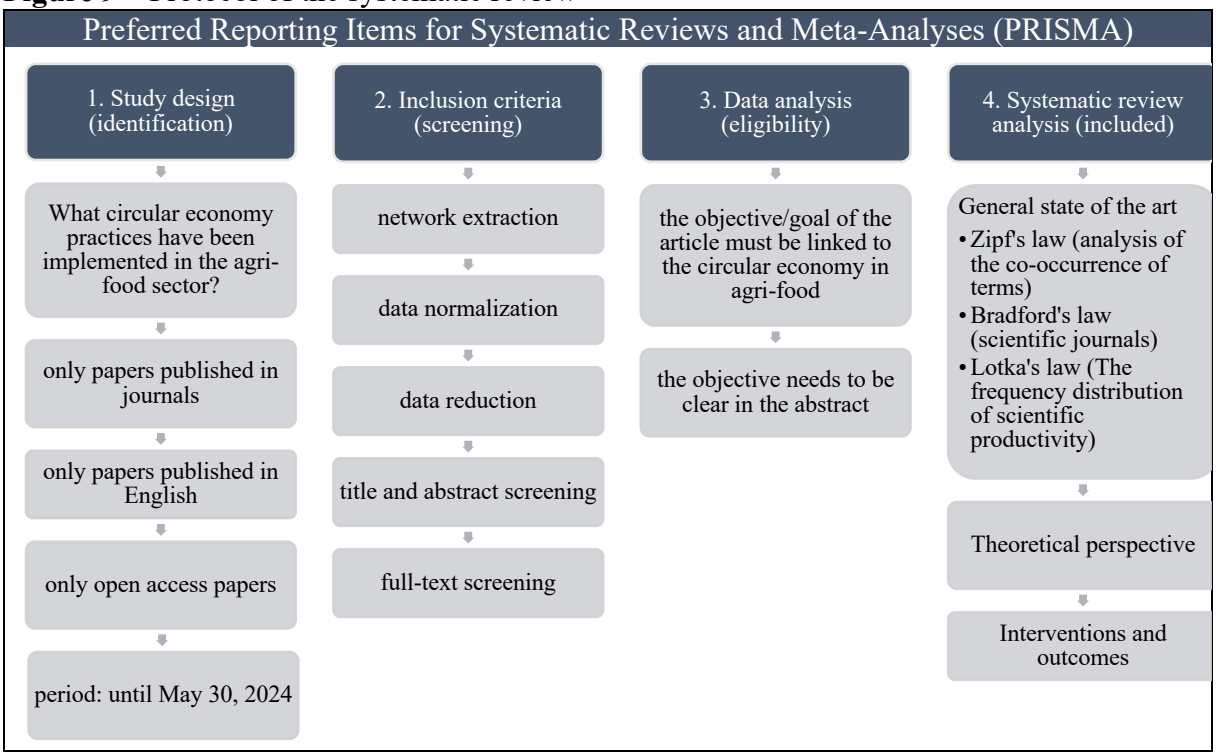
Database	Search String	Results
Scopus	(TITLE-ABS-KEY ("circular econom*" OR "circular*" OR "by-product") **AND** TITLE-ABS-KEY ("agribusiness" OR "Agr*" OR "agricultural waste" OR “agri-food”) **AND** TITLE-ABS-KEY ("sustainab*" OR "business model" OR "circular business model") **AND** TITLE-ABS-KEY ("polic*" OR "practic*")) **AND** (LIMIT-TO (DOCTYPE , "ar")) **AND** (LIMIT-TO (PUBSTAGE , "final")) **AND** (LIMIT-TO (LANGUAGE , "English")) **AND** (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (OA , "all"))	542
Web of Science	"circular econom*" OR "circular*" OR "by-products" (Topic) **and** "agribusiness" OR "agr*" OR "agricultural waste" OR “agri-food” (Topic) **and** "sustainab*" OR "business model" OR "circular business model*" (Topic) **and** "practic*" OR "polic*" (Topic) **and** Open Access **and** Article (Document Types) **and** English (Languages) **and** All Open Access (Open Access)	525

Source: own design (2024).

The inclusion of the key words ‘practic*’ OR ‘polic*’ greatly limited the number of publications, showing that the combined use of CE in an agri-food context is new and innovative.

According to Petticrew and Roberts (2006, p. 282) Protocol “is a detailed plan of the procedures that a reviewer intends to adopt in order to identify, appraise, and synthesize the evidence, and disseminate the findings. Protocols may themselves be peer-reviewed.” See Figure 9.

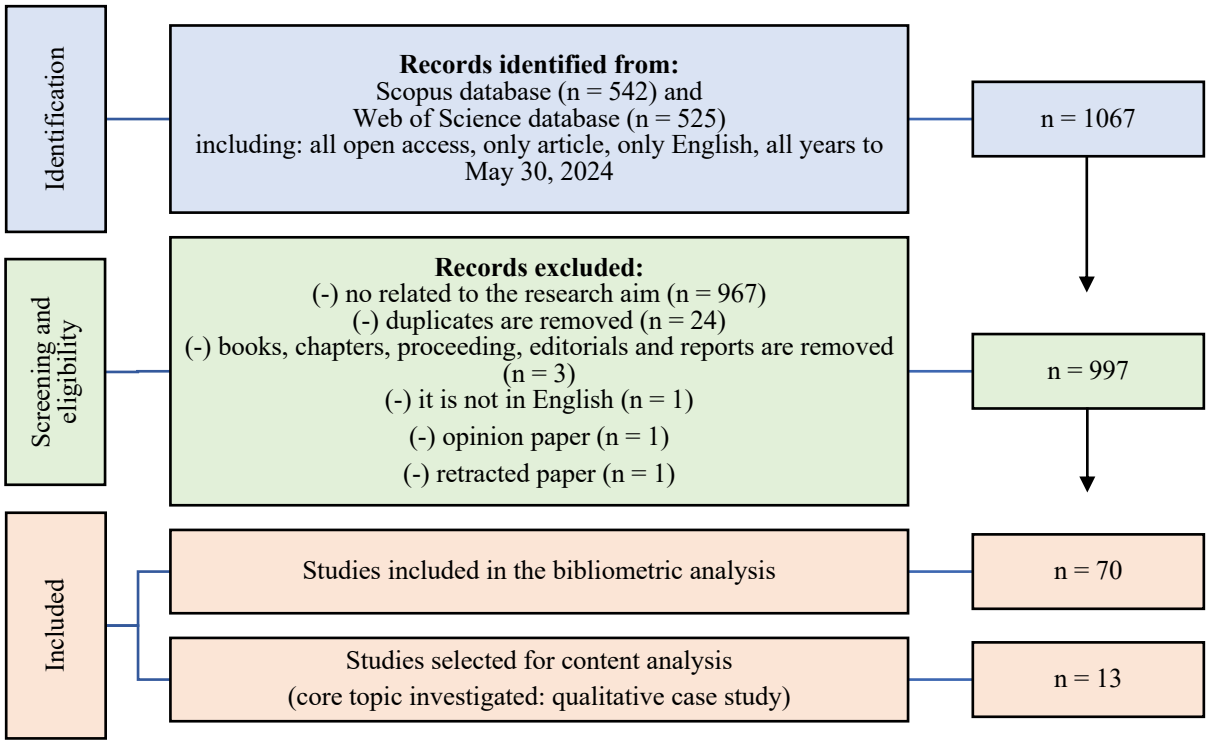
Figure 9 – Protocol of the systematic review



Source: own design (2024).

That is, the **first step** was the identification: this is the initial stage where all potential studies are identified through database searches, reference lists, and other sources. Three inclusion criteria were considered in this paper: only academic papers published in indexed journals were included in this review, only papers published in English, and only open access papers. All papers published until May 30, 2024, in all areas of knowledge. The **second step** is the title, keywords, and Abstract Screening: in this stage, the titles and abstracts of the identified studies are reviewed to quickly eliminate those that do not meet the inclusion criteria. This step was performed by three researchers independently to reduce bias; and the Full-Text screening: Studies that pass the title and abstract screening are then reviewed in full text to further assess their relevance and adherence to the inclusion criteria. Again, this stage is usually conducted by multiple reviewers to ensure accuracy and consistency. The **third step** is the eligibility: After full-text screening, the studies that meet all the criteria are considered eligible for inclusion in the systematic review. This may involve further critical appraisal and assessment of study quality. Finaly the **last step** of the review was the Inclusion: The final set of studies that meet all criteria and are deemed suitable for the review are included in the systematic review and meta-analysis. Figure 10 provides an overview of the four steps conducted in this research.

Figure 10 – Systematic review protocol based on PRISMA



Source: own design (2024).

The analyses of the selected documents were carried out in the Biblioshiny application, which is part of the Bibliometrix 4.2.3 package (Aria; Cuccurullo, 2017), developed to be used in R programming language. In addition to the research protocol stated in Figure 9 and Figure 10, the systematic review analysis followed four steps: identification, screening and eligibility, and, included. The laws governing bibliometric studies used in this review are outlined in Table 2.

Table 2 – Laws governing bibliometric studies

Law's	Measure	Criteria	Main goal
Bradford's Law	Degree of journal attraction	Journal reputation	Identify the most relevant journals that most effectively cover a specific topic
Zipf's Law	Keyword frequency	Ordered list of topics	Estimate the most recurring topics related to a field of knowledge
Lotka's Law	Author productivity	Size-frequency	Assess the impact of an author's production in a field of knowledge

Source: (Chueke; Amatucci, 2015, p. 3).

Bradford's Law focuses on the degree of journal attraction and journal reputation, is used to identify the most relevant journals that effectively cover a specific research topic, highlighting a small set of specialized journals as central sources (Chueke; Amatucci, 2015).

Zipf's Law is based on the frequency of keywords within academic literature, estimates the most recurring topics in a given field by analyzing the ordered list of keywords, with the law suggesting that a few keywords dominate while the majority appear less frequently. Lotka's Law examines author productivity and size-frequency distribution, helps assess the impact of individual authors by showing that a small number of researchers contribute a significant proportion of the publications in a field. These laws collectively provide a robust framework for understanding the concentration of knowledge and the structure of aca-demic contributions within a specific discipline.

To address the research questions, content analysis was employed as methodological approach. Coding was conducted deductively, focusing on themes relevant to the results and discussion sections. The process was performed using Atlas.ti (version 24) software, chosen for its advanced capabilities in managing and analyzing qualitative data. To ensure consistency and reliability, each paper was coded independently by two authors, and discrepancies were resolved through comparison and consensus.

At our knowledge, only Morea at al. (2023) and Corral et al. (2022) assessed the transition to a circularity with the 9R model in the agri-food sector, providing further evidence of the applicability of this model. The study advances mixed-methods CE research by integrating bibliometric trends with qualitative case study analysis to expose gaps between theoretical frameworks (e.g., 9R model) and on-the-ground implementation challenges. Thus, it is necessary to conceptualize both categories – intervention and outcome:

- Intervention: Term used to refer to an action intentionally undertaken to bring about some beneficial outcome – for example, a treatment, a program, or a policy (Petticrew; Roberts, 2006, p. 280)
- Outcome(s): The effects of an intervention: for example, the outcomes of an educational intervention could include exam grades, and employability in later life (Petticrew; Roberts, 2006, p. 281)

A total of 1.173 interventions (across 10 codes) and outcomes (across 3 codes) were coded (see Frame 4).

Frame 4 – Category and associated codes: intervention and outcome

Category	Code	Magnitude	%	Category	Code	Magnitude	%
Intervention	R0 Refuse	7	1,16%	Outcome	economic	198	34,68%
	R1 Rethink	118	19,60%		environmental	244	42,73%
	R2 Reduce	151	25,08%		social	129	22,59%
	R3 Reuse	47	7,81%		Total	571	100,00%
	R4 Repair	14	2,33%				
	R5 Refurbish	34	5,65%				
	R6 Remanuf.	11	1,83%				
	R7 Repurpose	66	10,96%				
	R8 Recycle	82	13,62%				
	R9 Recover	72	11,96%				
	Total	602	100,00%				

Source: own design (2024).

Both the Bibliometrix file and the Atlas.ti project have been included as Supplementary Material to ensure transparency and reproducibility of this research. This aligns with the principles of open science, providing full access to the data and tools used in the analysis, fostering collaboration and facilitating further exploration by other researchers.

3.4 Results and discussion

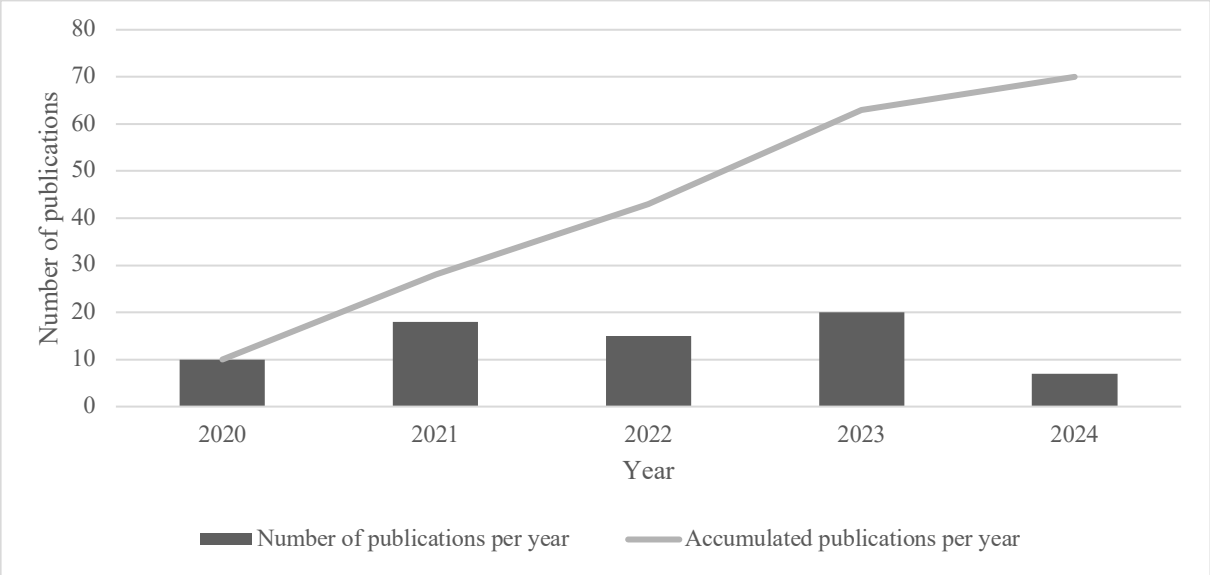
In this section, the results of the research will be presented.

3.4.1 General state of art on circular economy and agri-food

Here we present and discuss three bibliometric analyses: the productivity of authors (Lotka's Law), the distribution of journals (Bradford's Law) and the frequency of words (Zipf's Law). The portfolio comprises 70 documents (articles) published between 2020 and May 2024, involving 308 authors and 42 sources (journals), and including 4.842 references. On average, each document has received 13.13 citations, and there are 4.64 co-authors per document. To comprehend the impact of the circular economy on the agri-food sector, we compiled insights on knowledge dissemination and research progress from a bibliometric perspective.

Our initial focus was to assess the interest in circular economy research within the agri-food sector by analyzing the annual number of publications. This analysis addressed the first research question concerning the global dissemination of knowledge. Our findings revealed that research on the circular economy in the agri-food sector has generated 70 publications (refer to Figure 11).

Figure 11 – Publications on circular economy and agri-food (2020-2024)



Source: own design (2024).

Figure 11 presents the annual and cumulative trends in publications focused on the circular economy within the agri-food sector from 2020 to 2024. The bar chart illustrates the number of publications per year, while the line graph depicts the cumulative total of publications across this period. From 2020 to 2023, there is an upward trend in the number of annual publications. This growth reflects a rising academic interest in the intersection of circular economy and agri-food topics. The cumulative line follows this upward trend, indicating a consistent increase in total research outputs each year.

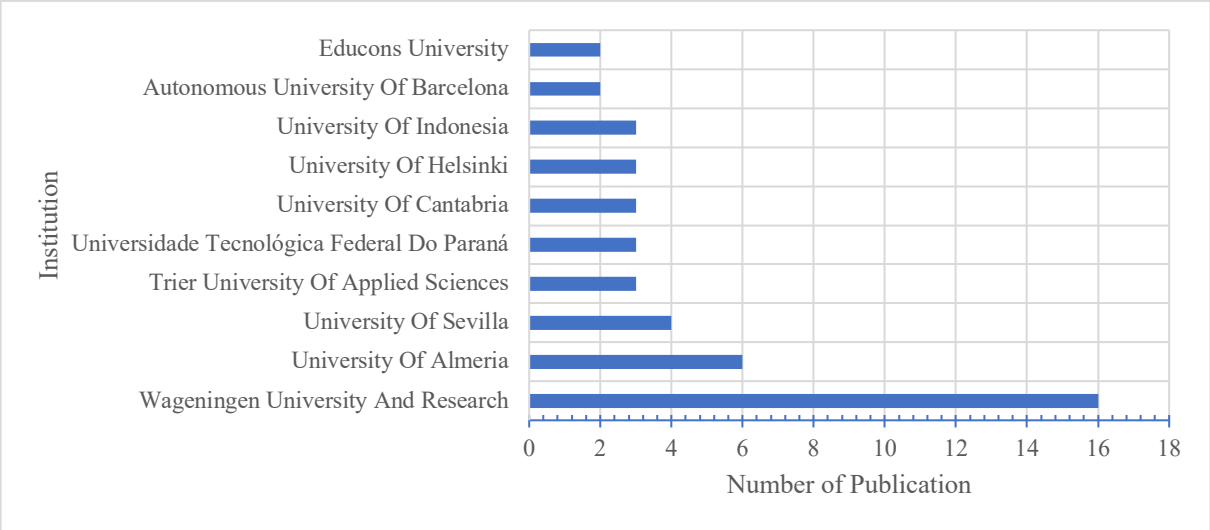
Highlighting the novelty of this research area, to the best of our knowledge, the study conducted by Skar and colleagues (Skar *et al.*, 2020) represents the pioneering effort to investigate the circular economy in relation to the agri-food sector. Notably, the most significant increase in research activity on this topic was observed in 2023. The article provides a roadmap for cities to leverage Urban Agriculture for sustainability, combining empirical evidence (e.g., Sankey diagrams of resource flows) with actionable frameworks (e.g., institutional logics for policy design). It bridges gaps between research and practice, urging policymakers to prioritize Urban Agriculture in climate adaptation strategies.

2.4.1.1 Frequency distribution of scientific productivity: Lotka's law

Regarding the most productive institutions on the topic, as shown in Figure 12, Wageningen University And Research Netherlands is the leader, with 16 publications, followed by University Of Almeria (Spain), University Of Sevilla (Spain), Trier University Of Applied Sciences (Germany), Universidade Tecnológica Federal Do Paraná (Brazil), Universitat

d'Alacant (Spain), University Of Cantabria (Spain), University Of Helsinki (Finland), University Of Indonesia (Indonesia), Autonomous University Of Barcelona (Spain), and Educons University (Serbia).

Figure 12 – Most productive institutions on circular economy and agri-food (2020-2024)



Source: own design (2024).

The citation metrics of the selected papers indicate varying degrees of impact within their respective fields (Table 3). Notably, the paper by Hamam et al. (2021), named "Circular Economy Models in Agro-Food Systems: A Review" in "Sustainability" stands out with a total of 109 citations, averaging 27.25 citations per year and achieving a normalized total citation (TC) of 4.96. This high normalized TC suggests significant influence and relevance in its domain.

Table 3 – Most Global Cited Documents

Paper	Total Citations	TC per Year	Normalized TC
(Hamam *et al.*, 2021) Sustainability	109	27,25	4,96
(Muscio; Sisto, 2020) Sustainability	63	12,6	1,95
(Skar *et al.*, 2020) Bg Syst	62	12,4	1,92
(Fortunati; Morea; Mosconi, 2020) Agric Econ	56	11,2	1,73
(Liu *et al.*, 2021) Sustain Prod Consump	51	12,75	2,32

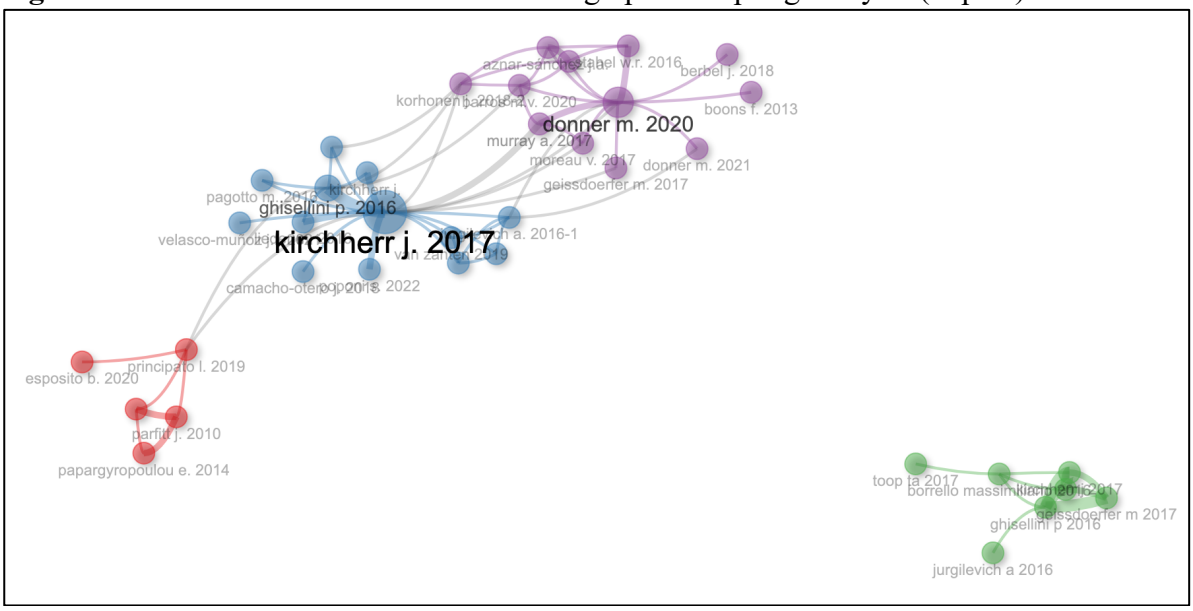
Source: own design (2024).

The authors (Hamam *et al.*, 2021) conduct a comprehensive review of the academic literature on the circular economy within agri-food systems, aiming to elucidate its primary characteristics and diverse perspectives. This review synthesizes and critically examines existing research in this domain. The findings underscore the imperative for the adoption of

cleaner production models and highlight the critical need for heightened stakeholder responsibility and awareness among both producers and consumers. Furthermore, the analysis reveals a pressing need for the development and implementation of appropriate policies and tools to support these initiatives (Hamam *et al.*, 2021).

Analyzing the cluster network data reveals distinct groupings and influential nodes within the research landscape on the circular economy. Figure 13 shows the clusters network between the publications. Kirchherr, Reike and Hekkert (2017) in Cluster 2 demonstrates the highest betweenness centrality (298.526) and PageRank (0.109), making it the most influential node in the overall network.

