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Is Circular Also Sustainable? Assessing Circularity and Sustainability to Enhance Legitimacy in Agri-Food Industry

Maria Elena Latino | Marta Menegoli | Maria Laura Giangrande

Department of Innovation Engineering, University of Salento, Lecce, Italy

Correspondence: Maria Elena Latino (mariaelena.latino@unisalento.it)

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ABSTRACT

The agri-food industry faces major sustainability challenges, requiring a shift in companies' approach. Circular economy principles offer a promising path by enhancing resource efficiency, reducing waste, and valorizing by-products. However, the integration of sustainability and circularity practices remains limited, especially in developing effective, sector-specific assessment models. This study addresses the gap by proposing a novel self-assessment framework based on mixed methods, to evaluate sustainability and circularity performance. It combines ESG dimensions with 10 circular R-strategies, offering a dual-level assessment. Legitimacy theory underpins the framework, highlighting that firms pursue sustainable and circular practices not only for compliance but also to gain social acceptance. The framework is validated through a multiple case study of three agri-food firms. Results show that circularity is not always equivalent to sustainability, revealing differing levels of strategy adoption. This research contributes a comprehensive, practical tool to support sustainable innovation and measure circularity in agri-food.

1 | Introduction

The agri-food industry is confronted with an array of challenges that demand innovative and sustainable solutions (Assa et al. 2021) to ensure its long-term viability and environmental responsibility. With the rising global demand for food and an increasing strain on natural resources (Flores and Villalobos 2020), the sector must evolve to address sustainability issues throughout its entire supply chain (Rohmer et al. 2019)—from agricultural production to food distribution and storage. The overconsumption of resources and the high levels of agricultural waste exacerbate environmental degradation, with the agri-food sector being a major contributor to global food waste and carbon emissions (Colozza et al. 2022; Gupta and Gupta 2021). As a result, there is an urgent need to adopt more resource-efficient, sustainable practices to minimize these negative impacts (Hina et al. 2023; Rugani and Lamastra 2023).

One potential solution to these challenges lies in the implementation of circular economy (CE) principles, which aim to optimize resource use, minimize waste generation, and encourage the reuse, recycling, and valorization of by-products (Jurgilevich