Figure 13 – Clusters network based on bibliographic coupling analysis (Papers)

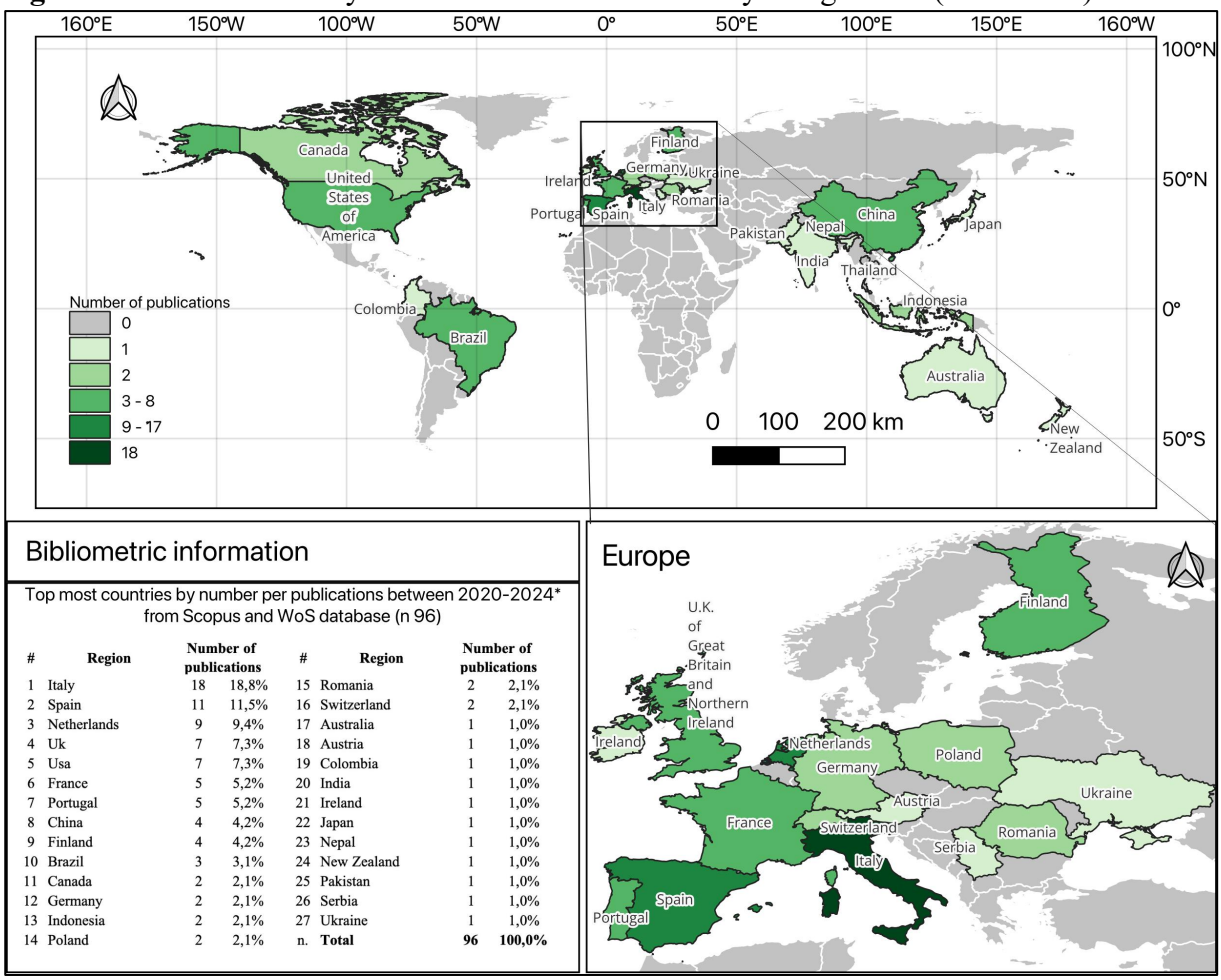


Source: own design (2024).

Closeness centrality values indicate the relative accessibility of nodes within their clusters, with Cluster 3 nodes generally having higher closeness centrality. These metrics collectively illustrate the structural and influential dynamics within the circular economy literature, highlighting pivotal works and their interconnections.

Regarding the countries, Figure 14 shows that 27 countries published on the topic during 2020 and 2024 may. Italy is the most productive country, with 18 publications, followed by Spain, with 11 publications, the Netherlands (9), UK (7), USA (7), France (5), Portugal (5), China (4), Finland (4), Brazil (3), and others.

Figure 14 – Publications by countries on circular economy on agri-food (2020-2024)

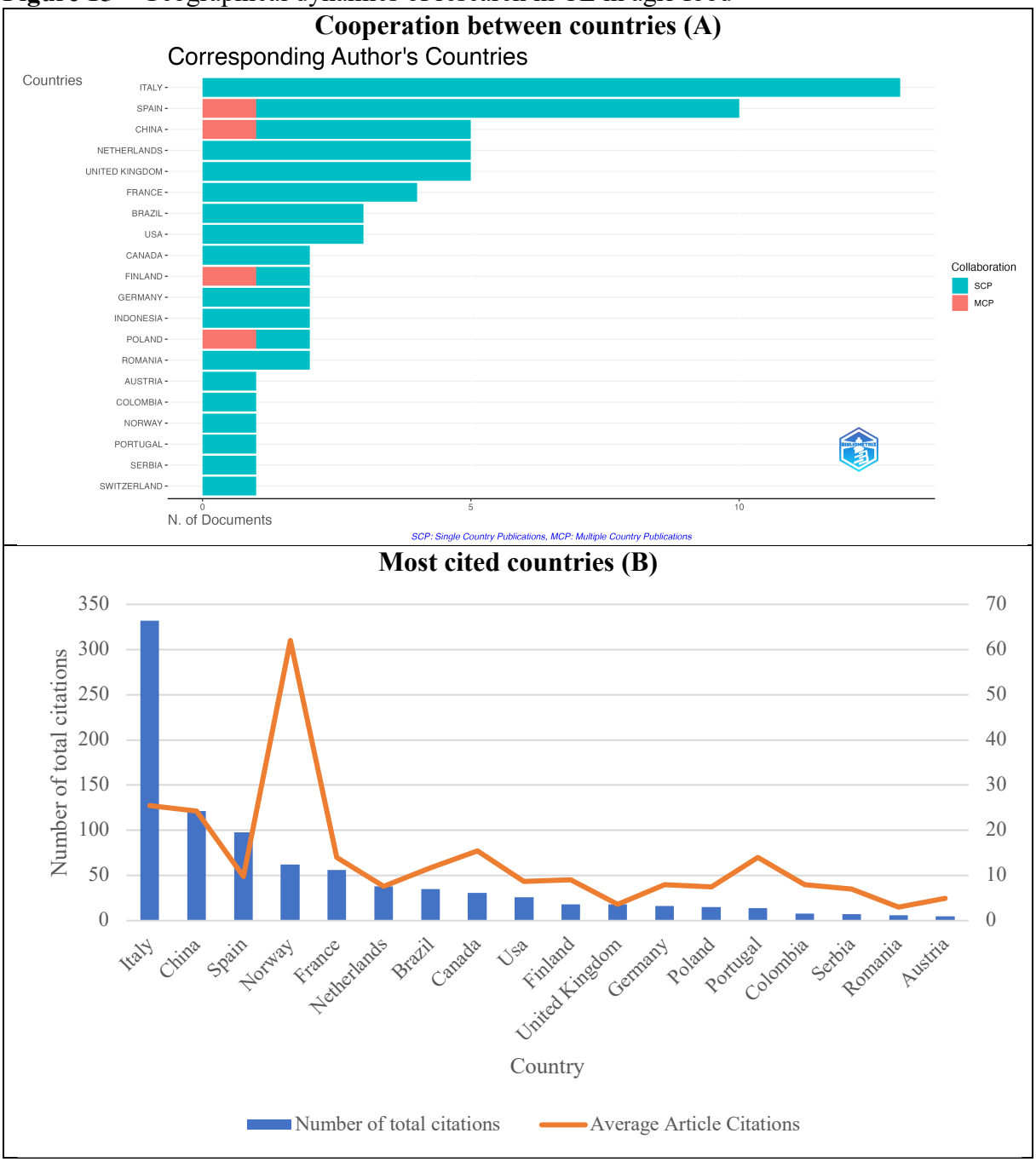


#	Region	Number of publications		#	Region	Number of publications	
1	Italy	18	18,8%	15	Romania	2	2,1%
2	Spain	11	11,5%	16	Switzerland	2	2,1%
3	Netherlands	9	9,4%	17	Australia	1	1,0%
4	Uk	7	7,3%	18	Austria	1	1,0%
5	Usa	7	7,3%	19	Colombia	1	1,0%
6	France	5	5,2%	20	India	1	1,0%
7	Portugal	5	5,2%	21	Ireland	1	1,0%
8	China	4	4,2%	22	Japan	1	1,0%
9	Finland	4	4,2%	23	Nepal	1	1,0%
10	Brazil	3	3,1%	24	New Zealand	1	1,0%
11	Canada	2	2,1%	25	Pakistan	1	1,0%
12	Germany	2	2,1%	26	Serbia	1	1,0%
13	Indonesia	2	2,1%	27	Ukraine	1	1,0%
14	Poland	2	2,1%	n.	**Total**	**96**	**100,0%**

Source: own design (2024).

Country cooperation was assessed by measuring whether a single country (SCP) or multiple countries (MCP) appeared in a publication (Figure 15A). Interestingly, single-country publications dominate the entire ranking, only Spain, China, Finland and Poland worked with join collaboration with different countries. We noted that Italy ranks first, with the largest number of both single-country publications and multiple-country publications. Spain and United Kingdom rank second and third, respectively, in both types of cooperation.

Figure 15 – Geographical dynamics of research in CE in agri-food



Source: own design (2024).
Note: (A) represents the cooperation between countries in publishing about CE, and (B) shows the most cited countries

The orange line reveals the citation impact or quality of articles from each country (Figure 15B), while the blue bars indicate the overall research visibility and contribution in terms of citation. Italy is the most-cited country in its publications, with 364 citations. With less than half of the citations are the other countries, wherein China and Spain complete the ranking of countries that exceed 100 citations. The Norway is fourth with 62 citations and the France is

fifth with 56. Norway stands out with a notably high average number of citations per article, despite having fewer total citations compared to Italy or China. This suggests that while Norway may have published fewer articles, those articles are highly influential or impactful. Conversely, countries like Italy have a very high total number of citations but a moderate average citation per article, indicating a larger volume of publications with relatively distributed citation counts.

2.4.1.2 Analysis of the scientific journals: Bradford's law

The bibliometric analysis shows that publications are distributed in 42 journals. Table 4 lists the top 5 journals, with the number of publications (NP), total citations (TC), and impact factor (h-index, g-index and m-index). This data underscores the prominent roles of these journals in disseminating research on sustainability and related fields, with "Sustainability (Switzerland)" leading in terms of both publication volume and citation impact.

Table 4 – Top 5 journals per number of publications

Source	NP	TC	h-index	g-index[1]	m_index[2]	PY_start
Sustainability (Switzerland)	16	309	8	16	1,6	2020
Frontiers In Sustainable Food Systems	3	43	3	3	0,6	2020
Sustainability	3	40	3	3	0,75	2021
Sustainable Production And Consumption	3	61	2	3	0,5	2021
Agronomy-Basel	2	40	2	2	0,4	2020

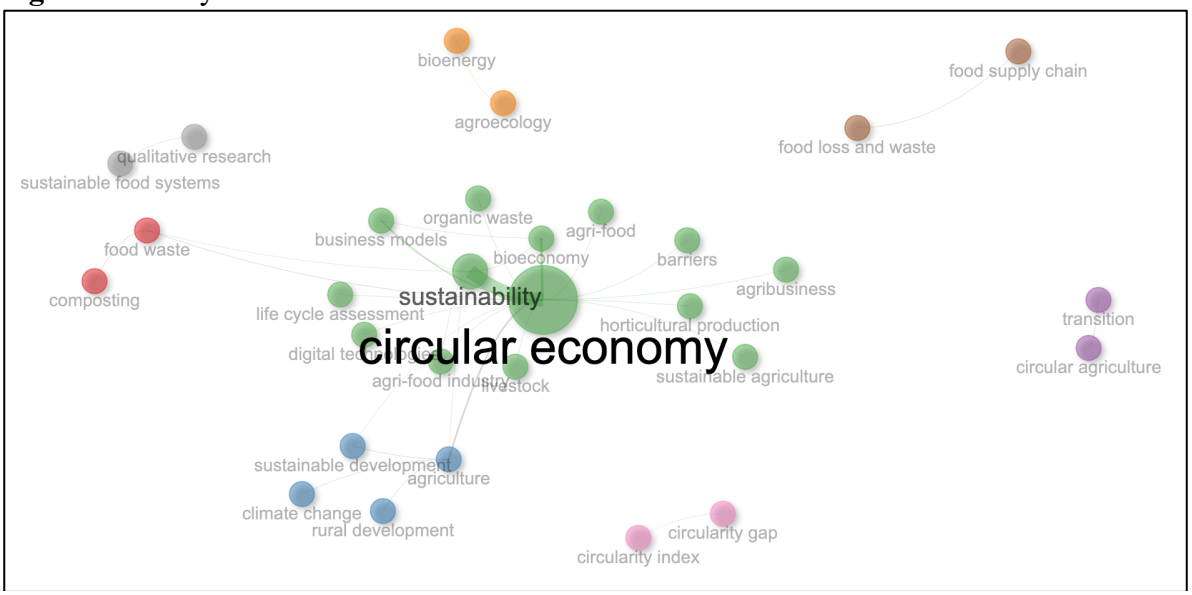
Source: own design (2024).
The g-index gives more weight to highly cited articles[1].
The m-index displays h-index per year since first publication[2].

The most productive journal identified is Sustainability stands out with the highest number of publications (NP=16) and total citations (TC=309) since its inception in 2020, reflecting a strong impact in the field, as indicated by its h-index of 8 and g-index of 16. It also has a interesting to note the m-index of 1.6, indicating rapid citation growth. "Frontiers in Sustainable Food Systems" and "Sustainability" each have three publications, with total citations of 43 and 40, respectively, both beginning in 2020 and 2021. These journals have an h-index and g-index of 3, with "Sustainability" showing a slightly higher m-index (0.75) compared to "Frontiers in Sustainable Food Systems" (0.6). "Sustainable Production and Consumption" also has three publications and a moderate total citation count of 61, starting in 2021, with a lower m-index of 0.5. Lastly, "Agronomy-Basel" has two publications and 40 citations, with an h-index and g-index of 2, reflecting its contributions starting from 2020.

2.4.1.3 Analysis of the co-occurrence of terms: Zipf's law

The popular keywords on the topic were identified through a co-occurrence analysis. The analysis started with a total of 292 keywords, as shown in Figure 15. There are eight clusters, and Circular economy (green in the Figure 16) is the most central and influential keyword in the network, indicated by its high betweenness, closeness, and PageRank scores.

Figure 16 – Keywords network based on co-occurrence



Source: own design (2024).

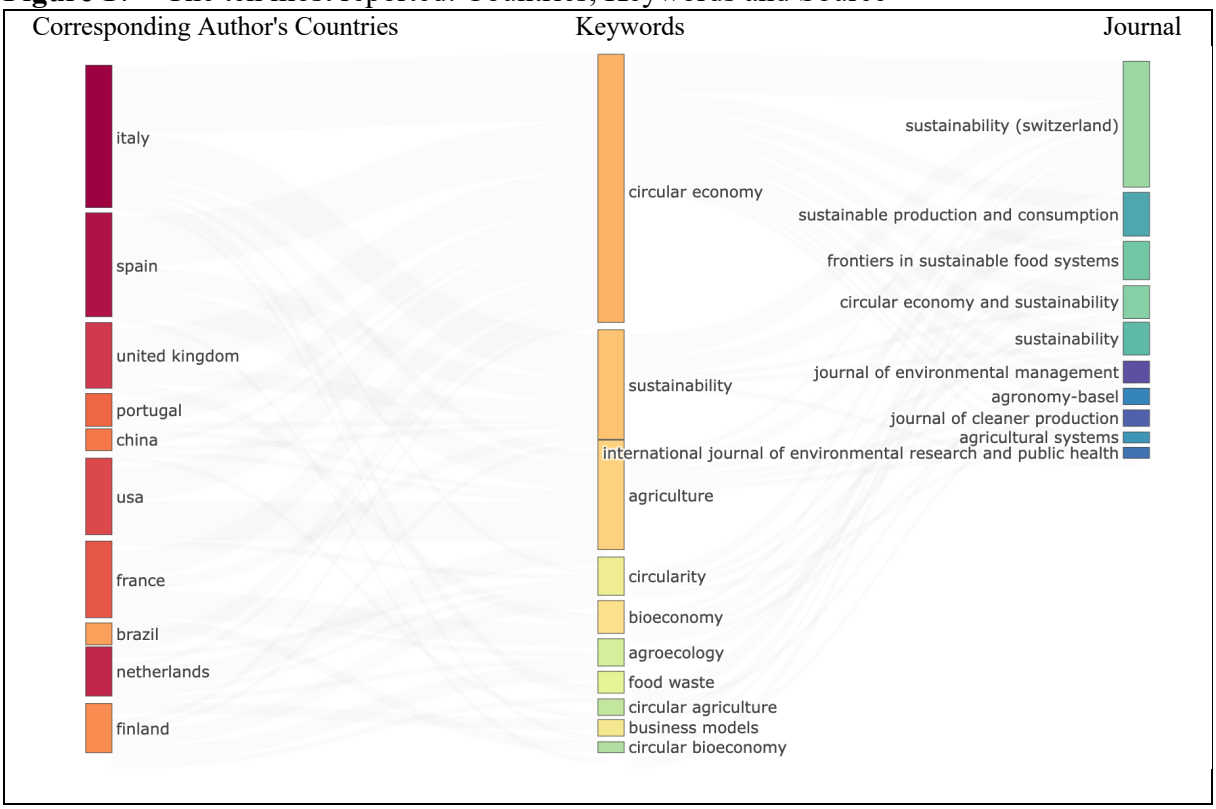
Keywords with high betweenness such as circular economy and agriculture act as critical connectors within the network, facilitating the flow of information between different parts (bridging keywords). Keywords in Clusters node: circular agriculture and transition; agroecology and bioenergy; food loss and waste, and food supply chain; circularity gap and circularity index; qualitative research and sustainable food systems – have identical centrality measures within their clusters, suggesting a high level of interconnectedness and equal significance (equal centrality).

That is, the network is highly influenced by the concepts of circular economy and agriculture, with food waste also playing a significant role. The analysis of centrality measures indicates that some keywords act as crucial connectors and influencers within their clusters, while others share equal importance. This network analysis can help prioritize focus areas for research, policymaking, and implementation strategies in the context of sustainability and circular economy.

Additionally, we described the most reported countries, keywords and source reported in a Sankey diagram (Figure 17). The Sankey diagram illustrates the interconnectedness of

global research efforts in sustainability and circular economy, highlighting key contributing countries, thematic areas, and major academic journals.

Figure 17 – The ten most reported: Countries, Keywords and Source



Source: own design (2024).

As it can be seen, Italy is the main country, researching about CE and publishing at Sustainability (Switzerland). Sustainability and Circular Economy are dominant themes across multiple countries, highlighting a global emphasis on addressing environmental and resource management challenges. Journals like "Sustainability (Switzerland)" and "Journal of Cleaner Production" are key outlets for disseminating research on these themes, indicating their importance in the academic community. Countries like the United States of America and France contribute to a wide range of themes, suggesting a holistic approach to sustainability and environmental research. Countries like Brazil and Finland focus on specific research areas, indicating specialized expertise and targeted research efforts.

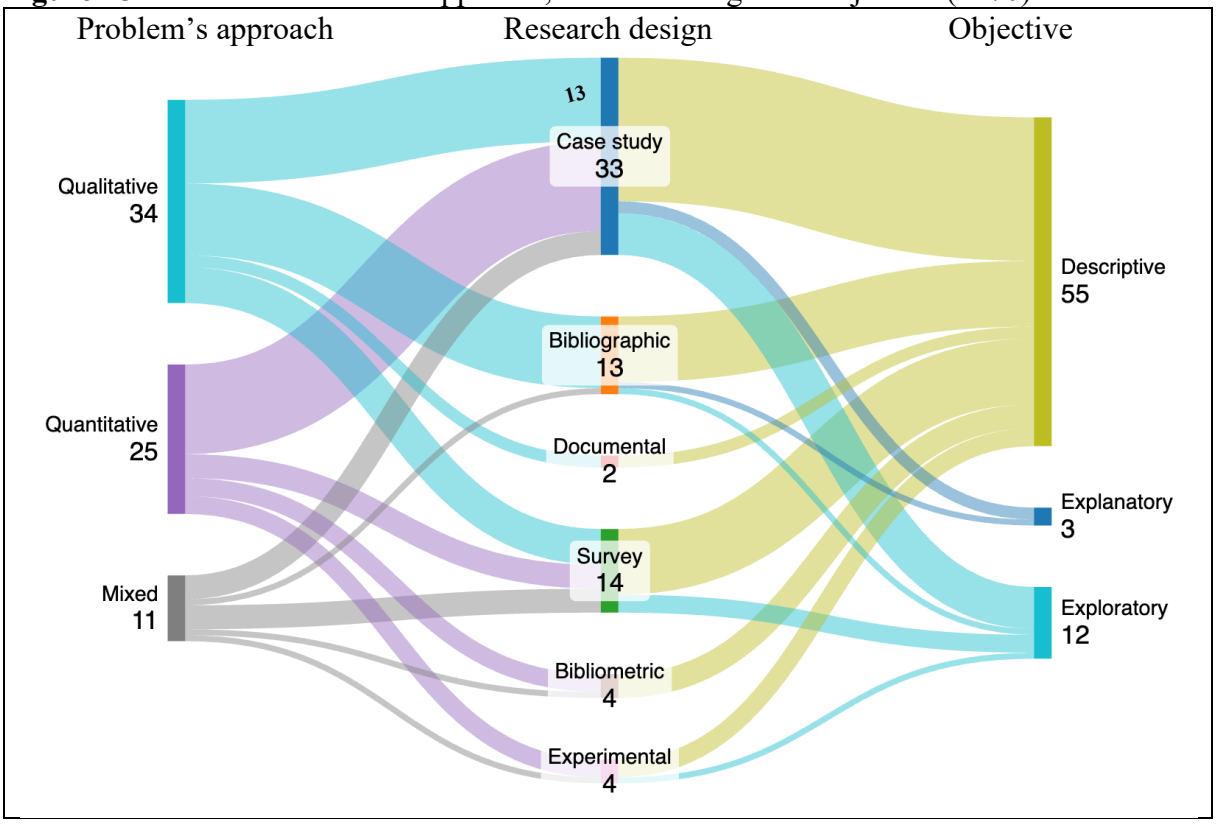
The above discussion is used to answer the first research question (RQ1). That is, we state that the general state of research on CE in agri-food is multifaceted. The implementation of CE in agri-food is focused not only on technical innovations but also, social, economic, environmental, and policy dimensions, aiming for transformation toward sustainability on agri-food sector. Wageningen University (Netherlands) is the most productive institution,

accounting for 16 publications (22.85%). The journal Sustainability (Switzerland) has published the highest number of articles considering the production over time (2020/2024), and the paper by Hamam et al. (2021) is the most cited.

3.4.2 Theoretical perspectives on circular economy and agri-food

Considering that the comprehensive tabulation of the research, including information on the study procedures, participants, and findings, should be the first step in the synthesis of the included studies (Petticrew; Roberts, 2006), Figure 18 shows how the portfolio's problem's approach, research design and objective are connected.

Figure 18 – Portfolio Problem's approach, research design and objective (n. 70)



Source: own design (2024).

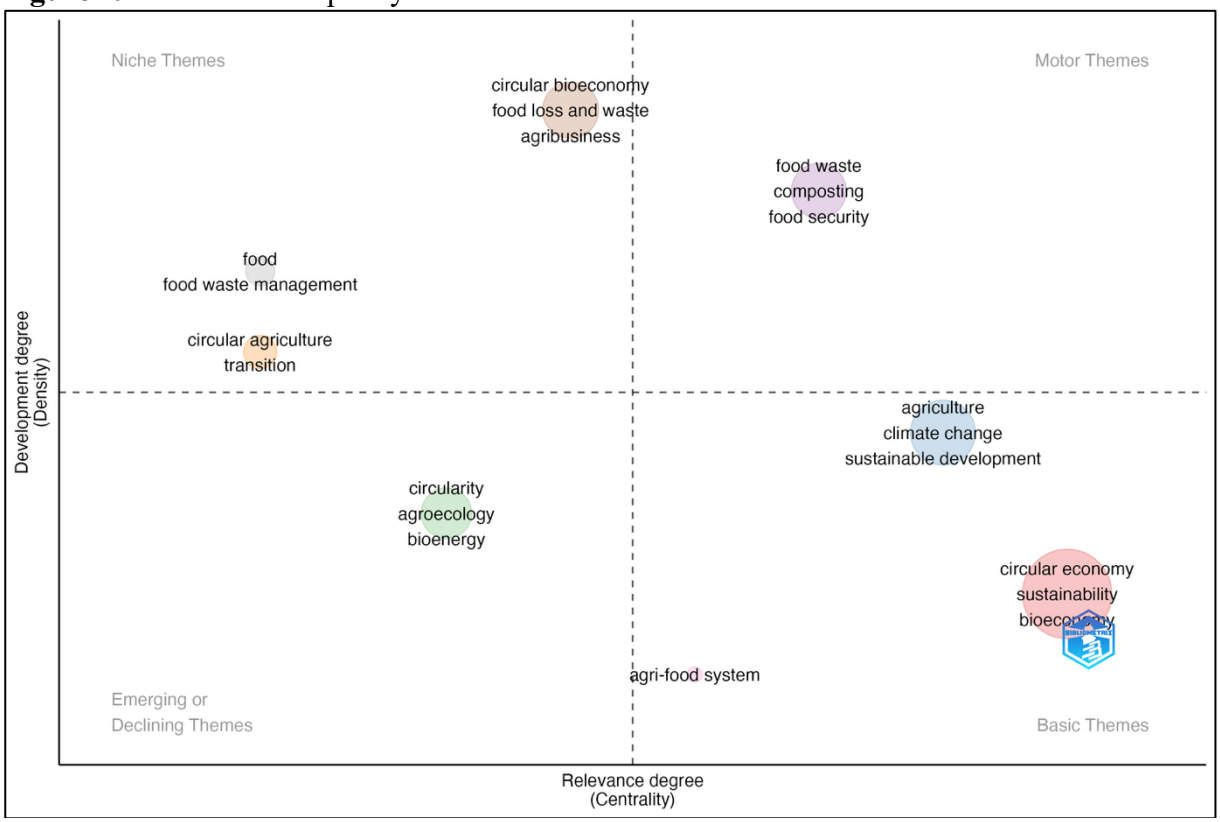
From the Figure 17, it can be observed that the most utilized problem approach method was qualitative (n = 34), with the predominant research design being a case study (n = 33) and the primary research objective being descriptive (n = 55). Employing this combination of qualitative case study, 13 articles were selected for content analysis.

Also, it is noteworthy that only four papers employed a bibliometric strategy pertinent to the topics in question. Yang et al. (2021) proposed a solution framework grounded in change

management (CM) strategies to address organizational challenges posed by a circular economy (CE), with a particular focus on agribusinesses. Sánchez-Teba, Gemar, and Soler (2021) investigated the evolution and interrelationship between the concepts of food waste and the supply chain within agricultural companies. Hamam et al. (2021) conducted a comprehensive review of the academic literature on the circular economy within agri-food systems. Finally, Salinas-Velandia et al. (2022) illustrated the transition of horticulture towards a circular economy.

The thematic map (Figure 19) illustrates the conceptual structure of the literature on CE in the agri-food sector, organized by centrality (relevance) and density (development). Cluster 1 reveals that CE emerges as the most central theme, with high frequency and strong betweenness centrality values for terms like “circular economy” (44 occurrences), “sustainability” (16), and “bioeconomy” (6). These results indicate that cluster 1 forms the backbone of the academic discussion, connecting environmental concerns with systemic transformation. Closely linked, cluster 2 shows that agriculture includes themes such as “agriculture”, “climate change”, and “sustainable development”, showing high centrality but lower density, suggesting its foundational yet evolving role in the field.

Figure 19 – ThematicMap: keywords



Source: own design (2024).

Regarding cluster 4, food waste appears in the motor quadrant, with terms such as “food waste”, “composting”, and “food security”, reflecting its maturity and strategic relevance. In custer 6, circular bioeconomy includes “food loss and waste”, “agribusiness”, and “sustainable food systems”, positioned as niche themes with internal consistency but less centrality, signaling specialized subfields. In contrast, cluster 3 – circularity (e.g., “agroecology”, “bioenergy”) – and cluster 5 – circular agriculture (e.g., “transition”) – fall into the emerging or declining quadrant, indicating topics under development or with growing academic interest. Cluster 7 – agri-food system – and cluster 8 – food – are less developed and peripheral, suggesting conceptual areas that might require further integration into mainstream discussions.

Our study and observations also enable us to address the second research question (RQ2): "What are the theoretical perspectives on the circular economy in the agri-food field?" The theoretical perspectives in the CE agri-food field are drawn from different disciplines, including corporate social responsibility (CSR), agroecological symbiosis, governance and stakeholder theory, sustainable consumption and production, food waste management, and strategic management.

3.4.3 Circular economy in the agri-food: interventions and outcomes

Based on a selection of studies employing a qualitative approach with a case study research design, 13 papers were identified from the 70 RSL. This last specific objective aims to propose a qualitative exploration of circular economy (CE) interventions and their outcomes, synthesizing the qualitative evidence from case study experiences. In refining the research questions, consideration was given to three key aspects: the level of analysis, the intervention (implementation of CE practices/actions), and the outcomes (the effects of these interventions) (see Table 5).

Table 5 – The 13 selected papers for content analysis: qualitative case study

Level of Analysis	Paper	Focus	Intervention	Outcomes
macro-level (4)	(Aznar-Sanchez *et al.*, 2020)	Almería (South-East Spain)	143	66
	(Corral *et al.*, 2022)	Municipality of Almócita (Almería, Spain)	35	36
	(Iagăru; Șipoș; Iagăru, 2023)	Agri-Food Sector in the Sibiu Depression Microregion, Romania	53	29
	(Hoogstra *et al.*, 2024)	circular agriculture initiatives in the North of the Netherlands	24	29
meso-level (1)	(Huang *et al.*, 2022)	industrial ecology in Mexico	11	6
micro-level (8)	(Morea *et al.*, 2023)	agri-business small or midsize (SMEs) companies operating in Italy	53	38
	(Fortunati; Morea; Mosconi, 2020)	nine companies in the Italian territory	59	95
	(Klein; Nier; Tamásy, 2022a)	potato production in Lower Saxony (northwest Germany)	55	48
	(Klein; Nier; Tamásy, 2022b)	potato and rapeseed production in Lower Saxony, Germany	21	16
	(Tait *et al.*, 2023)	salmon farming in Scotland	17	15
	(Donner; De Vries, 2023)	circular bioeconomy business initiatives in the French agrifood sector	74	109
	(Tumuyu; Marthalia; Asteria, 2024)	Agroindustry Company at Sumatera Island, Indonesia	27	42
	(Tumuyu; Marthalia, 2023)	agrocompany in Indonesia	30	42

Source: own design (2024).

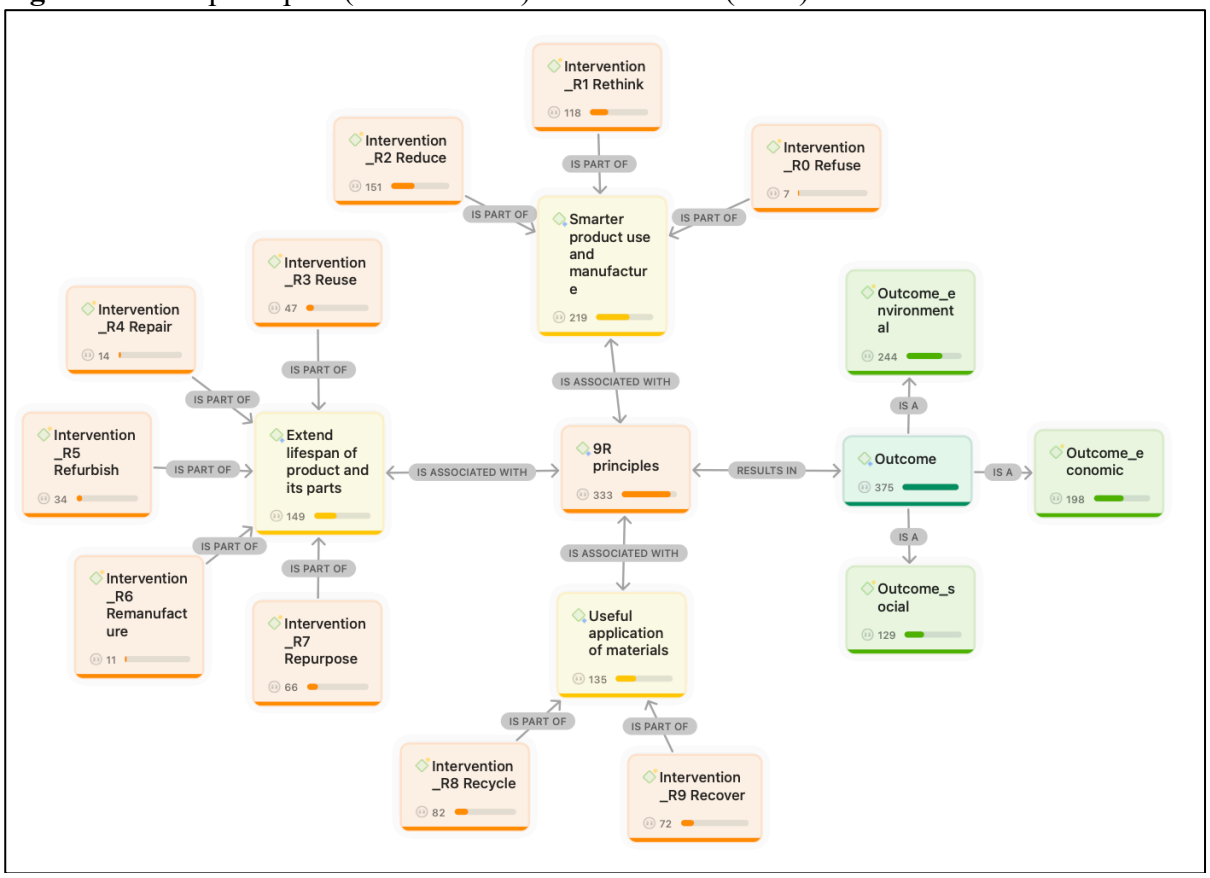
Many papers provided minimal details regarding implementation processes. Among the studies that did include information on these processes, the majority were deemed to lack sufficient detail on study design, rendering the assessment of their quality challenging. Furthermore, it was frequently ambiguous whether the “implementation relevant” statements were grounded in empirical research.

Although it was possible to code the 13 selected articles according to their level of analysis (micro, meso, and macro), none of them explicitly address circular economy from a regional development perspective. For instance, while it is widely acknowledged that adopting circular economy practices positively impacts society, the mechanisms through which these

benefits materialize remain underexplored. This highlights a significant gap for future research, emphasizing the need for studies that investigate the regional dynamics of circular economy adoption and their contributions to sustainable development.

Figures 20 and 21 illustrate the relationship between the interventions and the outcomes.

Figure 20 – 9R principles (interventions) and outcomes (n. 13)



Source: own design (2024).

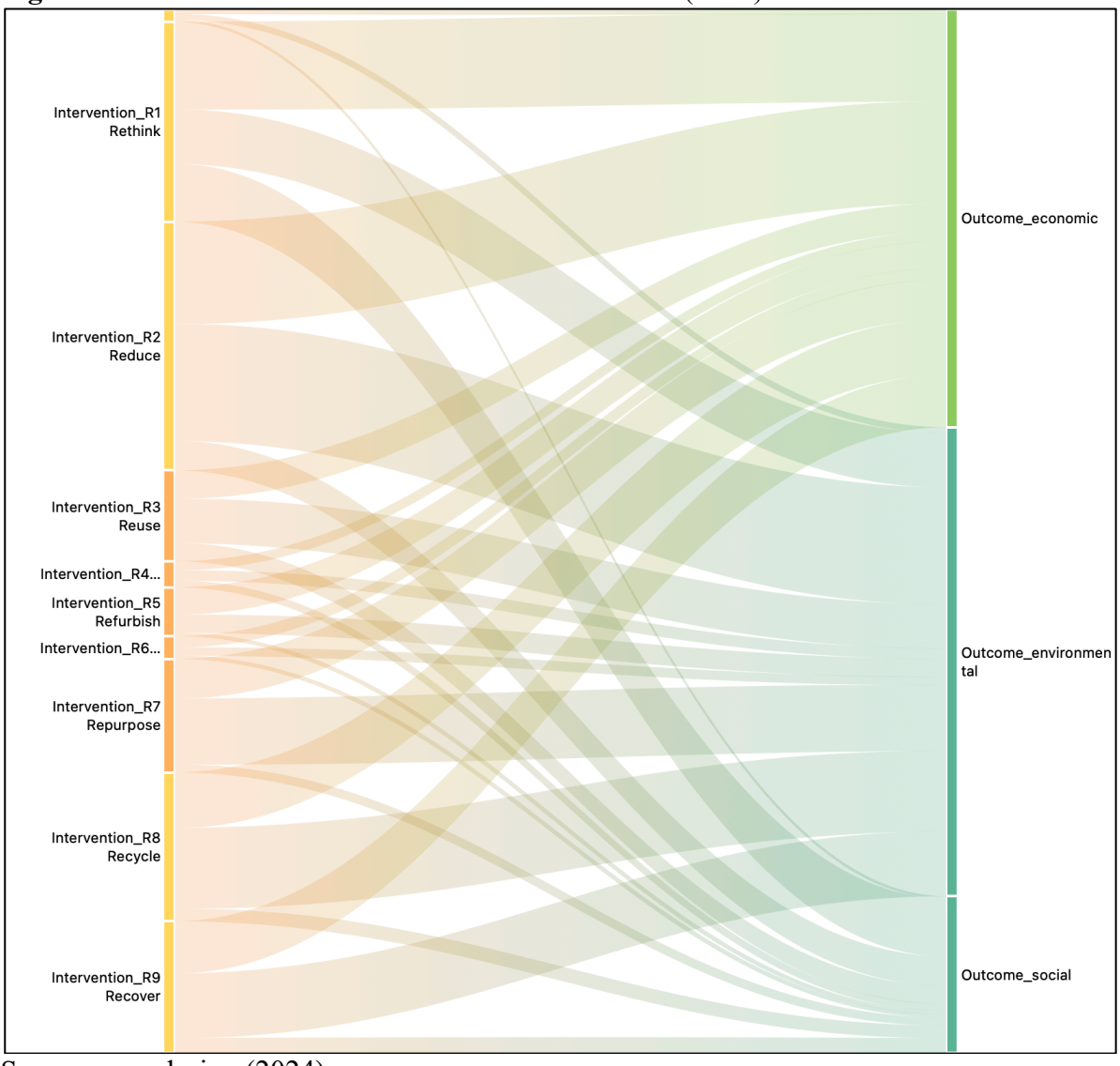
The Sankey diagram (Figure 20) illustrates the relationships between nine interventions (e.g., Rethink, Reduce, Reuse) and their corresponding outcomes (economic, environmental, social), with the thickness of the connecting flows indicating the strength of these relationships. Each intervention (e.g., R1 Rethink, R2 Reduce) has a number indicating how frequently it appears or is discussed in the analyzed studies. he numbers next to outcomes reflect how often each type of outcome (e.g., environmental, economic, social) was identified in connection with the 9R principles (environmental: 244 occurrences, economic: 198 occurrences and social: 129 occurrences).

This numerical representation helps highlight areas of focus, gaps, or emphasis in the research on circular economy interventions and their outcomes. “Rethink” is more associated with economic outcomes, as the flow from this intervention predominantly connects to the

economic category. Additionally, most interventions in the diagram lead to environmental outcomes (44,64%), suggesting a stronger emphasis on environmental impact compared to economic (40,04%) and social outcomes (15,02%), which are less prominently connected.

Also, our application of the 9R model reveals that Rethink and Reduce dominate in contexts with strong policy and cost incentives, respectively. Notably, Reuse remains underutilized (15,3%) due to fragmented supply chains – a key gap for future policy. For practitioners, our findings suggest that CSR commitments (e.g., Italian SMEs) can amplify Repurpose strategies, while regional policies (e.g., Spain's Almería) effectively scale Rethink. This challenges the 3R paradigm (Kirchherr; Reike; Hekkert, 2017) by showing that advanced Rs (e.g., Refuse) require systemic innovation. See Figure 21.

Figure 21 – Co-occurrence: interventions and outcomes (n. 13)



Source: own design (2024).

The results obtained in this research converge in part with Kirchherr, Reike, and Hekkert (2017). Even though the authors chose to be coding only the 3R Framework (Reduction, Reuse, and Recycling), we found that Reduce, Rethink and Recycle were the most intervention strategies used by the case studies. These three interventions together sum up more than 58% of the total coded. This suggests that a more comprehensive framework can lead to a more specific result.

Morea et al. (2023) provide empirical evidence demonstrating how Corporate Social Responsibility (CSR) can facilitate the adoption of CE practices, particularly within the agri-food industry. Their research enhances our understanding of the synergistic relationship between CSR and CE, showing that CSR initiatives can significantly promote the implementation of CE strategies in this sector. Also, it could be observed that companies operating in the food industry exhibit heightened awareness of sustainability concerns and are progressively pursuing value creation strategies grounded in circularity principles (Fortunati; Morea; Mosconi, 2020).

To address the third research question (RQ3) – "What are the interventions and outcomes of implementing a circular economy in the agri-food sector?" – we observed that most of the research focuses on the micro-level, particularly within companies in Italy, Germany, Scotland, France, and Indonesia. The most frequently implemented circular economy practice identified in the qualitative research was the reduction strategy, accounting for 25.08% of interventions. The outcomes of these interventions were primarily environmental (42.73%), followed by economic (34.68%) and social (22.59%) impacts.

The 13 case studies cover multiple countries (Spain, Italy, Germany, France, Indonesia, etc.), although our aim was not to systematically compare the administrative, cultural, or infrastructural factors influencing CE adoption. Our comparative analysis reveals that CE implementation is highly contextual. In EU regions with strong policy frameworks, the ‘Rethink’ strategy dominates (44% of interventions), whereas in resource-scarce Southeast Asia, the focus shifts to ‘Recover’ (32%). This divergence suggests that top-down EU policies are less transferable to regions with weak governance. SME-driven circularity models – such as those found in Italy – may offer more adaptable approaches for emerging economies. Future CE strategies must align with local institutional logics – state, market, or community – to avoid ‘one-size-fits-all’ failures.

Building on our mixed methods results, we synthesize how contextual factors at macro, meso, and micro levels shape CE interventions and outcomes. For instance, macro-level policy incentives (e.g., Spain’s agro-industrial regulations) drive environmental outcomes via

‘Rethink’ strategies, while micro-level CSR commitments (e.g., Italian SMEs) favor ‘Reduce’ with social benefits. This integration of bibliometrix trends and case study evidence addresses the need for contextual rigor highlighted by Kirchherr et al. (2017) and identifies levers for scalable CE adoption.

3.5 Essay final remarks

This study aimed to identify and analyze circular economy practices implemented within the agri-food sector globally. By reviewing 70 research papers and analyzing 13 case studies, the study gives a detailed look at the trends, actions, and results related to the 9R framework in different situations.

The findings indicate that the application of CE in agri-food is still at a developmental stage, with significant emphasis placed on reduction strategies and environmental impacts. However, economic and especially social outcomes remain underexplored, pointing to a gap in both empirical evidence and policy focus.The first research question (RQ1) explored: “What is the current state of research on circular economy practices in the agri-food sector?” It was concluded that the research landscape is multifaceted, addressing not only technical innovations but also social, economic, environmental, demographic, and policy aspects, with a clear focus on transforming the sector toward sustainability.

The second research question (RQ2) investigated: “What theoretical frameworks underpin this field of study?” It was found that theoretical perspectives in the circular economy of the agri-food sector are derived from various disciplines, including corporate social responsibility (CSR), agroecological symbiosis, governance and stakeholder theory, sustainable consumption and production, food waste management, and strategic management.

The third research question (RQ3) examined: “What are the key interventions and measurable outcomes associated with implementing circular economy principles in the agri-food sector?” Based on the 13 papers analyzed in the content analysis, the most frequently implemented circular economy practice identified was the reduction strategy, accounting for 25.08% of interventions. The outcomes of these interventions were primarily environmental (42.73%), followed by economic (34.68%) and social (22.59%) impacts.

Addressing the aim outlined in this study (to identify and analyze circular economy practices implemented in the agri-food sector around the world), we concluded that aligning people's mindsets with a circularity-oriented culture over time required setting clear goals and

targets, developing strategies for effective business innovation, and continually assessing progress through a sustainability lens (environmental, social and economic perspective).

Theoretically, this study contributes to the literature by integrating bibliometric analysis and case study research to map the dissemination of CE knowledge and practices. It highlights how frameworks such as CSR, stakeholder theory, and agroecological models underpin the evolving landscape of circular strategies in agriculture. Practically, the results emphasize the importance of localized implementation pathways. Interventions such as 'Rethink' or 'Repurpose' are more effective when aligned with contextual drivers, such as regional policy instruments or company-level sustainability commitments. This concept is particularly relevant in emerging economies where top-down frameworks may not always translate into operational impact.

In this sense, Brazil represents a fertile ground for future CE research and policy experimentation. As one of the world's leading agri-food producers, Brazil faces both challenges and opportunities in embedding circular practices in rural, industrial, and urban food systems. Integrating CE into Brazil's national sustainability agenda – through inclusive policies, regional pilot programs, and support for SMEs – can serve as a benchmark for scalable models in Latin America.

However, some limitations must be acknowledged. This study relies exclusively on theoretical methods, making it necessary to validate the findings through case studies and expert interviews to better analyze the results. Future research should, therefore, focus on two key areas: (a) providing a quantitative diagnostic of the agri-food sector based on regionalization, specifically measuring circularity across different regions, and (b) systematically applying circular economy principles in the agri-food industry to empirically assess how these principles influence and reshape the architecture of existing business models.

ESSAY 3

4 RESHAPING AGRI-FOOD BUSINESS MODELS THROUGH CIRCULAR ECONOMY: A CROSS-NATIONAL ANALYSIS OF BRAZIL AND ITALY AND THEIR REGIONAL DEVELOPMENT POTENTIALS

Abstract: The integration of sustainability into business strategies is increasingly recognized as a driver of regional development, fostering economic stability, social cohesion, and environmental stewardship. However, there is still limited understanding of how circular economy (CE) practices reshape business model architectures in the agri-food sector and contribute to regional development across different contexts. This study aims to investigate how CE practices transform agri-food business models and support regional development, through a comparative analysis of experiences from Italy and Brazil. Adopting a qualitative approach of explanatory and descriptive nature, the research analyzes how CE principles influence value creation, delivery, and capture in agri-food firms, focusing on the Intermediate Geographic Region (RGInt) of Cascavel (Brazil) and the Marche region (Italy). The comparative diagnosis reveals distinct yet complementary trajectories. RGInt Cascavel shows robust growth driven by livestock and diversification into fish processing and spirits, while Marche reflects a mature but relatively stagnant structure gradually reorienting toward value-added niches. CE shapes business models differently: in Italy, family-owned firms and cooperatives embed circularity via territorial identity, artisanal quality, certification, and sustainable food safety, whereas in Brazil, emerging diversification integrates circular principles in dynamic subsectors. The study contributes cross-national empirical evidence on CE-business model interactions, offering theoretical and practical insights for advancing regional development.

Keywords: agri-food sector; agro-food; by-products; closed-loop systems.

"O fato de ser brasileiro só me enche de orgulho".
Ayrton Senna

4.1 Essay introduction

Regional development is a dynamic, uneven, and multifaceted process shaped by production systems and social structures. It drives transformation from underdeveloped areas to more advanced regions, highlighting persistent disparities across territories (Ferrera de Lima, 2024). This complexity directly connects to the concept of the circular economy (CE), especially in the context of shifting economic systems from linear to more sustainable models.

The CE offers a critical framework for rethinking traditional linear processes of "take, make, dispose." Instead, it promotes regenerative systems that minimize waste, optimize resource use, and create value through closed material and energy loops (Ellen MacArthur Foundation, 2015). By increasing circularity, CE strategies enhance environmental performance while boosting economic and resource efficiency (Lewandowski, 2016).

Given that the CE is inherently tied to patterns of production and consumption, industries play a pivotal role in its implementation. In this context, the concept of a business model refers to the structure or pattern through which value is created, delivered, and captured, outlining the underlying logic and providing evidence of how a company generates and delivers value to its customers (Teece, 2010).

Recent literature, particularly in studies published since 2015, shows that CE practices are not merely peripheral innovations, but fundamentally restructure how value is created, delivered, and captured (Donner; De Vries, 2023). Moreover, the integration of sustainability into business strategies increasingly contributes to regional development by promoting economic stability, social cohesion, and environmental stewardship (Chertow; Park, 2016).

In this regard, agri-food regions provide fertile ground for examining how CE principles are put into practice. Both the Intermediate Geographic Region (RGInt) of Cascavel (Paraná) and Marche Region, Italy exemplifies this potential, standing out as key agri-food regions in Brazil and Italy, respectively. Paraná combines diverse production systems, ranging from smallholder farming to advanced agribusiness with growing attention to sustainability (Shikida; Galante; Cattelan, 2020). Likewise, Marche is recognized for its longstanding agri-food tradition and strong orientation toward sustainable development (Chiaraluce, 2024).

Against this background, this study seeks **to investigate how circular economy practices transform agri-food business models and contribute to regional development,**

comparing experiences from Italy and Brazil. Its specific objectives are: (a) to diagnose the regional specialization of the agri-food industry (b) to investigate the influence of the circular economy on the architecture of existing business models in agri-food industries; (c) to assess the potential of circular models in fostering regional development in two distinct cross-national agri-food regions.

This research is justified across four dimensions: (a) Social: it fills a gap in the literature by identifying the structural changes necessary to guide the agri-food sector toward circularity, supporting stakeholders aiming to foster environmentally responsible practices; (b) Scientific: the study contributes empirical evidence to an emerging field, strengthening the understanding of how CE principles impact business models in practice; (c) Economic: by addressing implementation challenges, it offers insights to help businesses maximize resource use, improve competitiveness, and operate sustainably amid shifting market and environmental pressures; (d) Regional: CE implementation varies across territories due to differences in institutional capacity, infrastructure, and economic structures. This study emphasizes the need for place-based strategies adapted to local conditions.

Two theoretical insights guide this study. First, the pursuit of sustainability by firms/organizations can be both proactive – driven by the recognition of profitability and long-term benefits – and regulatory – responding to institutional and policy pressures. Second, the transition to circular models is often more complex than theoretical models suggest. It requires specific organizational adaptations and is frequently adopted only when clearly aligned with financial incentives or risk mitigation.

Theoretically, this research responds to calls for understanding CE in agri-food industries. Practically, this study provides insights for organizations seeking to align their business models with CE principles, thereby enhancing competitiveness while contributing to regional development.

4.2 Theoretical background: business model for a circular economy

When a business is founded, it adopts a specific business model, intentionally or by default. This model outlines how the business will create, deliver, and capture value. At its core, a business model defines how the company provides value to customers, encourages them to pay for it, and ultimately turns these payments into profit. It embodies the management's assumptions about customer desires, preferred delivery methods, and how the business can structure itself to meet these needs, generate revenue, and achieve profitability (Teece, 2010).

This alignment of corporate strategies with regional development goals creates a synergistic relationship, where businesses thrive in supportive communities, and regions benefit from sustainable growth and improved quality of life (Elkington, 1994, 1998).

According to Porter and Kramer (2011), the concept of "shared value" highlights how businesses can enhance their competitiveness while simultaneously advancing the economic and social conditions in the communities where they do business. "The purpose of the corporation must be redefined as creating shared value, not just profit per se" (Porter; Kramer, 2011, p. 4).

Concept connected with the notion of externalities, that is, externalities occur when companies generate social costs, like pollution, that they do not have to pay for. Consequently, society enforces taxes, regulations, and penalties to make firms "internalize" these externalities, an idea that shapes numerous government policy decisions. However, in the case of business models grounded in circular economy and sustainability principles, externalities can also be positive, generating broader societal and environmental benefits, while simultaneously offering internal advantages in terms of cost savings, new revenue streams, and increased profitability.

Also, Porter and Kramer (2011) states that companies can generate shared value opportunities through three main strategies: by reimagining their products and markets, by enhancing productivity within their value chains, and by fostering the development of local clusters. All of them connected with circular economy. A shared value perspective emphasizes enhancing farming methods and bolstering the local network of supporting suppliers and institutions to improve farmers' efficiency, yields, product quality, and sustainability.

Business model innovation is based on changes (through creation, diversification, acquisition or transformation) that lead to the business model responding to internal and external incentives (Geissdoerfer *et al.*, 2020). Also, innovations in sustainable business models are made possible by the circular economy. Notwithstanding, applying the circular economy to companies can improve activity and process management and provide a chance to end cycles related to the flow of materials, energy, and trash (Barros *et al.*, 2023).

Creating a cost and revenue structure that is compatible with sustainability and profitability, as well as incorporating the concepts of the circular economy into the design or redesign of business operations and partnerships, are the primary responsibilities of the business model (Zucchella; Previtali, 2019). That is, **"a circular business model is an economic and operational architecture, encompassing the organizational boundaries of different actors (ecosystem)"** (Zucchella; Previtali, 2019, p. 285). Its goal is dictated by the amount of tangible and intangible resources invested, the flow of trust and knowledge, the participation of various

partners, and all these factors that allow the loop to be closed.

Related to circularity, Lewandowski (2016) proposed a framework of the circular business model canvas. This circular business model framework emphasizes sustainable practices through collaboration, resource optimization, and customer engagement. It highlights the role of cooperative networks, key activities like product design and recycling, and essential resources such as high-performance materials and natural capital regeneration. The value proposition includes Product-Service Systems, circular products, and virtual services, with incentives for customer participation in resource return programs. Customer relations are strengthened through on-demand production, customer-driven design, and community partnerships. Revenue streams vary from input-based to performance-based models, while the cost structure and adoption factors account for financial and external influences, supporting a resilient and economically viable approach to the circular economy.

In the shift to a circular bioeconomy, business models that prioritize utilizing local resources and adhering to territorial, communal, and/or social methods are becoming increasingly significant. Donner and Vries (2023) analyzed 44 bioeconomy business model initiatives from the agrifood sector in France, and they found that small and collaborative circular bioeconomy business models could trigger resilient territorial development and counteract the future (bio-)resources gap.

A value network with mutual adjustment based on a complex combination of resources, collaborative forms, and governance mechanisms is necessary for a circular business model. Additionally, the orchestrator's primary responsibility is to select and apply the ideal combination of these vital network relationship components while managing the demands of each individual actor with those of the ecosystem as a whole (Rantala *et al.*, 2018).

According to Donner, Gohier, and Vries (2020), the first step in effectively implementing circular business models in the agricultural sector is managing organizational transformation. They identify and describe five distinct business models, each with specific applications in the sector: Resource Recovery, Circular Supplies, Product Life Extension, Product-as-a-Service, and Sharing Platforms. Circular business models have the potential to foster sustainability and economic efficiency in the agro-industrial sector by optimizing resource use, extending product lifecycles, and promoting collaborative consumption practices.

An empirical multiple case study with 39 business cases was done to identify and characterize different types of circular business models (Bocken; Weissbrod; Antikainen, 2021). Accordingly, Circular Business Model Experiment is an iterative process that begins with a common objective and is used to design and evaluate circular value propositions with

customers and stakeholders in a real-world setting. It entails quick learning based on factual information to demonstrate the plausibility of circular value propositions. Experiments become more sophisticated during iterations. A learning emphasis is placed on starting more extensive changes, such changing consumer behavior to support the circular economy (Bocken; Weissbrod; Antikainen, 2021).

Other agri-food sectors face similar challenges and opportunities. To address the issue of waste generation in the agri-food industry, Chiaraluce, Bentivoglio and Finco (2023) interviewed six industries from different supply chain (frozen vegetables, fresh stuffed egg pasta, dry pasta company, roastery, farm producing – extra virgin olive oil, and winery). The authors suggest that managers and technicians should be aware of the potential solutions that may be used to recover and valorize their waste to establish creative circular business models. Also, "circular economy is a model of production and consumption and it could not be effectively implemented if the consumer is not ready to be involved in this process" (Chiaraluce; Bentivoglio; Finco, 2021, p. 867).

As pointed out in this section, the implementation of circular business models faces numerous challenges, often stemming from high costs, technological constraints, and other structural limitations. Transitioning from a linear to a circular economy requires significant investment, not only in technology but also in redesigning processes and developing new skills, which can impose financial burdens on companies (Geissdoerfer *et al.*, 2020). Furthermore, regulatory pressures may enforce these changes, making them mandatory for compliance, while at the same time potentially limiting market expansion for businesses unable to adapt (Kirchherr *et al.*, 2023). These challenges underscore the complexity of adopting circular practices and emphasize the necessity for supportive policies and incentives to ease the transition.

In the agri-food sector, a linear business model can be represented by a conventional dairy processor purchasing milk and producing cheese and throwing away by-products such as whey as garbage with no value extracted except from the primary product. On the other hand, a circular business model integrates sustainability by turning whey into protein powder or through biogas production, thus creating extra sources of revenue, reducing environmental spillovers, and generating positive spillovers such as decreased waste disposal costs and production of renewable energy. This shows how circularity reshapes value creation, delivery, and capture within the same system.

In this study, the circular economy in the agri-food sector is defined as a place-based system of production and consumption that seeks to regenerate natural resources, minimize waste, and maximize the value of agricultural and food by-products by employing circular

business models that incorporate technological and organizational changes, while also fostering regional development. The following section outlines the materials and methods applied.

4.3 Materials and methods

4.3.1 Research design

The present study will follow a qualitative approach and explanatory and descriptive nature, as the objective is to understand to analyze how the principles of the circular economy influence and reshape the architecture of existing business models (focus on value propositions: how value is created, delivered, and captured) in the agri-food industry. In other words, the aim is not only to describe the process, but to explain it as well.

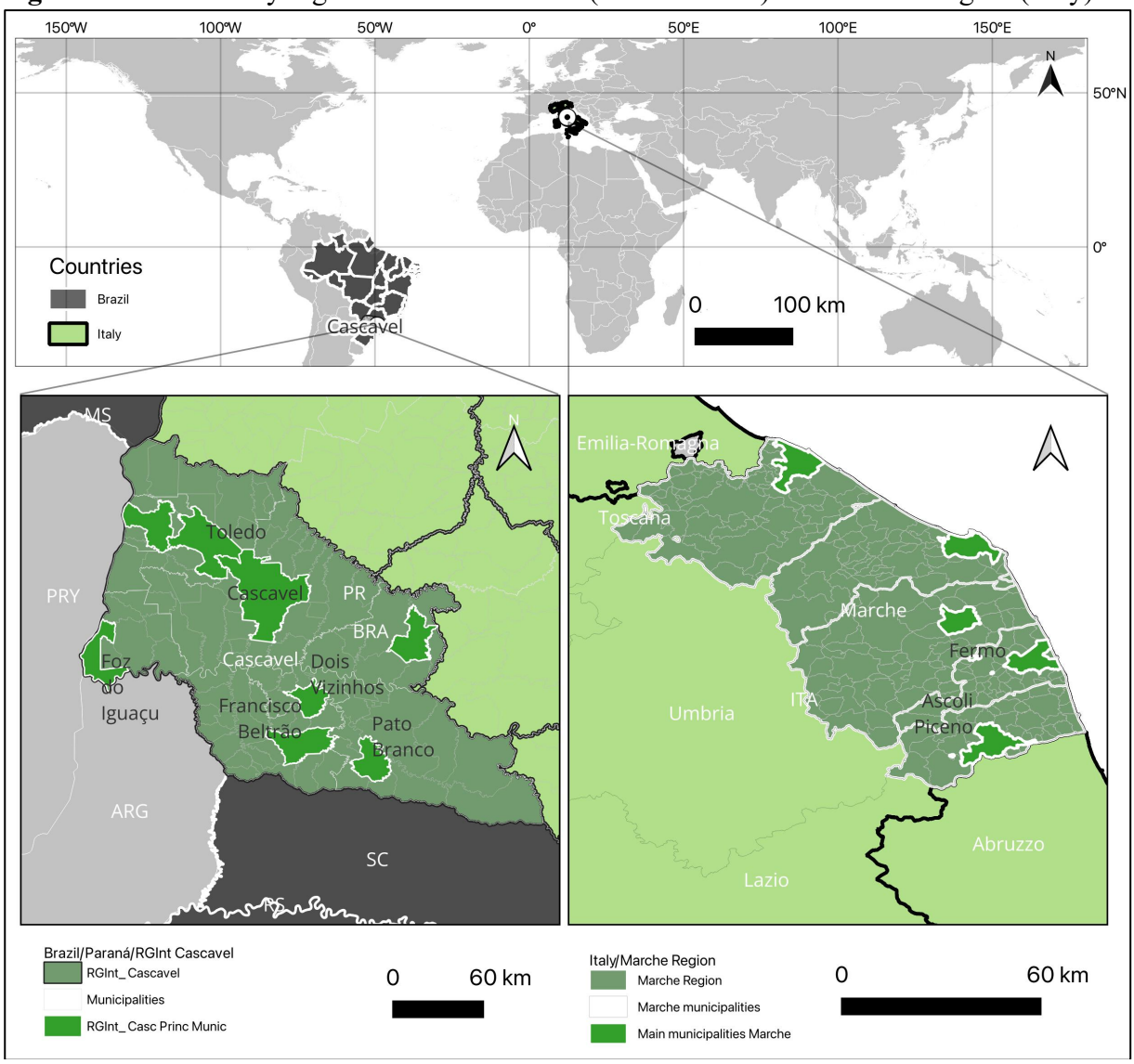
This means that context and processes play an important role as it shapes stakeholders' strategies and decisions towards this end. Given the importance of contextual understandings, the approach used will be qualitative to analyze the events, elements and the meaning of such phenomena, unfolding the social processes related to them (Bardin, 2011; Creswell, 2009).

The research method (design or purpose) adopted is in-depth case studies with interviews and field visits. For Yin (2018), the case study is an empirical investigation that researches a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. Also, the author argues that case studies can be used in empirical research whose problems are of the "how" and "why" type and which seek to investigate a contemporary phenomenon within its context.

4.3.2 Cases study

A comprehensive understanding of a real context setting will be provided by investigating and comparing different realities within the regional agri-food industries through a multiple case study approach (Chiaraluce; Bentivoglio; Finco, 2023), focusing on a portion of Paraná, Brazil and Marche Region, Italy (Figure 22).

Figure 22 – Case study regions: RGInt Cascavel (Paraná/Brazil) and Marche Region (Italy)



Source: own design (2025).

Both regions can be regarded as representative of robust agri-food sectors, significantly contributing to the productive structures of their respective countries. Paraná is one of Brazil's most important agricultural poles, where a wide range of production systems can be found, from small-scale farming to highly industrialized, with an increased interest in sustainable approaches (Shikida; Galante; Cattelan, 2020). Similarly, Marche is one of the most important Italian agricultural regions, boasting a long tradition in food production combined with a strong commitment to sustainable development (Chiaraluce, 2024).

The productive structure of a region represents the result of its productive choices over time (Alves, 2022a). Analyzing the underlying productive structures is essential for determining the local production system, elucidating its development trajectory, assessing industrial capacity and brand presence, understanding the distribution of income and employment, and

fostering the creative and efficient use of local resources and production factors (both tangible and intangible). Such analysis also supports the promotion of local development, the attraction of economic activity, the improvement of living standards, and the advancement of regional development.

To illustrate regional dynamics and specializations, data on the number of formal establishments were analyzed, with sectoral classifications based on the **Groups** from the statistical classification of economic activities – CNAE 2.0 in Brazil and the NACE Rev. 2 for Italy. Both the CNAE and NACE classifications follow a hierarchical structure: the first level is organized by alphabetical codes (sections), the second by two-digit numerical codes (divisions), the third by three-digit numerical codes (**groups**), and the fourth by four-digit numerical codes (classes). See Frame 5.

Frame 5 – Groups analyzed from CNAE 2.0 (Brazil) and NACE Rev. 2 (Italy)

Brazil		Italy	
C	Indústrias de transformação	C	Manufacturing
10	Fabricação de produtos alimentícios	10	Manufacture of food products
10.1	Abate e fabricação de produtos de carne	10.1	Processing and preserving of meat and production of meat products
10.2	Preservação do pescado e fabricação de produtos do pescado	10.2	Processing and preserving of fish, crustaceans and molluscs
10.3	Fabricação de conservas de frutas, legumes e outros vegetais	10.3	Processing and preserving of fruit and vegetables
10.4	Fabricação de óleos e gorduras vegetais e animais	10.4	Manufacture of vegetable and animal oils and fats
10.5	Laticínios	10.5	Manufacture of dairy products
10.6	Moagem, fabricação de produtos amiláceos e de alimentos para animais	10.6	Manufacture of grain mill products, starches and starch products
10.7	Fabricação e refino de açúcar	10.7	Manufacture of bakery and farinaceous products
10.8	Torrefação e moagem de café	10.8	Manufacture of other food products
10.9	Fabricação de outros produtos alimentícios	10.9	Manufacture of prepared animal feeds
11	Fabricação De Bebidas	11	Manufacture of beverages
		11.01	Distilling, rectifying and blending of spirits
		11.02	Manufacture of wine from grape
11.1	Fabricação de bebidas alcoólicas	11.03	Manufacture of cider and other fruit wines
		11.04	Manufacture of other non-distilled fermented beverages
		11.05	Manufacture of beer
		11.06	**Manufacture of malt**
11.2	**Fabricação de bebidas não-alcoólicas**	**11.07**	**Manufacture of soft drinks; production of mineral waters and other bottled waters**

Source: Own Design (2025) from (CCIAA, 2025; RAIS, 2025).

The Locational Quotient (QL), a measure used to assess regional specialization, helps identify concentrations and structural differences in production. In this study, QL calculations were applied to the food and beverage manufacturing sector (CNAE 2.0 divisions C10 and C11) using data (number of manufacturing) from 2009 and 2023 (see appendix C).

In Marche Region, Italy served as the reference geography, revealing 1,664

establishments. In contrast, in the same year of 2023, Paraná State reported 5,852 establishments in the same divisions, with specializations in meat processing, dairy manufacturing, and grain milling.

Although Paraná State is geographically larger and hosts a greater number of establishments than Marche, the comparison becomes more meaningful when focusing on a specific intermediate geographic region. For this reason, the RGint of Cascavel, located in the western part of Paraná State, which alone accounts for 1,189 establishments in the manufacture of food products and beverages, is taken as the reference point for comparison with Marche.

For Paraná, the QL was calculated at the level of its Intermediate Geographic Regions, using the state of Paraná as the reference area. For Marche Region, Italy was considered the reference area. This approach allows for a consistent comparison of intra-regional specialization in Paraná and inter-regional specialization in Marche, relative to their broader territorial contexts.

4.3.3 Data collection[12]

A key criterion of scientific rigor in qualitative research is data triangulation, which enhances validity and reliability by combining multiple sources and collection techniques (Creswell, 2009). In this study, triangulation is ensured using both primary and secondary data. A mixed-method approach, incorporating a survey and subsequent in-depth case studies with interviews and field visits, were employed. Utilizing mixed methods enables us to align the research strategy more closely with the study's objectives and the sample's characteristics. Conducting interviews after the survey allows for a more in-depth exploration of the topic, providing an opportunity to seek clarifications when survey responses are ambiguous (Scandurra *et al.*, 2024).

The main data collection techniques used were primary data: direct observations with the possibility to contextually ask additional question to interviewees; field notes collected during the conduction of the semi structured interviews and questionnaire. The interviews were semi-structured, given the importance of a certain flexibility for this type of instrument (Creswell, 2009).

According to Gil (2008), the semi-structured interview is a data collection method that

[12] Ethics committee approval and informed consent obtained: Certificate of Submission for Ethical Appraisal (CAAE/Plataforma Brasil) N. 85558124.5.0000.0107 (Report number: 7.417.037).

combines pre-formulated questions with the flexibility to explore new topics as they arise during the conversation. In this type of interview, the researcher has a basic script of questions but is free to adapt the order and formulate additional questions, allowing for a deeper exploration of relevant themes that may emerge spontaneously. This format seeks to balance structure and spontaneity, facilitating the collection of detailed information and promoting a richer understanding of the subject of study.

Whenever possible, interviews were conducted face-to-face; otherwise, online meetings were arranged. The questionnaire, comprising 26 questions, was developed based on prior research and is structured into three sections. The first section gathers general information about the company. The second section employs a qualitative approach to explore aspects of the circular economy, analyze Circular Economy Business Models (CEBM), and examine regional development. The third section utilizes a survey strategy to assess circular economy factors, including barriers, opportunities, services, and adoption (see Frame 6).

Frame 6 – Empirical validation protocol (Appendix B)

#	Section	Data collection	Question	Based on
1	A) General company information	Survey	1) Name of the company 2) Location 3) Year of foundation 4) Productive sector (ATECO/Partita IVA/Italy or CNPJ/CNAE code/Brazil) 5) Contacts (phone/e-mail) 6) Interviewee 7) Legal form of the company 8) Number of employees 9) Main products of the company	(Chiaraluce, 2024)
2	B) Circular economy	Interviews; direct observations; field notes	10) What is your definition of circular economy? (The first word to come to your mind to describe circular economy) 11) Do you think CE adoption is important for you company? 12) Which practices did you adopt towards circularity? 13) Do you measure circular performance? How?	(Kirchherr *et al.*, 2023; Potting *et al.*, 2017; WBCSD, 2023)
	C) Analysis of selected business model	Interviews; direct observations; field notes	14) Can you describe your production model? 15) Have there been any changes or adaptations to your business model influenced by circular economy practices? 16) If so, were these changes drive by regulatory requirements, and market demands (such as buyer requirements), or were they independently by the company? 17) Have you observed any financial or operational impacts (positive or negative) resulting from these changes? 18) Has your company invested in or developed any innovations because of adopting circular economy principles? 19) Have the implemented processes contributed to reducing costs? If so, by approximately what percentage? 20) Have these changes brought added value to the company?	(Kirchherr *et al.*, 2023; Potting *et al.*, 2017; WBCSD, 2023)
	D) Regional development	Interviews; direct observations; field notes	21) Do you think your company's circular economy practices contribute to regional development? How? 22) How could public administration contribute to implementing circular economy practices in your company?	(Alves, 2022b; Ferrera de Lima, 2024)
3	E) Circular Economy: barriers, opportunities, services and adoption[1]	Survey	23) Please indicate how much you agree / disagree on a scale from 1 to 5 with the following statements (CE barriers) 24) Please indicate how much you agree / disagree on a scale from 1 to 5 with the following statements (CE opportunities) 25) How important is it (CE services) on a scale from 1 to 5 the following services for the implementation of a circular model? 26) Please, indicate how much you agree / disagree on a scale from 1 to 5 with the following statements (CE adoption)	(Cagno *et al.*, 2023; Chiaraluce, 2024)

Source: own design (2024).

Note[1]: please, see the Appendix B to see the whole empirical validation protocol.

Part two employed data collection methods such as interviews, direct observations, and field notes. In contrast, parts one and three involved a self-administered online survey, developed using Microsoft Forms, as the primary method for empirical analysis. See Frame 7.

Frame 7 – Interviews conducted over the research (n. 7)

Code	Country	Date	Agri-food Industry	Position	Format	Length			
						Interview	Survey	Visiting	Transcribed Pages
2	Italy	21/11/2024	Meat and production of meat products	Research and Development Manager	In-person	00:35:27	00:29:40	01:13:00	8
4	Italy	26/11/2024	Manufacture of grain mill products	President and member	In-person	01:04:32	00:23:24	00:30:00	12
6	Italy	29/11/2024	Processing and preserving of fish	Quality Control team	In-person	01:00:52	00:25:28	01:15:01	14
7	Italy	29/11/2024		CEO	In-person	01:02:07			10
8	Brazil	12/05/2025	Meat and production of meat products	President and member; and Accountant	In-person	00:41:45	00:21:15	00:00:00	8
9	Brazil	15/05/2025	Meat and production of meat products	Research, development and innovation manager; and Environmental analyst team	Google Meet	00:23:55	00:19:13	00:00:00	6
12	Brazil	12/06/2025	Processing and preserving of fish	Environmental analyst and ESG Analyst	Microsoft Teams	00:33:22	00:13:38	00:00:00	7
Total						**05:22:00**	**1:51:23**	**02:58:01**	**65**

Source: own design (2025).

Language: English Language: Italian Language: Portuguese

And secondary materials: firm website (general firm information, firm attention to CE, sustainability report, description of products and technologies); online newspapers (news related to the firm, especially referred to circular economy and activities within the region as sustainability); national database (economic reports and balance sheets) (CCIAA, 2025; RAIS, 2025). The period of analysis for the number of establishments spanned 2009 and 2023, capturing long-term trends and structural changes in the sector.

Based on the design of the research strategies outlined, Frame 8 presents how the general and specific objectives of this study is addressed through the data collection procedures.

Frame 8 – Research objectives and data collection matching

General Objective (GO) And Specific Objectives (SO)	Type Of Data Source	Data Collection Procedure	Criteria inclusive	Outcomes
GO: to investigate the ways in which circular economy practices transform agri-food business models and contribute to regional development, comparing experiences from Italy and Brazil	1. Primary sources (to a high extent) 2. Secondary sources (to a less extent)	1. Interviews with entrepreneurs and agri-food firms 2. Documentary research and analysis	1. Willing to be an informant for research purposes 2. Belong to different supply chains from the Region's agri-food sector 3. Produce by-products with a potential circular use 4. Profitable business able to support investment for the circular transition	- Guide practical decisions - Inform policies and strategies - Contribute to the advancement of academic and practical knowledge in the field of circular economy
SO1: To diagnose the regional specialization of the agri-food industry	1. Secondary sources (only)	1. RAIS and CCIAA database		- Empirical evidence on regional specialization
SO2: To investigate the influence of the circular economy on the architecture of existing business models in agri-food industries	1. Primary sources (to a high extent) 2. Secondary sources (to a less extent)	1. Interviews with entrepreneurs and agri-food firms 2. On-site observations and notes 3. Documentary research and analysis		- Sector diagnosis to assess circularity - Findings related to the research question and addressed by a list of propositions
SO3: To assess the potential of circular models in fostering regional development in two distinct cross-national agri-food regions	1. Primary sources (to a high extent)	1. Interviews with stakeholders 2. On-site observations and notes 3. Documentary research and analysis		- Interviews with stakeholders - Development of guidelines for practical recommendation

Source: own design (2025).

As can be seen in Frame 8, the selection of interviewees for this study was contingent upon several criteria, including the eligibility of the businesses, their willingness to participate, and their relevance to the research focus on the circular economy within the agri-food sector.

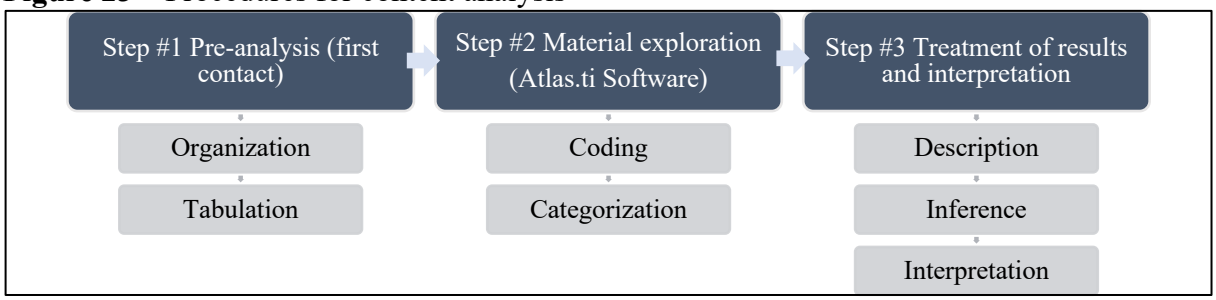
The research employs an intentional non-probabilistic sampling method, also known as purposive sampling. This approach was chosen because we deliberately selected participants who could provide specific insights into the phenomenon under study, rather than aiming for statistical representativeness of the general population. While non-probabilistic, the final number of participants (elements) was carefully determined to ensure sufficient depth and coverage of the target research population

4.3.4 Data analysis

The Locational Quotient (QL)[13] was employed to assess regional specialization in the food and beverage manufacturing sector (CNAE 2.0 divisions C10 and C11) in Paraná, Brazil, and Marche Region, Italy. QL measures the relative concentration of a specific industry within a region relative to a larger reference area, indicating whether the region is specialized in that sector. Values greater than 1 signal a higher relative concentration than the reference, suggesting regional specialization, whereas values below 1 indicate underrepresentation. For the calculation, data on the number of establishments in each subsector were collected for the target region (e.g., the RGint of Cascavel) and for the reference area (e.g., Paraná State), along with the total number of establishments across all sectors in both areas. This allowed identification of subsectors with higher local significance and facilitated comparison between regions with different sizes and economic structures.

Also content analysis was employed as data analysis methodology. For Bardin (2011), content analysis must follow three stages: pre-analysis (1), exploration of the material (2) and treatment and interpretation of results (3). Figure 23 summarizes the three steps for content analysis suggested by the author.

Figure 23 – Procedures for content analysis



Source: elaborated by the author (2025) based on Bardin (2011).

Coding was carried out using both deductive and inductive approaches. Deductive coding involved applying an existing theoretical framework or prior research findings to the data, while inductive coding aimed to extract meaning and generate insights directly from the qualitative data itself. The combined use of these approaches enabled a more comprehensive analysis by integrating established theoretical perspectives with the identification of emergent and less familiar dimensions of the phenomenon under investigation (see Frame 9).

[13] See Alves (2022a) for the calculation details.

Frame 9 – Coding framework

Category	Codes	Brazil	Italy	Dialogue
Circular Economy	○ CE_Barriers	17	22	Inductive
	○ CE_Definition	9	20	Inductive
	● CE_R0 Refuse	3	3	Deductive
	● CE_R1 Rethink / Redesign	15	13	Deductive
	● CE_R2 Reduce	3	1	Deductive
	● CE_R3 Reuse	10	15	Deductive
	● CE_R4 Repair	1	1	Deductive
	● CE_R5 Refurbish	0	1	Deductive
	● CE_R6 Remanufacture	4	9	Deductive
	● CE_R7 Repurpose	10	9	Deductive
	● CE_R8 Recycle / Upcycle	5	7	Deductive
	● CE_R9 Recover	11	2	Deductive
Regional Development	● RD_Application of knowledge	13	18	Deductive
	● RD_Commercial capability	12	25	Deductive
	● RD_Endogenous actions	16	23	Deductive
	● RD_Exogenous public policies	15	9	Deductive
	● RD_Opposing public administration	8	4	Deductive
	● RD_Sense of local belonging	18	11	Deductive
	● RD_Social capital	18	8	Deductive
	● RD_Supportive public administration	7	5	Deductive

Source: own design (2025).

Given that coding is a key activity (Bardin, 2011), the qualitative data analysis software ATLAS.ti (version 25) was chosen to support this process. The use of the software allows, among other factors, greater robustness to research analyses, makes it possible to find non-evident patterns and greater reliability in qualitative research (Saldaña, 2016).

The research methodology used is recommended by the utility proven in similar studies, including (Cagno *et al.*, 2023; Chiaraluce, 2024). While the sample is limited in number, this qualitative methodology is optimized to extract rich, detailed data necessary for analysis, prioritizing depth of insight over broad statistical generalization.

4.4 Results

The results are organized following the conceptual structure outlined above and are presented in three subsections: the regional agri-food industry and the case study descriptions; the influence of the circular economy on agri-food business model architecture; and the contribution of circular models to regional development.

4.4.1 Regional agri-food specialization and case studies description

Intermediate Geographic Region of Cascavel (Paraná State, Brazil)

In the Intermediate Geographic Region (RGInt) of Cascavel, between 2009 and 2023, the number of firms in the manufacture of food products and beverages grew from 741 to 1.189, an increase of 60%. In Paraná State, this number increased from 3.429 to 5.852, representing a 70% growth. Although RGInt of Cascavel's absolute growth was slightly below the state average, the location quotient (QL) in 2023 indicates that the region's share in this sector remains proportional to the state's structure.

That is, RGInt Cascavel holds a balanced representation of the food and beverage manufacturing sector when compared to Paraná's industrial landscape. However, disaggregated data reveal internal asymmetries: some subsectors show strong regional specialization (e.g., fish processing, meat processing, dairy), while others (e.g., fruit/vegetable processing, coffee roasting) are underrepresented. Nevertheless, in aggregate terms, Cascavel continues to mirror the broader trends of Paraná's agri-food industrial base, maintaining its relative weight within the state's productive structure (see Frame 10).

Frame 10 – RGInt Cascavel: Stock of Active Companies (31/12 – 2009/2023)

Manufacture of food products and beverages		**RGInt Cascavel (reference region: Paraná)**					Paraná State (reference region: Brazil)				
		2009	2023	Evolution 2009/2023	QL 2009	QL 2023	2009	2023	Evolution 2009/2023	QL 2009	QL 2023
10.1	Meat process	118	177	50%	**1,41**	**1,55**	388	562	44%	**1,14**	**1,37**
10.2	Fish process	8	23	187%	**2,18**	**3,23**	17	35	105%	0,54	0,60
10.3	Fruit/veg proc	16	18	12%	0,77	0,51	96	175	82%	0,64	0,68
10.4	Oils & fats	16	13	-18%	**1,54**	**1,33**	48	48	0%	**1,04**	**1,18**
10.5	Dairy manuf	158	153	-3%	**1,32**	**1,48**	555	510	-8%	0,97	0,96
10.6	Animal feeds	163	172	5%	**1,08**	**1,22**	700	696	-0,57%	**1,62**	**1,59**
10.7	Sugar factory	2	2	0%	0,42	0,38	22	26	18%	0,63	0,85
10.8	Coffee roast.	13	6	-53%	0,5	0,33	120	89	-25%	**1,15**	0,93
10.9	Other food	229	570	148%	0,78	0,81	1367	3458	152%	0,90	0,95
11.1	Spirits drinks	11	43	290%	0,88	**1,13**	58	187	222%	0,49	0,90
11.2	Soft drinks	7	12	71%	0,56	0,89	58	66	13%	0,65	0,53
Total		741	1189	60%	1	1	3429	5852	70%	1	1

Source: own design (2025).

The evolution of Cascavel's food and beverage manufacturing industry between 2009 and 2023 (Frame 10) reveals a clear regional specialization pattern focused on animal-based

sectors. Meat processing, the largest subsector, grew from 118 to 177 establishments (+50%), with its QL increasing from 1,41 to 1,55, indicating a concentration above the Paraná State average (QL 1,37 in the state). Dairy manufacturing, although slightly declining in absolute numbers (158 to 153 establishments, -3%), strengthened its relative specialization (QL 1,32 to 1,48), contrasting with Paraná, where the subsector shows a slight underrepresentation (QL 0,97 to 0,96). Fish processing experienced the most dramatic relative growth in Cascavel (+187%) and reached a very high QL of 3,23, far exceeding the state average (QL 0,60), highlighting Cascavel as a clear hub for this emerging subsector.

In contrast, fruit and vegetable processing and coffee roasting remained limited in both growth and specialization. Cascavel's QL for fruit and vegetable processing decreased from 0,77 to 0,51, while coffee roasting fell sharply from 0,50 to 0,33, suggesting persistent structural constraints or strategic disinterest. In Paraná, these subsectors remain underrepresented but with higher QLs (fruit/vegetable: 0,64 to 0,68; coffee: 1,15 to 0,93), indicating slightly stronger state-level relevance than in Cascavel.

Other subsectors show varied trajectories: oils and fats declined in Cascavel (-18%, QL 1,54 to 1,33), whereas animal feeds grew modestly (+5%, QL 1,08 to 1,22), both maintaining QLs above 1 and highlighting continued regional specialization. The sugar and soft drinks sectors remain minor, with QLs below 1, although soft drinks show some growth in Cascavel (QL 0,56 to 0,89). Notably, the spirits subsector emerged as a high-growth niche (+290%, QL 0,88 to 1,13), while Paraná shows a similar upward trend but with lower relative concentration (QL 0,49 to 0,90), signaling Cascavel's potential advantage in value-added diversification.

Marche Region (Italy)

Between 2009 and 2023, the number of firms in the food and beverage manufacturing sector in the Marche Region decreased slightly, from 1,697 to 1,664, a drop of 2%. At the national level, the total number of firms remained practically stable, decreasing marginally from 59.185 to 59.154. Within this general balance, specific structural patterns emerge. The region exhibits strong specialization in fish processing, animal feeds, grain mill, meat processing (see Frame 11).

Frame 11 – Marche Region: Stock of Active Companies (31/12 – 2009/2023)

Manufacture of food products and beverages		Marche Region (reference region: Italy)					Italy		
		2009	2023	Evolution 2009/2023	QL 2009	QL 2023	2009	2023	Evolution 2009/2023
10.1	Meat process	206	156	-24%	**1,40**	**1,31**	5134	4234	-18%
10.2	Fish process	50	41	-18%	**2,77**	**2,32**	630	628	0%
10.3	Fruit/veg proc	39	41	5%	0,55	0,62	2469	2341	-5%
10.4	Oils & fats	114	91	-20%	0,87	0,92	4566	3503	-23%
10.5	Dairy manuf	24	35	46%	0,23	0,34	3677	3673	0%
10.6	Grain mill	69	44	-36%	**1,49**	**1,35**	1612	1161	-28%
10.7	Bakery manuf	1025	976	-5%	**1,04**	**1,00**	34523	34677	0%
10.8	Other food	71	148	108%	0,89	**1,15**	2787	4569	64%
10.9	Animal feeds	30	28	-7%	**1,69**	**1,72**	619	579	-6%
11.1 - 11.5	Spirits distill	60	94	57%	0,76	0,96	2750	3484	27%
11.6 - 11.7	Soft drinks	9	10	11%	0,75	**1,17**	418	305	-27%
	Total	1697	1664	-2%	1,00	1,00	59185	59154	0%

Source: own design (2025).

On the other hand, sectors like dairy manufacturing (QL = 0,34) and fruit/vegetable processing (QL = 0,62) remain significantly underrepresented compared to the national average (Italy). Notably, 'Other food products' showed impressive growth (+108%) in Marche, accompanied by a high QL (1,15), pointing to a diversification dynamic. That is, while the overall number of firms in Marche slightly declined, the region continues to show regional specialization in select sub-sectors of food manufacturing, reflecting enduring structural advantages and emerging areas of growth.

Other sectors display contrasting trends. Fruit and vegetable processing and oils & fats remain underrepresented (QL < 1) despite minor absolute changes, while grain milling shows a marked decline (-36%, QL 1,49 to 1,35), suggesting a weakening of traditional processing activities. Bakery manufacturing remains stable in both absolute numbers and relative concentration (QL 1,04 to 1,00), indicating that it continues to be a core but non-dominant sector. Other food products show notable expansion (+108%, QL 0,89 to 1,15), emerging as a new area of regional specialization. Animal feeds maintain high QLs (1,69 to 1,72), signaling continued relative importance. Among beverages, spirits distillation and soft drinks exhibit strong growth and increasing QLs (spirits: 0,76 to 0,96; soft drinks: 0,75 to 1,17), highlighting diversification toward higher-value segments

In short, in 2009, both regions had five subsectors with QL values above 1, indicating comparable initial levels of specialization. By 2023, Marche increased to seven specialized

subsectors, while Cascavel reached six, suggesting that both regions experienced diversification in their industrial profiles. The average QL values show a convergence over time, with Marche increasing slightly from 1,13 to 1,17 and Cascavel rising more markedly from 1,04 to 1,17, reflecting a growing relative concentration in both regions.

However, measures of dispersion reveal contrasting dynamics: Marche's standard deviation and coefficient of variation decreased over time (0,69 to 0,53 and 0,61 to 0,45), indicating a more balanced distribution across subsectors, whereas Cascavel's dispersion increased (0,53 to 0,81 and 0,51 to 0,69), highlighting growing heterogeneity and the emergence of strongly specialized subsectors within the regional industrial structure. To see a summary of descriptive statistics, please access the Appendix C.

Description of the case studies and its business model

Founded in 1993 and located in the Marche region of Italy, this family-run business is a limited liability company (LLC or *società a responsabilità limitata* – SRL in Italian) and employs 17 people. It specializes in the artisanal production of cured meats. Rooted in local traditions, the company prioritizes quality by using only selected pork sourced from controlled regional farms ("Only Italian pigs, born and raised in Italy"), combined with carefully chosen spices. Emphasizing manual processing, the production includes hand-stuffing, natural casing use, and artisanal binding with jute twine. This traditional approach ensures products with distinctive aromas, flavors, and authenticity, reflecting the cultural heritage and craftsmanship of the Marche region (Italian Firm, 2).

Established in 1947 in the Marche region of Italy, this agricultural cooperative brings together more than 400 members and employs approximately 160 people. Its main products include soft wheat, durum wheat, pasta, and bread. The cooperative's modern structure began to take shape in the 1970s, when a group of farmers-initiated efforts to collectively address rising bread prices by managing the entire value chain – from wheat cultivation to bread production. In addition to producing baked goods, the cooperative also oversees the joint management of agricultural and forestry land, reflecting its commitment to both food security and sustainable land use. The organization operates through a democratic structure, with corporate officers appointed by member consensus (Italian Firm, 4).

Founded in 1970 and located in the Marche region of Italy, this individually owned company (Erede) operates with a vertically integrated model in the seafood and agricultural sectors. Specializing primarily in trout production, the company manages the entire supply chain internally – from the reproduction of eggs and breeding to processing and packaging –

ensuring full control and traceability throughout all production phases. With a workforce of 40 employees, the business reflects a longstanding philosophy centered on a closed-cycle, high-quality production approach (Italian Firm, 6 and 7).

Founded in 1997 and headquartered in RGInt of Cascavel, Paraná, Brazil, this cooperative brings together more than 10.900 members and employs 1.245 people. Initially focused on representing the swine and dairy sectors in Toledo and surrounding areas, the cooperative has since diversified its operations to include feed production, grain reception, livestock, the food industry, and a broad retail network encompassing supermarkets, restaurants, pharmacies, and gas stations. With 46 operational units across more than 340 municipalities, the cooperative ensures proximity and quality service to its members, promoting efficient and sustainable food production across the region (Brazilian Firm, 8).

Established in 1977 and located in RGInt of Cascavel, Paraná, Brazil, this central cooperative is composed of five member cooperatives and employs over 12.500 people. Specializing in processed and frozen food products and by-products, the cooperative operates a vertically integrated production model aimed at ensuring sustainability and long-term value. All stages of the commodity production chain are carefully monitored, with a structured approach to purchasing, balancing operations, and regulating the distribution of results. Its mission is to generate consistent returns for affiliated cooperatives, member producers, employees, customers, and consumers, reinforcing its commitment to a sustainable and inclusive agri-food system (Brazilian Firm, 9).

Founded in 1963 and based in RGInt of Cascavel, Paraná, Brazil, this cooperative has over 28.200 members and employs more than 15.000 people. It specializes in tilapia-based products, including fillets, steaks, snacks, whole fish, and gutted options. Operating under a fully integrated production model, the cooperative controls every stage of the supply chain – from seed production to final product delivery. A robust traceability system ensures that all processes are monitored, allowing full access to information on any product batch, thus guaranteeing food safety, transparency, and quality for consumers (Brazilian Firm, 12).

To better understand the organizational profiles under study, Frame 12 provides a comparative description of the case studies. It outlines key features such as ownership structure, scale of operations, and product focus, thereby illustrating the diversity between Italian firms and Brazilian cooperatives within the agri-food sector.

Frame 12 – Description of the case studies

#	Legal form	Location	Foundation year	Number of employees	Main products
2	Individual (familiar *SRL*)	Marche / Italy	1993	17	Ciauscolo PGI, salami without lard, loin, pancetta, guanciale, lonzini, sausages
4	Cooperative (more than 400 members)	Marche / Italy	1947	160	Soft wheat, durum wheat, pasta, bread
6/7	Individual (*Erede*)	Marche / Italy	1970	40	Seafood (trout) and agricultural products
8	Cooperative (more than 10.900 members)	RGInt Cascavel / Paraná / Brazil	1997	1245	Agricultural, food industry, livestock and retail
9	Central cooperative (five cooperatives' RGInt Cascavel / Paraná / Brazil members)	RGInt Cascavel / Paraná / Brazil	1977	12504	Processed, frozen food products and by-products
12	Cooperative (more than 28.200 members)	RGInt Cascavel / Paraná / Brazil	1963	15018	Tilapia Fillet, Steak, Snack, Whole Fish, Gutted

Source: own design (2025).

These contrasting patterns underscore how regional agri-food systems evolve in response to their structural endowments and market opportunities, illustrating that regional specialization is neither static nor uniform but shaped by the interplay between resource availability, historical trajectories, and adaptive strategies to remain competitive in a changing global agri-food landscape.

4.4.2 Analysis of the influence of circular economy on agri-food business model architecture

To investigate the influence of the circular economy on the architecture of existing business models in agri-food industries, the interviewees' understanding of circular economy plays a central role. In this sense, analyzing how they define and interpret circularity is essential to identify which principles are embedded in their business practices and strategic decisions. To support this analysis, the definitions provided by the interviewees were collected and examined, offering insights into the conceptual basis that underpins their approach to circular business models.

The Figure 24 represents a word cloud of the most frequently mentioned terms in the definitions of CE provided by the interviewees. The size of each word corresponds to its frequency, indicating which concepts were most salient in their understanding of CE.

Figure 24 – Most recurring words in the CE definitions given by the interviewees

Source: own design (2025).

Central terms such as “waste”, “by-products”, “reuse”, and “biogas” suggest that interviewees primarily associate circular economy with strategies aimed at reducing waste and recovering value from residual materials. Other recurring terms, including “sustainability”, “recovery”, “renewable”, and “traceability”, reflect an awareness of environmental benefits, resource optimization, and governance aspects. Overall, the word cloud highlights that the interviewees conceptualize CE as a framework that integrates waste management, resource efficiency, and sustainable practices within production and consumption systems.

The following Frame (Frame 13) deepens the analysis by examining how value is generated and sustained in practice. Specifically, it maps the processes of value creation (proposition), delivery (supply chain), and capture (customer relationships), thus illustrating the distinct strategies adopted across the Italian and Brazilian cases.

Frame 13 – How value is: created, delivered and captured

#	How value is…		
	Created (Value proposition)	Delivered (Supply chain)	Captured (Customer)
2	"Our Salumificio produces the Ciauscolo PGI typical of the Marche region, using artisanal techniques passed down from generation to generation!"	Wholesalers, distributors, restaurants, shops, grocery stores	"From our traditions, the finest pork and the most fragrant spices, all our cured meats are born, distinguished by their typical flavors"
4	"there's a social return, that is, cooperative, means walking together".	Directly manages two sales outlets and sells some of its products through large-scale retail outlets	Provides agricultural equipment to its members and manages the agricultural land Its main activity is in the agri-food sector, where it produces, processes, and markets its own agricultural products and those of its members
6/7	"The company is aware that, today, the "certification" of its activity is a necessary condition, not only for an effective commercial strategy, but for the research of a "sustainable quality" in full respect of the environment and final consumer"	Large-scale retail trade and wholesalers	The certifications available are a voluntary choice of the company that chooses to establish, implement, maintain and improve its business management system to continue to provide its customers with a "healthy and safe" product, the rainbow trout
8	seeks a balance between financial success and positive impact on the environment, society and governance	Direct, indirect and hybrid	Producing healthy food for people with cooperation, innovation, and sustainability, guaranteeing income for members and employees.
9	Provide valuable food for people	The company utilizes a distribution network that includes sales branches and distribution centers in several Brazilian states, as well as representatives in major capital cities	Continuously develop in a sustainable manner, creating value for the stakeholders involved
12	Produce food through continuous improvement, aiming to reduce and/or optimize the use of natural resources, promote economic, social and environmental development, preserve the integrity of communities for future generations, comply with legal requirements and improve socio-environmental performance	Direct / Distributor / Indirect / Reseller	Meet the expectations of our members, suppliers, customers, consumers, employees and community, through a safe, legal and authentic system, promoting a culture of food safety and quality and the continuous improvement of people, processes and products

Source: own design (2025).

As we can see on Frame 13, Italian firms emphasize tradition, certification, and artisanal quality as central to their value proposition, relying on wholesalers, restaurants, and retail outlets to reach consumers. In contrast, Brazilian cooperatives adopt broader and more structured supply chains, combining direct, indirect, and hybrid channels, while focusing on sustainability, food safety, and stakeholder inclusion.

Particularly noteworthy is the case of Brazilian Firm 8, which emphasizes the role of a biogas plant located in Western Paraná. This facility converts pig waste produced on local farms into renewable energy, which is subsequently utilized either as fuel for transport vehicles or to offset electricity consumption among cooperative members. The interviewee (Brazilian Firm 8) demonstrated a clear and consistent understanding of this process, which aligns with the empirical evidence collected.

> We take organic minerals from swine manure, poultry litter, and cattle waste, which then go into corn and soybean cultivation. These crops are processed into animal feed, turned into protein, sent to slaughterhouses, and then we start the cycle again – biogas, organominerals, biomethane – it all starts over.
>
> and we have bills to pay. So I see it like this: diversification – and it's not easy. We keep challenging ourselves, then you look at the bottom line and I say, "My God, [the company] had a turnover of 150 million last month – in one month." But how much is left? What's the final line?
>
> Yeah, but [name of the interviewee], there's a market that demands this!" – I disagree! I think we have a beautiful story, a kind of poetry – but very few people want to buy it. So you get there and say, "Here's a green pig – it doesn't pollute, we treat it well." I don't see anyone paying more for that. There are very few markets in the world that actually put a price on this.
>
> We make use of everything: the liquid, the solid, the organomineral, the CO_2, biomethane, biogas, the trucks – which are new products, new negotiations. So making better use of each property… (Brazilian Firm, 8).

On the other hand, the other two Brazilian firms, show a different perspective on the matter: "all water reuse comes with a cost – there's some initial treatment involved. But the goal is to reduce the amount of water drawn from wells or from the public supply." (Brazilian Firm, 9). And as underlined by Brazilian Fish Process Industry (12):

> Thinking of an activity as a whole, the idea is to be able to close the loop, right? So when I extract raw material, to be able to use it in the best possible way – and then find either a proper destination or a new function for that product or for the action I'm taking.
>
> […] when we talk about circular economy here, actually, we don't really use the term "circular economy" much, because many by-products from one operation end up being used in another operation within the chain. So it's kind of normal for us, this kind of operation. Of course, there are residues from some processes that we can't use, but there are even reuse projects being worked on – the innovation team usually looks into that.
>
> We have a variety of processes within the company, so I think it all happened very naturally. (…) There wasn't really a moment when we said, "Oh, we're doing circular economy now." It was more like, "We're optimizing our processes, we're optimizing our resources," and all of that within our own operations.

Italian firms describe circularity as giving a "second life" to food waste, integrating sustainability into production processes, and ensuring that nothing is wasted:

> is like a system that you can adopt, for example, if you want to give a second life to a food waste, so is a way to reduce the amount of food waste in the world in general and also to, to try to improve, also for an industry, this economy, because you can create something new and is also connected with the sustainability. So we named environmental problem. (Italian Firm 2)

Others emphasize the role of member involvement and sustainable land management, or the creation of closed production cycles that maximize resource efficiency, such as water reuse or by-product transformation.

> means an economy that tries to involve. […] It's a beautiful vision because it's the most realistic one, because if we just stop at waste, we remain in the circular economy. […] what I mean by circularity, we have tried to involve the members in the management of their lands. For example, we managed in a decade to increase productivity and also the quality of wheat without the excessive use of fertilizers and pesticides. […] nothing should be wasted (Italian Firm 4)

> […] has succeeded in completing the 360 ° view of the entire production sector that has always been the basis of the company philosophy: all the production phases are carried out on their own, thus ensuring a complete cycle that starts with reproduction eggs, breeding, processing and packaging. […] Our facilities ensure the complete use and return of 100% of the water taken. There are no losses or waste, and we don't use water for other crops.
> the two things diverge a bit: the search for a healthier, more territorial, more zero-kilometer product, and industrial production lead to following paths that, perhaps, are a bit different. Trying to unite these two things, however, would not be bad, indeed. (Italian firm, 6)

> The poultry slaughterhouse waste is transformed – that's circular economy. […] It's a whole brand, a complete product cycle. (Italian Firm, 7).

Italian agri-food firms are increasingly adapting their business models in response to circular economy principles, driven by market pressures, regulatory requirements, and operational efficiency. Practices such as recyclable packaging, renewable energy integration, and reduced fertilizer use reflect efforts to improve sustainability, often motivated more by retailer demands than internal strategy.

> We are trying to use for example some package which is recyclable. We have done photovoltaic panels try to use the free energy to produce energy. But we have to do this not because it's our decision, because the price of the light increased a lot especially last year in and so we have to do this. We have a lot of machines, a lot of refrigerating cells that are that work all every day, all day. So we consume a lot of energy. (and these changes brought added value?) Yes. Of course, but for the consumer, no. [Italian Firm, 2]

> (…) we managed in a decade to increase productivity and also the quality of wheat without the excessive use of fertilizers and pesticides. We spent many hours explaining that it's not the fertilizer, especially here, we use a lot of nitrogen and urea. If you throw it down, especially with this climate here, when it rains, you find it in the water, and in the end, it all goes into the river [Italian Firm, 4]

> Today, largescale retail (GDO) demands it a lot, as it focuses heavily on sustainability. Now, the goal of all GDO is sustainability: circular economy, recyclable packaging,

> feed derived from waste rather than caught fish. This is the main focus. The relationship with the territory is important, but it is not the goal that the market demands at the moment. [Italian Firm, 6]

This highlights how circular economy adoption intersects with business model architecture, influencing value creation, resource use, and strategic orientation. In Brazilian agri-food industries, circular practices are often embedded in operational routines, reflecting a pragmatic approach to resource efficiency and regional development rather than explicit reference to the "circular economy":

> Sustainability has to do with the bottom line. This thing has to be profitable and stand on its own – otherwise, we're not going to have anyone else willing to be part of this circular economy flow tomorrow. [Brazilian Firm, 8]

> For instance, the biogas project has quantified savings. Do you remember how much that gas alone saved per month? It was something like 100.000 reais – just from the gas (used as a substitute). (…) Water, for example: with 5.000 m³ of water reused per day, that's water you no longer need to extract from nature – and that has a cost too, right? (…) We're trying to motivate the region to use more biogas and biomethane, whether for vehicles or energy generation. So these initiatives we implement end up supporting regional development in different ways. [Brazilian Firm, 9]

> Of course, there are residues from some processes that we can't use, but there are even reuse projects being worked on – the innovation team usually looks into that. But we don't use the term "circular economy" a lot because of the flexibility we have to place by-products from one process into another somewhere in the chain. [Brazilian Firm, 12]

Brazilian firms highlight initiatives such as biogas and biomethane production, water reuse, and by-product reintegration across processes, which generate measurable financial savings and support local development. Profitability emerges as a central consideration, as sustainable practices are only viable if they create tangible economic value. This context underscores the interplay between circular practices and business model architecture, emphasizing how economic, environmental, and regional objectives converge to shape operational and strategic decisions.

All the business models studied indicate how they contribute to sustainable solutions via their business activities and value propositions. These examples illustrate how circularity reshapes value propositions, supply chains, and customer relations, reinforcing sustainability as a structural component of business model design. These results highlight that while in Italy circular economy practices strengthen the embeddedness of traditional agri-food models, in Brazil they act as a catalyst for broader organizational transformation, positioning cooperatives as drivers of inclusive and sustainable regional development.

4.4.3 Analysis of the contribution of circular models to regional development

To respond to the third specific objective "to assess the potential of circular models in fostering regional development", Frame 14 presents the results of a qualitative content analysis conducted with agri-food companies in Brazil and Italy. The analysis is structured around key dimensions related to regional development (RD) and the circular economy (CE), based on coded interview. The data are categorized under seven RD-related codes and ten CE-related code, referring to the 9Rs of the circular economy (Refuse, Rethink, Reduce, Reuse, Repair, Refurbish, Remanufacture, Repurpose, Recycle, Recover).

Frame 14 – Regional development and CE 9R: categories and codes

Category	Code	Brazil	Brazil (%)	Italy	Italy (%)	Total	Total (%)
Circular Economy (CE) Adoption	● R0 Refuse	3	4,84%	3	4,92%	6	4,88%
	● R1 Rethink / Redesign	15	24,19%	13	21,31%	28	22,76%
	● R2 Reduce	3	4,84%	1	1,64%	4	3,25%
	● R3 Reuse	10	16,13%	15	24,59%	25	20,33%
	● R4 Repair	1	1,61%	1	1,64%	2	1,63%
	● R5 Refurbish	0	0,00%	1	1,64%	1	0,81%
	● R6 Remanufacture	4	6,45%	9	14,75%	13	10,57%
	● R7 Repurpose	10	16,13%	9	14,75%	19	15,45%
	● R8 Recycle / Upcycle	5	8,06%	7	11,48%	12	9,76%
	● R9 Recover	11	17,74%	2	3,28%	13	10,57%
	CE Total	62	100,00%	61	100,00%	123	100,00%
Regional Development (RD)	● Application of knowledge	13	14,13%	18	19,15%	31	16,67%
	● Commercial capability	12	13,04%	25	26,60%	37	19,89%
	● Endogenous actions	16	17,39%	23	24,47%	39	20,97%
	● Exogenous public policies	15	16,30%	9	9,57%	24	12,90%
	● Opposing public administration	8	53,33%	4	44,44%	12	6,45%
	● Supportive public administration	7	46,67%	5	55,56%	12	6,45%
	● Sense of local belonging	18	19,57%	11	11,70%	29	15,59%
	● Social capital	18	19,57%	8	8,51%	26	13,98%
	RD Total	92	100,00%	94	100,00%	115	100,00%

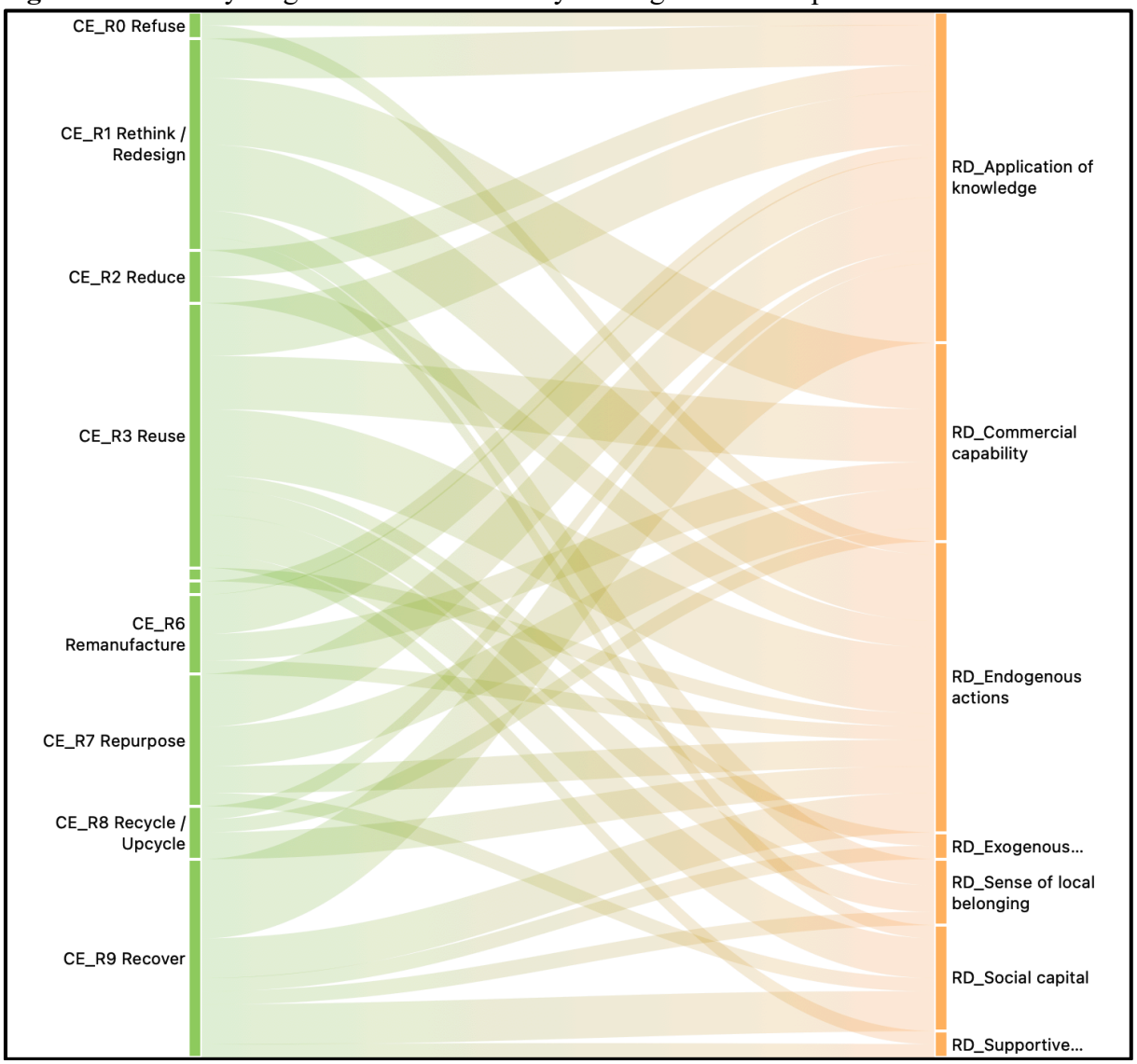
Source: own design (2025).

We can see (Frame 14) complementary patterns in how Brazil and Italy approach circular economy practices within the agri-food sector. In Brazil, circular practices such as reuse, repurposing, and recovery are closely linked to social capital, local belonging, and reliance on public policies, highlighting a socially embedded circularity that suggests a context where community and external support play a more significant role. Italy's emphasis on

remanufactures, refurbishment, and reuse aligns with knowledge application, commercial capability, and endogenous actions, indicating an institutionally embedded circularity driven by innovation systems and market orientation, likely reflecting structured innovation systems and stronger institutional frameworks.

Figure 25 underscore that CE practices are primarily driven by local initiatives, commercial capabilities, and knowledge application, highlighting the pivotal role of endogenous actions in operationalizing circular strategies within regional contexts.

Figure 25 – Sankey diagram: circular economy and regional development



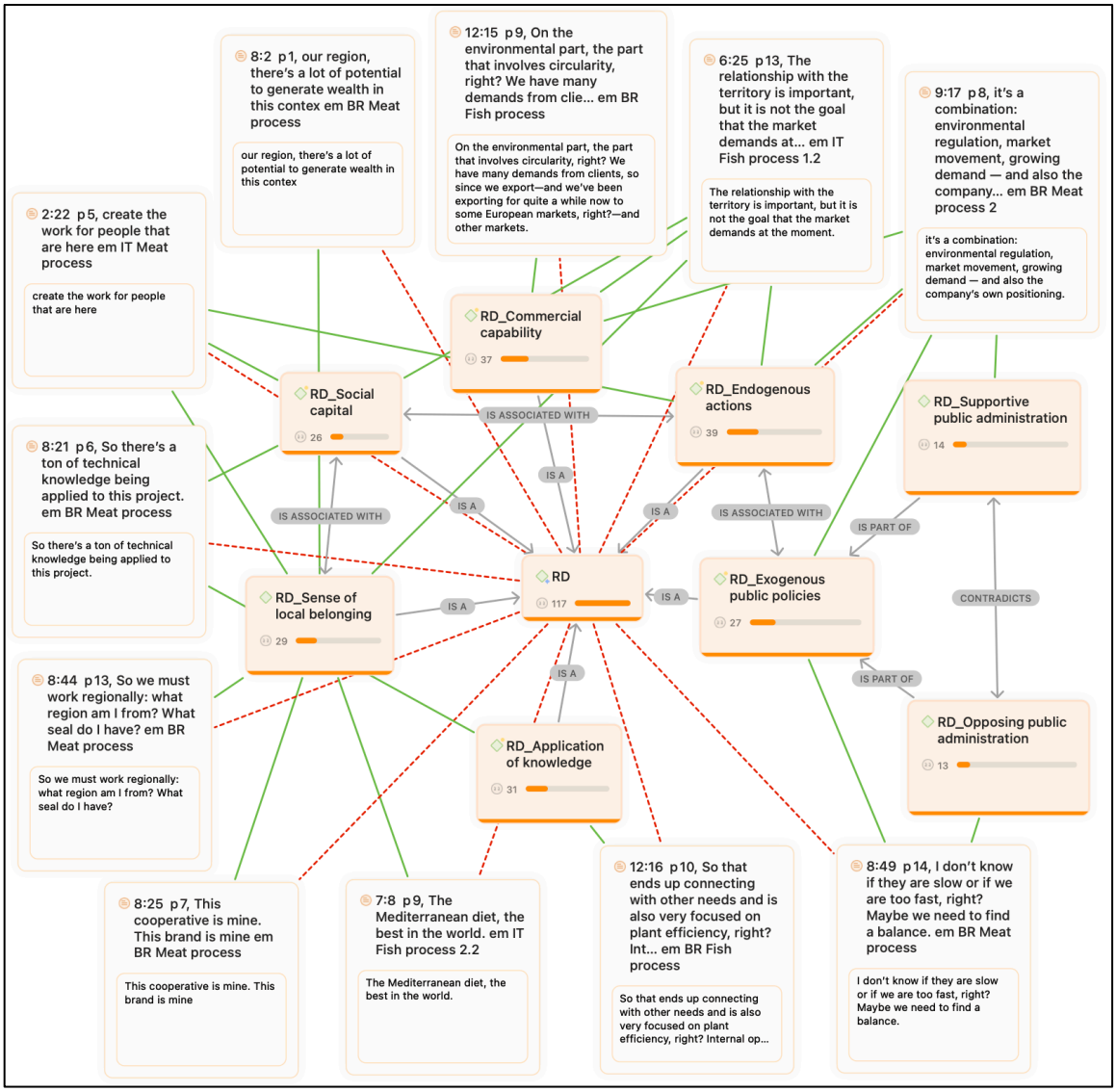
Source: own design (2025).

As we can see in Figure 24, the analysis of the coding frequencies reveals that CE strategies are predominantly associated with endogenous and knowledge-driven regional development (RD) dimensions. Among the CE strategies, Rethink/Redesign (CE_R1) and

Reuse (CE_R3) exhibit the highest citation counts, indicating their centrality in fostering business innovation and resource optimization. Repurpose (CE_R7) and Recover (CE_R9) also show notable relevance, reflecting practices oriented toward extending product life and valorizing resources. Conversely, Repair (CE_R4), Refurbish (CE_R5), and policy-oriented dimensions (both exogenous public policies and supportive public administration) appear infrequently, suggesting limited emphasis on formal governance mechanisms.

Figure 26 provides a concept map connecting Regional Development (RD) to several dimensions (e.g., social capital, commercial capability, endogenous actions, exogenous public policies, sense of local belonging, application of knowledge, supportive/opposing administration). Around it, we have empirical excerpts (interview fragments) that illustrate how these dimensions materialize in the agri-food sector in Italy and Brazil.

Figure 26 – Concept map of the Regional Development category (Brazil and Italy)



Source: own design (2025).

Figure 26 demonstrates that CE-driven regional development is systemic, requiring synergy between economic competitiveness, social identity, knowledge flows, and supportive governance. It also surfaces the paradoxes (supportive vs opposing policies, local belonging vs global markets) that condition how much CE can foster regional development.

The potential of circular models to foster regional development is articulated through multiple, interconnected dimensions. Commercial capability emerges as a central driver, with firms leveraging circular practices to respond to market demand, strengthen competitive positioning, and align with environmental regulation. At the same time, social capital and a strong sense of local belonging reinforce collective engagement, fostering cooperation, territorial identity, and pride in regional brands, which are essential for sustaining circular initiatives. The application of knowledge is another critical dimension, as technical expertise and organizational innovation enable industries to embed circular practices into production processes.

Moreover, evidence from the interview reveals the importance of both endogenous actions, e.g. initiatives rooted in local dynamics and exogenous public policies, e.g. regulation towards CE, which create enabling frameworks for circular transitions. However, the role of governance is not unidirectional: while supportive public administration facilitates adoption, contradictions and inefficiencies in regulatory processes also generate obstacles, exposing tensions that can constrain the scaling of circular strategies.

These results suggest that circular models hold strong potential to foster regional development, but their effectiveness depends on how social, institutional, and commercial capabilities align within each regional context. Taken together, these results suggest that CE models can indeed foster regional development, yet their impact depends on the alignment between endogenous actions, social capital, and supportive institutional frameworks, which determine whether circularity consolidates tradition or drives systemic transformation.

4.5 Discussion

In essence, both Porter and Kramer (2011) and Teece (2010) underscore that long-term business prosperity relies on innovative and adaptive models that not only generate profit efficiently but also integrate and contribute to broader societal well-being. This perspective aligns closely with the CE, where business transformation is inseparable from its territorial and regional context.

The findings illustrate a pragmatic view of how principles of circular economy are

shifting business model design in agri-food industries. Contrary to being visionary utopian visions of sustainability, transformation appears to be embedded deep inside economic reason and working pragmatism.

According to the first theoretical observation, firms manage sustainability both through forward and regulatory views. While there is familiarity with the long-term benefits of circular practices – e.g., less dependence on external water sources or less waste – there is a sharp concentration on short-term economic sustainability. One interviewee (Brazilian Firm 8) figuratively describes this challenge: “We have bills to pay. we did 150 million turnover. But how much is left?”

This is a reminder of the fine balance between profitability requirements and sustainability responsibilities, and of the hypothesis that even profitable companies will be unable to justify circular investment if it does not result in accelerated financial benefits. Moreover, the premise that “very few markets put a price on this” negates the assumption that consumers always reward eco-friendly action. This is reflective of a wider skepticism towards market rewards for circularity and aligns with the theoretical position that CE adoption is likely to be contingent on real monetary gains or risk mitigation.

Firms do not explicitly reject circularity, but they critically assess its market value and question whether “green” innovations – such as ecologically friendly pig breeding – are sufficiently rewarded by consumers or downstream buyers. This cautious stance underscores that the adoption of circular practices is often emergent rather than deliberate, reflecting the intricacy of CE transitions.

As one Brazilian firm explained, “There wasn’t really a moment when we said, ‘Oh, we’re doing circular economy now’,” pointing instead to a gradual process driven by internal efficiency improvements rather than explicit compliance with CE frameworks. Such evidence illustrates that business model transitions are largely adaptive and incremental, aligning with the view that the first step in effectively implementing circular business models in the agricultural sector is managing organizational transformation (Donner; Gohier; de Vries, 2020).

Efficiency focus, reuse, and maximization of resources are observed in approaches such as wastewater reuse (Firm 9) and product lifecycle thinking ("to close the loop"), which show that the CE principles are implemented step by step, as part of routines rather than through revolutionary redesigns. Moreover, these accounts are validating the second theoretical prediction: converting CE theory into reality requires some organizational adjustments, usually determined by local constraints, sectoral pressures, and economic pragmatism. The business model architecture is not being reshaped in an idealized or abstract fashion. Instead, it is being

informed by situated approaches, combining sustainability and survival, innovation and caution, and long-term horizons and proximate operating concerns.

Evidence from this study suggests that the contribution of circular models to regional development depends on the alignment between economic competitiveness, social and territorial/regional embeddedness, knowledge flows, and coherent policy and institutional support. These findings reinforce the theoretical arguments advanced by Alves (2022b) and Ferrera de Lima (2022, 2024), who emphasize the region not as a simple backdrop, but as a complex, living system (the "operating system") upon which all economic activity runs.

4.6 Essay final remarks

When conceptualizing the circular economy and its influence on a given region, companies may not always fully appreciate or prioritize this objective. However, when these principles are effectively integrated, the resulting benefits for the company can extend beyond its immediate operations, generating positive externalities for the surrounding region and its population. This exploratory research set out to investigate how circular economy (CE) practices transform agri-food business models and contribute to regional development, with a comparative focus on Italy and Brazil.

Answering the first specific objective, the comparative diagnosis reveals that Intermediate Geographic Region (RGInt) of Cascavel (Brazil) and Marche (Italy) embody distinct but complementary trajectories of agri-food industrial specialization. While RGInt Cascavel demonstrates robust growth anchored in livestock-related activities and an emergent diversification into dynamic subsectors such as fish processing and spirits, Marche reflects a more mature and diversified industrial structure, marked by relative stagnation in traditional domains yet accompanied by gradual reorientation toward value-added niches like spirits and specialty food products.

The second specific objective, analysis reveals that the CE exerts a differentiated influence on the architecture of agri-food business models in Italy and Brazil, reshaping how value is created, delivered, and captured according to organizational form and regional context. In the Marche region, family-owned firms and cooperatives embed circular principles primarily through territorial identity, artisanal quality, certification, and sustainable food safety practices, thereby reinforcing heritage-based value creation and consumer trust. By contrast, in RGInt Cascavel, Paraná, large-scale cooperatives integrate circularity into systemic strategies that combine resource optimization, waste reduction, innovation, and governance with social and

economic development, emphasizing multi-channel distribution and collective value capture for members, employees, and communities.

The third specific objective, results demonstrate that the potential of circular models to foster regional development lies in their capacity to integrate economic, social, and institutional dimensions in ways that are specific to each regional context. In RGint Cascavel, large cooperatives mobilize circular practices as transformative instruments, linking resource efficiency, innovation, and governance with social inclusion and collective wealth generation, thereby positioning the agri-food sector as a catalyst for territorial prosperity. In contrast, in the Marche region, circularity reinforces artisanal traditions, territorial identity, and certification systems, sustaining regional distinctiveness and consumer trust but without radically altering established industrial structures.

All in one, we can conclude that CE adoption necessitates specific organizational adaptations and is most effective when aligned with economic incentives, confirming that theoretical models of circular transition often underestimate practical complexities. Profitability (economic competitiveness) alone is insufficient. Long-term prosperity is achieved when a business's innovative capacity is channeled through and enhances the unique regional system it inhabits, creating a virtuous cycle of mutual reinforcement.

Integrating circular practices into agri-food business models not only enhances firm performance but also strengthens regional development through context-sensitive, knowledge-driven, and commercially viable approaches. When it comes to the transition to a circular model, this should not be understood as a managerial panacea, nor as a rule exclusive to rich countries and institutions, nor as an achievement. There is no one-size-fits-all solution for implementing CE in agri-food industries. Each organization must find its own way.

The study contributes to the literature by providing cross-national empirical evidence on the interaction between CE and business model architecture in the agri-food sector, offering insights for both scholars and practitioners. Nonetheless, the limited role of formal policy and administrative support suggests a gap in institutional engagement, indicating opportunities for future research to explore the influence of governance frameworks on CE adoption. Building on these findings, future studies could examine additional regions or sectors and inform place-based strategies to maximize sustainability and competitiveness.

5 CONCLUSIVE REMARKS AND FUTURE DIRECTIONS

The purpose of this phd dissertation was to investigate how circular economy practices transform agri-food business models and contribute to regional development, comparing experiences from Italy and Brazil. It was underpinned by three objectives: to examine how CE principles are inscribed in policy in both countries and how they influence regional development; to identify and critically assess practices that have been adopted in the agri-food sector globally; and to investigate how these practices reformulate business models and guide regional trajectories. The objectives were achieved through a combination of policy analysis, interviews with representatives from the sectors, and a comparative diagnosis of regional specialization patterns.

Comparing two distinct contexts allows for a deeper understanding of how circular economy practices are articulated within different institutional arrangements, production trajectories, and regional development models. While both territories exhibit strong specialization in the agri-food sector and the relevance of collective organizations, such as cooperatives and networks of small and medium-sized enterprises, historical, regulatory, and governance conditions shape the adoption, diffusion, and outcomes of circular strategies differently.

This comparative analysis highlights that the circular economy is not a homogeneous model, but rather a set of territorially anchored practices, influenced by public policies, institutional capacities, and local socioeconomic dynamics. Thus, the comparative approach contributes to identifying critical success factors and contextual limitations, offering support for both theoretical advancement and the formulation of policies and strategies more sensitive to regional specificities.

The findings are organized around three main findings. Firstly, the research demonstrates that effective CE implementation must balance between pragmatism and inclusiveness but also appreciate the influence of governance arrangements and socio-political contexts. The Brazilian and Italian experiences show how CE policies are framed by varying institutional contexts: Brazil prioritizes emergent and pragmatic initiatives that are frequently coupled with sectoral competitiveness, while Italy incorporates CE principles into a more established but also more fragmented policy context. This comparison adds to the understanding of how regionally adaptable and coherent policies can be conceived.

Second, the interdisciplinarity of CE research is confirmed by infusing sustainability thinking and technological innovation in business and policy practice. The application of the 9R framework (Reduction, Reuse, Recycling, Renewing, Redesign/Rethink, Remanufacturing, Reject, Repair, Recover) was proven useful for intervention diagnosis and outcome measurement (social, environmental and economic) within the agri-food system. By linking resource recovery, reuse, and recycling practices to certain business model innovations and regional development results, the research advances the methodological application of the 9R framework one step and offers a diagnostic instrument with direct applicability for practitioners and policymakers.

Third, the comparative research reveals distinctive but complementary regional trajectories. The Cascavel Intermediate Geographic Region (RGInt) of Paraná illustrates intense growth founded on livestock production, accompanied by diversification into lines such as fish processing and spirits. Conversely, the Marche Region is characterized by a more mature industrial structure with relative stagnation in traditional activities but gradual specialization in value-added niches such as specialty foods. These findings underscore the importance of understanding regional differences and specialization in shaping CE adoption trajectories, as well as the necessity of tailoring approaches to local strengths and constraints.

Taken together, the three essays reveal that the CE functions as a territorially embedded development strategy rather than a universally replicable model, with its regional impacts shaped by institutional arrangements, sectoral structures, and governance capacities. The findings show that while CE practices in the agri-food sector can enhance resource efficiency, stimulate innovation, and reinforce regional value chains, their contribution to regional development depends on policy coherence, coordination among actors, and the alignment between business models and territorial specificities.

The value of this Ph.D. dissertation lies in the contribution to CE in agri-food system knowledge from a regional perspective. By linking policies, business model evolution, and industrial specialization, the study shows how circularity is both an institutional design and socio-economic context problem as well as a technological innovation problem. Furthermore, the operationalization of the 9R framework to agri-food systems is a methodological innovation as it translates abstract CE principles into applied analysis categories. This approach generates evidence-based conclusions that can inform regional policy and guide the formulation of adaptive frameworks for CE transitions. This research advances existing literature by adopting a multilevel and comparative approach that connects regulatory frameworks, firm-level practices, and regional development dynamics, while empirically bridging Global North and

Global South contexts. By doing so, it moves beyond normative and firm-centric perspectives on CE, offering a territorially grounded and analytically integrated understanding of how circular economy practices contribute to sustainable regional development.

Despite these improvements, there are some gaps. The research did not develop a systematic set of indicators that could measure circularity quantitatively at the regional level. This limits the potential for measuring and comparing circularity levels in various contexts in a comparable manner. An expansion of scope beyond Cascavel and Marche would also allow for broader generalizations, while the social dimension of CE, especially inclusivity, equity, and labor impacts, was mentioned but not examined in detail.

These limitations suggest clear directions for future research. First, the development of regional CE indicators integrating environmental, economic, and social dimensions is needed to monitor progress and benchmark regions. Second, longitudinal studies are needed to trace the trajectory of CE practices as they evolve over time and their cumulative effect on regional development. Third, extending comparative analysis to additional regions, particularly in the Global South, would deepen understanding of the variety of contexts shaping CE transitions. Finally, greater emphasis must be given to social justice issues so that CE enhances not only environmental and economic value, but equity and inclusivity as well.

The next step, therefore, is to progress from comparative diagnosis to regional measurement and benchmarking. Designing and applying a set of CE indicators for intermediate geographic regions in Brazil and macro-areas in Italy would allow systematic evaluation of circularity and its effects on sustainable development. This would equip policymakers with operational instruments to design more coherent, adaptive, and inclusive policies, while strengthening the policy design-business model innovation interface. This allows future research to build upon the foundation of this dissertation to take the contribution of the circular economy as an enabler of competitiveness and sustainability in agri-food systems to the next level.

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APPENDIX A – PHD THESIS PROJECT SCHEDULE BY SEMESTER: 2022/2025

Planned activities \ Semester	Sem. 1 02/22	Sem. 2 01/23	Sem. 3 02/23	Sem. 4 01/24	Sem. 5 02/24	Sem.6 01/25	Sem. 7 02/25
1. PGDRA mandatory and optional subjects 780 h/a (46 credits)	x	x	x				
2. Reading and literature review				x	x		
3. International Mobility: UNIVPM • Corso de laurea magistrale: Food policy • IX EEDAA Évora • Qualification exam • Search, selection, analysis and systematization of data in Italy				x	x		
4. Review of the research project: qualification wording					x		
5. Qualification exam (Ancona, 19/11/2024) Available at: https://youtu.be/yzlsCDXKdBA					x		
6. Parecer Consubstanciado Do Comitê De Ética (CEP – Plataforma Brasil)					x		
7. Search, selection, analysis and systematization of data in Brazil						x	
8. Thesis writing						x	x
9. Review and conclusion of the thesis							x
10. Publication of first paper							x
11. Thesis defense (Toledo, 18/11/2025) Deadline PGDRA/Unioeste 10/02/2026 Available at: https://youtu.be/4TiycdxfltA							x

Source: elaborated by the author (2025).

APPENDIX B – EMPIRICAL VALIDATION PROTOCOL

UNIVERSITÀ POLITECNICA DELLE MARCHE

UNIVERSITÀ POLITECNICA DELLE MARCHE
Department of Agricultural, Food and Environmental Sciences (D3A)
Doctoral School on Agriculture, Food and Environmental Sciences

unioeste
Universidade Estadual do Oeste do Paraná

WESTERN PARANÁ STATE UNIVERSITY
Campus Toledo/Paraná/Brazil
Applied Social Sciences Center (CCSA)
Doctorate in Regional Development and Agribusiness (PGDRA)

Research Team	Gabriela Daiana Christ, PhD Student	gabriela.christ@unioeste.br
	Adele Finco, Full Professor	a.finco@univpm.it
	Crislaine Colla, Full Professor	crislaine.colla@unioeste.br
	Pery Francisco Assis Shikida, Full Professor	pery.shikida@unioeste.br

The project aims to analyze how the principles of the circular economy influence and reshape the architecture of existing business models in the agri-food sector.

We declare that the questionnaire is anonymous and under voluntary participation. The collected data will be processed in aggregate form, in compliance with the in-force law on privacy.[14,15]

Place and date of the interview: _____

Name and surname of the interviewee: _____

By completing the questionnaire, you agree to participate in this study.
□ I agree □ I do not agree

[14] Italy: CONFIDENTIALITY OF THE DATA PROVIDED IN THIS QUESTIONNAIRE In accordance with Regulation (EU) 2016/679, GDPR (General Data Protection Regulation), and Legislative Decree 196/2003, and subsequent amendments and additions, all information collected with the questionnaires will be used exclusively for scientific research purposes. Furthermore, the data collected in the context of this survey are protected by statistical confidentiality, and therefore cannot be disseminated or disclosed except in aggregated form. No individual reference can be made to them and may only be used for statistical purposes.

[15] Brazil: Ethics committee approval and informed consent obtained: Certificate of Submission for Ethical Appraisal (CAAE/Plataforma Brasil) N. 85558124.5.0000.0107 (Report number: 7.417.037).

unioeste
Universidade Estadual do Oeste do Paraná
Pró-Reitoria de Pesquisa e Pós-Graduação
Comitê de Ética em Pesquisa – CEP

Aprovado na CONEP
em 04/08/2000

TERMO DE CONSENTIMENTO LIVRE E ESCLARECIDO – TCLE

Título do Projeto: **ANÁLISE COMPARATIVA DAS PRÁTICAS DE ECONOMIA CIRCULAR NO SETOR AGROALIMENTAR: UM ESTUDO DO BRASIL E DA ITÁLIA**

Certificado de Apresentação para Apreciação Ética – "CAAE" N° 85558124.5.0000.0107

Pesquisador para contato: **Gabriela Daiana Christ**

Telefone: **+55 45 99807-5936**

Endereço de contato (Institucional): **gabriela.christ@unioeste.br**

Convidamos *você* a participar de uma pesquisa sobre **economia circular e o setor agroalimentar**. O objetivo desta pesquisa é analisar como os princípios da economia circular influencia e reformula a arquitetura de modelos de negócios existentes no setor agroalimentar e têm o propósito de **dar suporte às empresas no enfrentamento dos muitos desafios apresentados pela implementação de estratégias relacionadas à Economia Circular para maximizar o uso de recursos e no desenvolvimento de modelos de negócios sustentáveis que operem com sucesso em um ecossistema econômico, social e ambiental em rápida mudança.** Para que isso ocorra será submetido a **uma entrevista semiestruturada.**

Riscos para o participante: a pesquisa poderá causar a você reflexões sobre estratégias já usadas e possíveis ações futuras em sua empresa*;* além de exigir um tempo médio de 45 minutos, ou seja, pode interferir na rotina de trabalho.

Benefícios para o participante: a pesquisa poderá gerar debates e ideias valiosas sobre práticas de economia circular, promovendo reflexões sobre como otimizar recursos e tornar os modelos de negócios mais sustentáveis. Sua participação ajudará a ampliar o conhecimento sobre economia circular no setor agroalimentar, promovendo o desenvolvimento de diretrizes que podem beneficiar toda a cadeia produtiva.

Se ocorrer algum transtorno, decorrente de sua participação em qualquer etapa desta pesquisa, nós pesquisadores, providenciaremos acompanhamento e a assistência imediata, integral e gratuita. Havendo a ocorrência de danos, previstos ou não, mas decorrentes de sua participação nesta pesquisa, caberá a você, na forma da Lei, o direito de solicitar a respectiva indenização.

Também você poderá a qualquer momento desistir de participar da pesquisa sem qualquer prejuízo. Para que isso ocorra, basta informar, por qualquer modo que lhe seja possível, que deseja deixar de participar da pesquisa e qualquer informação que tenha prestado será retirada do conjunto dos dados que serão utilizados na avaliação dos resultados.

Você não receberá e não pagará nenhum valor para participar deste estudo, no entanto, terá direito ao ressarcimento de despesas decorrentes de sua participação.

Nós pesquisadores garantimos a privacidade e o sigilo de sua participação em todas as etapas da pesquisa e de futura publicação dos resultados. O seu nome, endereço, voz e imagem nunca serão associados aos resultados desta pesquisa, exceto quando você desejar. Nesse caso, você deverá assinar um segundo termo, específico para essa autorização e que deverá ser apresentado separadamente deste.

As informações que você fornecerem serão utilizadas exclusivamente nesta pesquisa. Caso as informações fornecidas e obtidas com este consentimento sejam consideradas úteis para outros estudos, você será procurado para autorizar novamente o uso.

Este documento que você vai assinar contém duas (02) páginas. Você deve vistar (rubricar) todas as páginas, exceto a última, onde você assinará com a mesma assinatura registrada no cartório (caso tenha). Este documento está sendo apresentado a você em duas vias, sendo que uma via é sua. Sugerimos que guarde a sua via de modo seguro.

Caso você precise informar algum fato ou decorrente da sua participação na pesquisa e se sentir desconfortável em procurar o pesquisador, você poderá procurar pessoalmente o Comitê de Ética em Pesquisa com Seres Humanos da UNIOESTE (CEP), de segunda a sexta-feira, no horário de 12h30 as 17h30min, na Reitoria da UNIOESTE, sala do Comitê de Ética, PRPPG, situado na rua Universitária, 1619 – Bairro Universitário, Cascavel – PR. Caso prefira, você pode entrar em contato via Internet pelo e-mail: cep.prppg@unioeste.br ou pelo telefone do CEP que é (45) 3220-3092 e (45) 99113-1149 – WhatsApp.

Cascavel, 25 de abril de 2024.

Declaro estar ciente e suficientemente esclarecido sobre os fatos informados neste documento.	Assinatura do participante **Nome do participante da pesquisa**:
Eu, ***Gabriela Daiana Christ***, declaro que forneci todas as informações sobre este projeto de pesquisa ao participante.	Assinatura da pesquisadora **Gabriela Daiana Christ**

Check list: Steps for applying interviews

	Steps for applying interviews
1	Personal presentation of the researcher
2	Thanks for your availability
3	Presentation of the project and research objectives
4	Explain that the research is academic in nature and will serve as a basis for the development of a Doctoral Thesis on Circular Economy in Agri-Food Sector
5	Explain that the companies' responses will be tabulated together and there will be no possibility of identifying the respondents
6	Explain the issue of confidentiality of the research in terms of preserving the identity of the interviewees.
7	Explain that the research takes place in stages: transcription and approval with subsequent tabulation of the collected data
8	Start of the interview (protocol)
9	Approach about willingness for additional contact if necessary
10	Final thanks for your availability and the information provided

Observable elements: dimensions

Dimensions / categorization	Observable elements / coding
Circular economy	- Barriers, Opportunities and services for the implementation of a circular model - Analysis of business model in circular economy - **Circular economy adoption (9R)** R0 Refuse: make product redundant by abandoning its function or by offering the same function with a radically different product R1 Rethink / Redesign: Make product use more intensive (e.g. by sharing product) R2 Reduce: Increase efficiency in product manufacture or use by consuming fewer natural resources and materials R3 Reuse: Reuse by another consumer of discarded product which is still in good condition and fulfills its original function R4 Repair: Repair and maintenance of defective product so it can be used with its original function R5 Refurbish: Restore an old product and bring it up to date R6 Remanufacture: Use parts of discarded product in a new product with the same function R7 Repurpose: Use discarded product or its parts in a new product with a different function R8 Recycle / Upcycle: Process materials to obtain the same (high grade) or lower (low grade) quality R9 Recover: Incineration of material with energy recovery - Circular economy for regional development - Operational control of waste generated in processes
Regional Development	- Exogenous public policies with a focus on sustainability - Endogenous actions aimed at improving living conditions for the population (local values) - Sense of local belonging - Dynamics (dynamic, stationary, or stagnant), vitality, and development of regions - Application of knowledge in the productive structure (technology, knowledge, innovation) - Improvement of productive forces and **commercial capability** (knowing how to sell) - Ability to work and produce cooperatively and associatively (social aspect, production, philanthropy, social capital)
Sustainable Business Model	- Information about business models, products and processes: - Partnerships (customer: to **who**) - Activities (supply chain: **how** is brought to the market) - Value propositions (**what** value is brought to the market) - Firm performance indicators - Environmental indicators of input consumption - Environmental indicators of waste generation - Commitment to society and the environment - Sustainability reports - Reports of improvements generated in processes

English Version
PART 1 – General Information

A) GENERAL COMPANY INFORMATION

1) Name of the company:

2) Location:

3) Year of foundation:

4) Productive sector (ATECO/Partita IVA/Italy or CNPJ/CNAE code/Brazil):

5) Contacts (phone/e-mail):

6) Interviewee: □ Owner □ Responsible □ Other, which? _____

Name and surname:

Gender: □M □F

Age: □ 18÷25 □ 26÷40 □ 41÷60 □ over 60

Educational level:

Years running the company: □ < 1 □ 1÷5 □ 6÷10 □ 11÷15 □ over 15

7) Legal form of the company:

□ individual □ corporate (number of members) □ cooperative (number of members) □ other

8) Number of employees:

9) Main products of the company:

Typology	Quantities (measure/year)	Distribution channels	Sales' price	Is this product part of a circular economy model? How?

PART 2 – Qualitative interview

B) CIRCULAR ECONOMY

10) What is your definition of circular economy? (The first word to come to your mind to describe circular economy)

11) Do you think CE adoption is important for your company?

12) Which practices did you adopt towards circularity?

To stimulate discussion, e.g.:

( ) Reduction of wasteful by-products (water)
( ) Use of recyclable packaging
( ) Production / use of renewable energy
( ) Technological modernization in function of circularity
( ) Other? What? _____

13) Do you measure circular performance? How?

(e.g. % of by-product recovered)

C) ANALYSIS OF SELECTED BUSINESS MODELS

14) Can you describe your production model? (Production partner, raw materials, customer, target market, value proposition).

15) Have circular economy practices influenced any changes or adaptations to your business model?

16) If so, were these changes driven by regulatory requirements and market demands (such as buyer requirements), or were they independent of the company?

17) Have you observed any financial or operational impacts (positive or negative) resulting from these changes?

18) Has your company invested in or developed any innovations by adopting circular economy principles?

19) Have the implemented processes contributed to reducing costs? If so, by approximately what percentage?

20) Have these changes brought added value to the company?

D) REGIONAL DEVELOPMENT

21) Do you think your company's circular economy practices contribute to regional development? How?

22) How could public administration contribute to implementing circular economy practices in your company?

PART 3 – Survey

E) CIRCULAR ECONOMY: BARRIERS, OPPORTUNITIES, SERVICES AND ADOPTION

23) Please indicate **how much you agree / disagree** on a scale from 1 to 5 with the following statements (Where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree)

Barriers	1 Completely disagree	2 Disagree	3 Undecided	4 Agree	5 Completely agree
Circular economy legislation is unclear					
The circular economy concept is unclear					
The public administration does not facilitate the implementation of circular practices					
I am not aware of alternative solutions for the reuse of waste/ by-products in my company					
I do not receive any incentive (national and/or regional) in the implementation of a circular model					
The costs of implementing a circular model would not be sustainable for my company					
I consider limited the profitability of the implementation of a circular model					
There is no logistical system capable of collecting and transferring waste to a specialized recovery company					
There are geographic-organizational impediments to the implementation of a circular model in my territory					

The available technologies are not suitable for the implementation of a circular model					
There are no trained figures who can guide the transition to the circular model in my company					
The consumer will not perceive the added value of the waste/by-product recovery					

24) Please indicate **how much you agree / disagree** on a scale from 1 to 5 with the following statements (Where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree)

Opportunities	1	2	3	4	5
	Completely disagree	Disagree	Undecided	Agree	Completely agree
I can contribute to the reduction of the amount of generated waste through a circular economy					
I can improve the production sustainability through circular economy					
Public intervention would be desirable to support the diffusion of the circular model					
I can create further added value through the circular valorization of the waste					
The circular economy can support the diversification of income					
Circular economy can support the job creation					
I would have the possibility to widen the markets of interest through the creation of new products					
Research Institutes and Universities can help companies in the transition process					
It would be desirable to create networking for better waste/by-product management					
I could build consumer loyalty through involvement in circular processes					

25) How important is it on a scale from 1 to 5 the following services for the implementation of a circular model? (Where:1: Not important; 2: Slightly important; 3: Moderately important; 4: Important; 5: Very important)

Services	1	2	3	4	5
	Not important	Slightly important	Moderately important	Important	Very important
Networking between companies in the agri-food sector					
Initiatives of industrial symbiosis (creation of Industrial Districts – AgroParks)					
Training of dedicated personnel					
Establishment of a corporate sustainability report					
Implementation of a logistics platform for waste collection and disposal					

Creation of an online platform/database for waste quantification and qualification					
Partnerships with companies specializing in waste reuse					
Dedicated national/regional/international calls and incentives					
Facilitation of bank loans					
Partnerships with University/Research Institutes Support of trade associations					
Dedicated consultancy services (agronomists, specialist companies, university lecturers, ...)					

26) Please, indicate **how much you agree / disagree** on a scale from 1 to 5 with the following statements (Where: 1 Completely disagree; 2 Disagree; 3 Undecided; 4 Agree; 5 Completely agree)

Circular Economy Adoption	1	2	3	4	5
	Completely disagree	Disagree	Undecided	Agree	Completely agree
Our company's current management system is suitable for adopting the circular economy					
The management board of our company is interested in adopting the circular economy					
Our company is willing to revise the management system to adopt the circular economy					
Our **customers** care about products that originate from the circular economy					
Our **customers** are increasingly interested in products from the circular economy					
Our **customers** have specific criteria regarding the circular economy when choosing products					
Society requires products that are derived from the circular economy					
Society is increasingly interested in products from the circular economy					
There is **societal** pressure on our company to adopt the circular economy					

Portuguese Version

PARTE 1 – Informações Gerais

A) INFORMAÇÕES GERAIS DA EMPRESA

1) Nome da empresa:

2) Localização:

3) Ano de fundação:

4) CNPJ da empresa – CNAE (setor produtivo):

5) Contatos (telefone/e-mail):

6) Entrevistado: □ Proprietário □ Responsável □ Outro, qual? _____

Nome e sobrenome:

Gênero: □M □F

Idade: □ 18÷25 □ 26÷40 □ 41÷60 □ acima de 60

Nível de escolaridade:

Anos de atuação na empresa: □ < 1 □ 1÷5 □ 6÷10 □ 11÷15 □ acima de 15

7) Forma jurídica da empresa:

□ individual □ sociedade (número de sócios) □ cooperativa (número de membros) □ outra

8) Número de funcionários:

9) Principais produtos da empresa:

Tipologia	Quantidades (medida/ano)	Canais de distribuição	Preço de venda	Este produto faz parte de um modelo de economia circular? Como?

PARTE 2 – entrevista qualitativa

B) ECONOMIA CIRCULAR

10) Qual é a sua definição de economia circular? (a primeira palavra que vem à sua mente para descrever economia circular)

11) Você acha que a adoção da economia circular é importante para sua empresa?

12) Quais práticas você adotou em direção à circularidade?

Para estimular a discussão, por exemplo:

( ) Redução de resíduos de subprodutos (água)

( ) Utilização de embalagens recicláveis

( ) Produção/utilização de energia renovável

( ) Modernização tecnológica para circularidade

( ) Outro? O que? _____

13) Você mede o desempenho circular da sua empresa? Como?

(por exemplo, % de subproduto recuperado)

C) ANÁLISE DO MODELO DE NEGÓCIO SELECIONADOS

14) Você pode descrever seu modelo de produção? (produção, matéria-prima, cliente, mercado-alvo, proposta de valor).

15) Houve alguma mudança ou adaptação no seu modelo de negócio influenciada pelas práticas de economia circular?

16) Em caso afirmativo, essas mudanças foram motivadas por requisitos regulatórios e demandas do mercado (como requisitos do comprador) ou foram iniciadas de forma independente pela empresa?

17) Você observou algum impacto financeiro ou operacional (positivo ou negativo) resultante dessas mudanças?

18) Sua empresa investiu ou desenvolveu alguma inovação devido à adoção dos princípios de economia circular?

19) Os processos implementados ajudaram a reduzir os custos? Se sim, em aproximadamente qual porcentagem?

20) Essas mudanças levaram a lucros maiores ou os níveis de lucro permaneceram os mesmos?

D) DESENVOLVIMENTO REGIONAL

21) As práticas de economia circular utilizadas em sua empresa podem contribuir para o desenvolvimento regional? De que maneira?

22) Como a administração pública poderia contribuir na realização das práticas de economia circular em sua empresa?

PARTE 3 – Survey

E) ECONOMIA CIRCULAR: BARREIRAS, OPORTUNIDADES, SERVIÇOS E IMPLEMENTAÇÃO

23) Por favor, indique o quanto você concorda ou discorda numa escala de 1 a 5 com as seguintes afirmações (Onde: 1 Discordo totalmente; 2 Discordo; 3 Indeciso; 4 Concordo; 5 Concordo totalmente)

Barreiras	1	2	3	4	5
	Discordo totalmente	Discordo	Indeciso	Concordo	Concordo totalmente
A legislação de economia circular é pouco clara					
O conceito de economia circular é pouco claro					
A administração pública não facilita a implementação de práticas circulares					
Não conheço soluções alternativas para o reaproveitamento de resíduos/subprodutos na minha empresa					

Não recebo nenhum incentivo (nacional e/ou regional) na implementação de um modelo circular					
Os custos de implementação de um modelo circular não seriam sustentáveis para minha empresa					
Considero limitada a rentabilidade da implementação de um modelo circular					
Não existe um sistema logístico capaz de coletar e transferir resíduos para uma empresa especializada em recuperação					
Existem impedimentos geográficos-organizacionais para a implementação de um modelo circular no meu território					
As tecnologias disponíveis não são adequadas para a implementação de um modelo circular					
Não há pessoas capacitadas que possam orientar a transição para o modelo circular na minha empresa					
O consumidor não perceberá o valor agregado da recuperação de resíduos/subprodutos					

24) Por favor, indique o quanto você concorda ou discorda numa escala de 1 a 5 com as seguintes afirmações (Onde: 1 Discordo totalmente; 2 Discordo; 3 Indeciso; 4 Concordo; 5 Concordo totalmente)

Oportunidades	1	2	3	4	5
	Discordo totalmente	Discordo	Indeciso	Concordo	Concordo totalmente
Posso contribuir para a redução da quantidade de resíduos gerados por meio da economia circular					
Posso melhorar a sustentabilidade da produção por meio da economia circular					
Seria desejável uma intervenção pública para apoiar a difusão do modelo circular					
Posso criar mais valor agregado por meio da valorização circular dos resíduos/subprodutos					
A economia circular pode apoiar a diversificação da renda					
A economia circular pode apoiar a criação de empregos					
Eu teria a possibilidade de ampliar os mercados de interesse por meio da criação de novos produtos Institutos de pesquisa e universidades podem ajudar as empresas no processo de transição					
Seria desejável criar networking para melhor gestão dos resíduos/subprodutos					
Eu poderia fidelizar os consumidores por meio do envolvimento em processos circulares					

Posso contribuir para a redução da quantidade de resíduos gerados por meio da economia circular					

25) Quão importante é numa escala de 1 a 5 os seguintes serviços para a implementação de um modelo circular? (Onde: 1: Não é importante; 2: Pouco importante; 3: Moderadamente importante; 4: Importante; 5: Muito importante)

Serviços	1	2	3	4	5
	Não é importante	Pouco importante	Moderadamente importante	Importante	Muito importante
Networking entre empresas do setor agroalimentar					
Iniciativas de simbiose industrial (criação de Distritos Industriais – AgroParks)					
Treinamento de pessoal dedicado					
Estabelecimento de um relatório de sustentabilidade corporativa					
Implementação de uma plataforma logística para coleta e descarte de resíduos					
Criação de uma plataforma/banco de dados online para quantificação e qualificação de resíduos					
Parcerias com empresas especializadas em reutilização de resíduos/subprodutos					
Editais e incentivos nacionais/regionais/internacionais dedicados					
Facilitação de empréstimos bancários					
Parcerias com Universidades/Institutos de Pesquisa Apoio de associações comerciais					
Serviços de consultoria dedicados (agrônomos, empresas especializadas, professores universitários, ...)					

26) Por favor, indique o quanto você concorda ou discorda numa escala de 1 a 5 com as seguintes afirmações (Onde: 1 Discordo totalmente; 2 Discordo; 3 Indeciso; 4 Concordo; 5 Concordo totalmente)

Adoção da Economia Circular	1	2	3	4	5
	Discordo totalmente	Discordo	Indeciso	Concordo	Concordo totalmente
O sistema de gestão atual da nossa empresa é adequado para a adoção da economia circular					

A diretoria da nossa empresa está interessada em adotar a economia circular					
Nossa empresa está disposta a revisar o sistema de gestão para adotar a economia circular					
Nossos **clientes** se importam com produtos que se originam da economia circular					
Nossos **clientes** estão cada vez mais interessados em produtos da economia circular					
Nossos **clientes** têm critérios específicos em relação à economia circular ao escolher produtos					
A **sociedade** exige produtos que sejam derivados da economia circular					
A **sociedade** está cada vez mais interessada em produtos da economia circular					
Há **pressão social** sobre nossa empresa para adotar a economia circular					

Italian Version
PARTE 1 – Informazioni Generali

A) INFORMAZIONI GENERALI SULL'AZIENDA

1) Nome dell'azienda:

2) Sede:

3) Anno di fondazione:

4) Codice ATECO (settore produttivo):

□ 10.1 Lavorazione e Conservazione di Carne e Produzione di Prodotti a Base di Carne

□ 10.2 Lavorazione e Conservazione di Pesce, Crostacei e Molluschi

□ 10.3 Lavorazione e Conservazione di Frutta e Ortaggi

□ 10.4 Produzione di Oli e Grassi Vegetali e Animali

□ 10.5 Industria Lattiero-Casearia

□ 10.6 Lavorazione delle Granaglie, Produzione di Amidi e di Prodotti Amidacei

□ 10.7 Produzione di Prodotti da Forno e Farinacei

□ 10.8 Produzione di Altri Prodotti Alimentari

□ 10.9 Produzione di Prodotti Per L'Alimentazione Degli Animali

5) Contatti (telefono/e-mail):

6) Intervistato: □ Proprietario □ Responsabile □ Altro, (specificare) _____

Nome e cognome:

Genere: □ M □ F

Età: □ 18÷25 □ 26÷40 □ 41÷60 □ oltre 60

Livello di istruzione:

Anni di gestione dell'azienda: □ < 1 □ 1÷5 □ 6÷10 □ 11÷15 □ oltre 15

7) Forma giuridica dell'azienda:

□ individuale □ societaria (numero di membri) □ cooperativa (numero di membri) □ altro (specificare) _____

8) Numero di dipendenti:

9) Principali prodotti dell'azienda:

Tipologia	Quantità (misura/anno)	Canali di distribuzione	Prezzo di vendita	Questo prodotto fa parte di un modello di economia circolare? In che modo?

PARTE 2 – Intervista qualitativa

B) ECONOMIA CIRCOLARE

10) Qual è la sua definizione di economia circolare? (la prima parola che le viene in mente per descrivere l'economia circolare)

11) Ritieni che l'adozione dell'economia circolare sia importante per la sua azienda?

12) Quali pratiche avete adottato verso la circolarità?

Per stimolare la discussione, ad es.:

( ) Riduzione dei rifiuti sottoprodotti (acqua)
( ) Utilizzo di imballaggi riciclabili
( ) Produzione/utilizzo di energia rinnovabile
( ) Modernizzazione tecnologica per la circolarità
( ) Altro? Cosa? _____

13) Misurate le performance di economia circolare nella vostra azienza? Come?
(Ad es. % di sottoprodotto recuperato)

C) ANALISI DEL MODELLO DI BUSINESS SELEZIONATO

14) Può descrivere il suo modelo produtivo? (Partner produttivo, materie prime, cliente, mercato di destinazione, proposta di valore)

15) Ci sono stati cambiamenti o adattamenti al suo modello di business influenzati dalle pratiche di economia circolare?

16) In tal caso, tali cambiamenti sono stati determinati da requisiti normativi, richieste del mercato (ad esempio, requisiti degli acquirenti), oppure sono stati avviati in modo independente autonomo dall'azienda?

17) Ha osservato impatti finanziari o operativi (positivi o negativi) derivanti da questi cambiamenti?

18) La sua azienda ha sviluppato o investito in innovazioni grazie all'adozione dei principi basati su un modello di economia circolare?

19) I processi circolari implementati hanno contribuito a ridurre i costi? In caso affermativo, approssimativamente, di quale percentuale?

20) Questi cambiamenti hanno portato ad un valore aggiunto all'azienda?

D) SVILUPPO REGIONALE

21) Pensa che le pratiche di economia circolare utilizzate nella vostra azienda contribuiscano allo sviluppo regionale? In che modo?

22) In che modo la pubblica amministrazione potrebbe contribuire all'implementazione delle pratiche di economia circolare nella vostra azienda?

PARTE 3 – Survey

E) ECONOMIA CIRCOLARE: DIFFICOLTA', OPPORTUNITÀ, SERVIZI ED ADOZIONE

23) Indichi il suo grado di accordo / in disaccordo su una scala da 1 a 5 con le seguenti affermazioni (Dove: 1 Completamente in disaccordo; 2 In disaccordo; 3 Indeciso; 4 D'accordo; 5 Completamente d'accordo)

Ostacoli	1	2	3	4	5
	Completamente in disaccordo	In disaccordo	Né d'accordo né in disaccordo	D'accordo	Completamente d'accordo
La legislazione sull'economia circolare è poco chiara					
Il concetto di economia circolare è poco chiaro					
L'amministrazione pubblica non facilita l'implementazione di pratiche circolari					
Non sono a conoscenza di soluzioni alternative per il riutilizzo dei rifiuti/sottoprodotti nella mia azienda					
Non ricevo alcun incentivo (nazionale e/o regionale) nell'implementazione di un modello circolare					
I costi per implementare un modello circolare non sarebbero sostenibili per la mia azienda					
Considero limitata la redditività dell'implementazione di un modello circolare					
Non esiste un sistema logistico in grado di raccogliere e trasferire i rifiuti / sottoprodotto a un'azienda specializzata nel recupero					
Ci sono impedimenti geografico-organizzativi per l'implementazione di un modello circolare nel mio territorio					
Le tecnologie disponibili non sono idonee per l'implementazione di un modello circolare					
Non ci sono figure formate che possono guidare la					

transizione verso il modello circolare					
Il consumatore non percepirà il valore aggiunto del recupero di rifiuti/sottoprodotti					

24) Indichi il suo grado di accordo / in disaccordo su una scala da 1 a 5 con le seguenti affermazioni (Dove: 1 Completamente in disaccordo; 2 In disaccordo; 3 Indeciso; 4 D'accordo; 5 Completamente d'accordo)

Opportunità	1	2	3	4	5
	Completamente in disaccordo	In disaccordo	Né d'accordo né in disaccordo	D'accordo	Completamente d'accordo
Posso contribuire alla riduzione della quantità di rifiuti generati attraverso l'economia circolare					
Posso migliorare la sostenibilità della produzione attraverso l'economia circolare					
L'intervento pubblico sarebbe auspicabile per supportare la diffusione del modello circolare					
Posso creare ulteriore valore aggiunto attraverso la valorizzazione circolare degli scarti					
L'economia circolare può sostenere la diversificazione del reddito					
L'economia circolare può sostenere la creazione di posti di lavoro					
Avrei la possibilità di ampliare i mercati di interesse attraverso la creazione di nuovi prodotti					
Gli Istituti di Ricerca e le Università possono aiutare le aziende nel processo di transizione					
Sarebbe auspicabile creare networking per una migliore gestione dei rifiuti/ sottoprodotto					
Potrei fidelizzare i consumatori attraverso il coinvolgimento in processi circolari					

25) Quanto ritiene importante su una scala da 1 a 5 i seguenti servizi per l'implementazione di un modello circolare? (Dove: 1: Non importante; 2: Leggermente importante; 3: Moderatamente importante; 4: Importante; 5: Molto importante)

Servizi	1	2	3	4	5
	Non importante	Leggermente importante	Moderatamente importante	Importante	Molto importante
Networking tra le aziende del settore agroalimentare					
Iniziative di simbiosi industriale (creazione di Distretti Industriali – AgroParchi)					
Formazione di personale dedicato					
Creazione di un report di sostenibilità aziendale					
Implementazione di una piattaforma logistica per la raccolta e lo smaltimento dei rifiuti					
Creazione di una piattaforma/database online per la quantificazione e qualificazione dei rifiuti					
Partenariati con aziende specializzate nel riutilizzo dei rifiuti / sottoprodotto					
Bandi e incentivi nazionali / regionali / internazionali dedicati					
Facilitazione di prestiti bancari					
Partenariati con Università/Istituti di Ricerca					
Servizi di consulenza dedicati (agronomi, aziende specializzate, docenti universitari, ...)					

26) Indichi il suo grado di accordo / in disaccordo su una scala da 1 a 5 con le seguenti affermazioni (Dove: 1 Completamente in disaccordo; 2 In disaccordo; 3 Indeciso; 4 D'accordo; 5 Completamente d'accordo)

Adozione dell'Economia Circolare	1	2	3	4	5
	Completamente in disaccordo	In disaccordo	Né d'accordo né in disaccordo	D'accordo	Completamente d'accordo
L'attuale sistema di gestione della nostra azienda è idoneo per l'adozione dell'economia circolare					
Il consiglio di amministrazione della nostra azienda è					

interessato all'adozione dell'economia circolare					
L'azienda è disposta a rivedere il sistema di gestione per adottare l'economia circolare					
I nostri **clienti** sono sensibili ai prodotti che derivano dall'economia circolare					
I nostri **clienti** sono sempre più interessati ai prodotti derivanti da un'economia circolare					
I nostri **clienti** hanno criteri specifici riguardo all'economia circolare nella scelta dei prodotti					
La **società** richiede prodotti che derivano dall'economia circolare					
La **società** è sempre più interessata ai prodotti derivanti da un modello di economia circolare					
C'è una **pressione sociale** sulla nostra azienda per adottare l'economia circolare					

APPENDIX C – NUMBER OF ESTABLISHMENTS: LOCATION QUOTIENT

PARANÁ STATE (RGInt) – BRAZIL – Manufacture of food products and beverages (Stock of Active Companies 31/12):

	Manufacture of food products and beverages	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023
		Curitiba			Maringá			Londrina			Cascavel			Ponta Grossa			Guarapuava			Total Paraná			Total Brazil		
10.1	**Carne fabr**	55	68	90	95	115	134	85	87	88	118	173	177	23	26	38	12	21	35	388	490	562	3.791	4.304	5.055
10.2	Pescado fabr	5	3	4	1	1	2	2	6	6	8	15	23	1	1	0	0	0	0	17	26	35	353	458	713
10.3	Conservas veg	38	50	57	24	41	44	12	22	42	16	25	18	6	11	12	0	1	2	96	150	175	1.656	2.376	3.146
10.4	Óleos/gord	6	4	3	12	9	11	10	8	13	16	16	13	3	5	5	1	1	3	48	43	48	513	461	498
10.5	**Laticínios**	63	70	76	152	133	122	116	100	92	158	155	153	42	41	46	24	25	21	555	524	510	6.344	6.165	6.541
10.6	**Moagem/alim**	86	88	90	209	231	210	166	174	160	163	168	172	40	40	43	36	25	21	700	726	696	4.799	4.929	5.382
10.7	Açúcar fabr	1	1	0	16	14	14	3	6	10	2	2	2	0	0	0	0	0	0	22	23	26	391	380	375
10.8	Café torref	10	7	6	28	28	26	62	62	47	13	8	6	2	2	2	5	3	2	120	110	89	1.158	1.154	1.176
10.9	**Outros alim**	462	725	1.271	262	351	619	300	401	628	229	359	570	70	125	257	44	69	113	1.367	2.030	3.458	16.810	26.854	44.895
11.1	Bebidas alc	27	26	67	5	8	21	11	20	29	11	16	43	1	6	18	3	1	9	58	77	187	1.322	1.303	2.547
11.2	Bebidas não-alc	21	19	17	14	15	16	9	15	14	7	12	12	3	2	4	4	3	3	58	66	66	991	1.246	1.538
	Total	**774**	**1.061**	**1.681**	**818**	**946**	**1.219**	**776**	**901**	**1.129**	**741**	**949**	**1.189**	**191**	**259**	**425**	**129**	**149**	**209**	**3.429**	**4.265**	**5.852**	**38.128**	**49.630**	**71.866**

PARANÁ STATE (RGInt) – BRAZIL – Manufacture of food products and beverages (location quotient – QL):

	Manufacture of food products and beverages	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023
		Curitiba			Maringá			Londrina			Cascavel			Ponta Grossa			Guarapuava			Paraná (Brazil)		
10.1	**Carne fabr**	0,63	0,56	0,56	1,03	1,06	1,14	0,97	0,84	0,81	1,41	1,59	**1,55**	1,06	0,87	0,93	0,82	1,23	1,74	1,14	1,32	1,37
10.2	**Pescado fabr**	1,30	0,46	0,40	0,25	0,17	0,27	0,52	1,09	0,89	2,18	2,59	**3,23**	1,06	0,63	0,00	0,00	0,00	0,00	0,54	0,66	0,60
10.3	Conservas veg	1,75	1,34	1,13	1,05	1,23	1,21	0,55	0,69	1,24	0,77	0,75	0,51	1,12	1,21	0,94	0,00	0,19	0,32	0,64	0,73	0,68
10.4	**Óleos/gord**	0,55	0,37	0,22	1,05	0,94	1,10	0,92	0,88	1,40	1,54	1,67	**1,33**	1,12	1,91	1,43	0,55	0,67	1,75	1,04	1,09	1,18
10.5	**Laticínios**	0,50	0,54	0,52	1,15	1,14	1,15	0,92	0,90	0,94	1,32	1,33	**1,48**	1,36	1,29	1,24	1,15	1,37	1,15	0,97	0,99	0,96
10.6	**Moagem/alim**	0,54	0,49	0,45	1,25	1,43	1,45	1,05	1,13	1,19	1,08	1,04	**1,22**	1,03	0,91	0,85	1,37	0,99	0,84	1,62	1,71	1,59
10.7	Açúcar fabr	0,20	0,17	0,00	3,05	2,74	2,58	0,60	1,23	1,99	0,42	0,39	0,38	0,00	0,00	0,00	0,00	0,00	0,00	0,63	0,70	0,85
10.8	Café torref	0,37	0,26	0,23	0,98	1,15	1,40	2,28	2,67	2,74	0,50	0,33	0,33	0,30	0,30	0,31	1,11	0,78	0,63	1,15	1,11	0,93
10.9	Outros alim	1,50	1,44	1,28	0,80	0,78	0,86	0,97	0,94	0,94	0,78	0,79	0,81	0,92	1,01	1,02	0,86	0,97	0,91	0,90	0,88	0,95
11.1	**Bebidas alc**	2,06	1,36	1,25	0,36	0,47	0,54	0,84	1,23	0,80	0,88	0,93	**1,13**	0,31	1,28	1,33	1,37	0,37	1,35	0,49	0,69	0,90
11.2	Bebidas não-alc	1,60	1,16	0,90	1,01	1,02	1,16	0,69	1,08	1,10	0,56	0,82	0,89	0,93	0,50	0,83	1,83	1,30	1,27	0,65	0,62	0,53
	Total	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
	Number of QLs > 1	5	4	3	7	7	8	2	6	6	5	5	6	6	5	4	5	3	5	4	4	3

QL Standard Deviation	0,65	0,48	0,44	0,72	0,65	0,59	0,48	0,53	0,59	0,53	0,65	0,81	0,43	0,53	0,50	0,63	0,51	0,62	0,34	0,34	0,32
QL Mean	1,00	0,74	0,63	1,09	1,10	1,17	0,94	1,15	1,28	1,04	1,11	1,17	0,84	0,90	0,81	0,82	0,71	0,91	0,89	0,96	0,96
QL Coefficient of Variation	0,65	0,65	0,70	0,66	0,59	0,50	0,52	0,46	0,46	0,51	0,59	0,69	0,51	0,59	0,62	0,76	0,71	0,69	0,39	0,35	0,33

MARCHE REGION – ITALY – Manufacture of food products and beverages (Stock of Active Companies 31/12):

	Manufacture of food products and beverages	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023
		Ancona			Pesaro e Urbino			Macerata			Ascoli Piceno			Fermo			Total Marche			Total Italy		
10.1	Meat process	55	50	37	42	38	37	44	36	32	29	25	18	36	35	32	206	184	156	5.134	4.572	4.234
10.2	Fish process	3	4	6	10	9	10	1	2	1	30	23	20	6	4	4	50	42	41	630	616	628
10.3	Fruit/veg proc	3	6	7	16	11	13	8	8	5	12	12	12	0	2	4	39	39	41	2.469	2.329	2.341
10.4	Oils & fats	20	21	18	15	18	14	35	30	25	25	25	21	19	17	13	114	111	91	4.566	3.931	3.503
10.5	Dairy manuf	5	11	10	4	7	9	8	11	7	4	8	6	3	4	3	24	41	35	3.677	3.980	3.673
10.6	Grain mil	18	16	12	13	10	5	24	20	18	8	6	6	6	3	3	69	55	44	1.612	1.360	1.161
10.7	Bakery manuf	269	285	246	232	231	216	223	249	213	148	156	164	153	155	137	1.025	1.076	976	34.523	36.622	34.677
10.8	Other food	12	20	31	15	31	34	25	23	30	11	26	39	8	17	14	71	117	148	2.787	3.915	4.569
10.9	Animal feeds	6	3	1	4	8	9	14	11	9	1	1	4	5	2	5	30	25	28	619	569	579
11.1 - 11.5	Spirits drinks	26	28	31	7	6	12	9	12	18	15	24	29	3	5	4	60	75	94	2.750	2.464	3.484
11.6 - 11.7	Soft drinks	1	2	3	1	0	1	5	4	3	0	1	1	2	1	2	9	8	10	418	334	305
	Total	418	446	402	359	369	360	396	406	361	283	307	320	241	245	221	1.697	1.773	1.664	59.185	60.692	59.154

MARCHE REGION – ITALY – Manufacture of food products and beverages (location quotient – QL):

	Manufacture of food products and beverages	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023	2009	2016	2023
		Ancona			Pesaro e Urbino			Macerata			Ascoli Piceno			Fermo			Marche (Ref. Italy)		
10.1	**Meat process**	1,08	1,08	0,98	0,96	0,99	1,10	0,92	0,85	0,95	0,84	0,78	0,60	1,23	1,38	1,54	1,40	1,38	1,31
10.2	**Fish process**	0,24	0,38	0,61	0,95	1,03	1,13	0,09	0,21	0,11	3,60	3,16	2,54	0,84	0,69	0,73	2,77	2,33	2,32
10.3	Fruit/veg proc	0,31	0,61	0,71	1,94	1,36	1,47	0,88	0,90	0,56	1,85	1,78	1,52	0,00	0,37	0,73	0,55	0,57	0,62
10.4	Oils & fats	0,71	0,75	0,82	0,62	0,78	0,71	1,32	1,18	1,27	1,32	1,30	1,20	1,17	1,11	1,08	0,87	0,97	0,92
10.5	Dairy manuf	0,85	1,07	1,18	0,79	0,82	1,19	1,43	1,17	0,92	1,00	1,13	0,89	0,88	0,71	0,65	0,23	0,35	0,34
10.6	**Grain mill**	1,06	1,16	1,13	0,89	0,87	0,53	1,49	1,59	1,89	0,70	0,63	0,71	0,61	0,39	0,51	1,49	1,38	1,35
10.7	**Bakery manuf**	1,07	1,05	1,04	1,07	1,03	1,02	0,93	1,01	1,01	0,87	0,84	0,87	1,05	1,04	1,06	1,04	1,01	1,00
10.8	**Other food**	0,69	0,68	0,87	1,00	1,27	1,06	1,51	0,86	0,93	0,93	1,28	1,37	0,79	1,05	0,71	0,89	1,02	1,15
10.9	**Animal feeds**	0,81	0,48	0,15	0,63	1,54	1,49	2,00	1,92	1,48	0,20	0,23	0,74	1,17	0,58	1,34	1,69	1,50	1,72
11.1 - 11.5	Spirits drinks	1,76	1,48	1,37	0,55	0,38	0,59	0,64	0,70	0,88	1,50	1,85	1,60	0,35	0,48	0,32	0,76	1,04	0,96
11.6 - 11.7	**Soft drinks**	0,45	0,99	1,24	0,53	0,00	0,46	2,38	2,18	1,38	0,00	0,72	0,52	1,56	0,90	1,51	0,75	0,82	1,17

Number of QLs > 1	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
QL Standard Deviation	4	5	5	2	5	7	6	6	5	4	6	5	5	4	5	5	7	7
QL Mean	0,43	0,33	0,34	0,39	0,43	0,36	0,64	0,57	0,47	0,96	0,80	0,59	0,44	0,33	0,41	0,69	0,53	0,53
QL Coefficient of Variation	0,82	0,88	0,92	0,90	0,92	0,98	1,23	1,14	1,03	1,16	1,25	1,14	0,88	0,79	0,93	1,13	1,13	1,17
Number of QLs > 1	0,52	0,38	0,38	0,44	0,47	0,37	0,52	0,50	0,46	0,83	0,64	0,52	0,50	0,41	0,44	0,61	0,47	0,45

Summary of descriptive statistics

Marche Region (Italy)	2009	2023	RGInt Cascavel (Paraná)	2009	2023
Number of QLs > 1	5	7	**Number of QLs > 1**	5	6
QL Standard Deviation	0,69	0,53	**QL Standard Deviation**	0,53	0,81
QL Mean	1,13	1,17	**QL Mean**	1,04	1,17
QL Coefficient of Variation	0,61	0,45	**QL Coefficient of Variation**	0,51	0,69

APPENDIX D – PLAGIARISM-CHECK REPORT

GABRIELA DAIANA CHRIST

_Circular Economy_GABI_22-09-25_3 cap

Universidade Estadual do Oeste do Paraná (Unioeste)

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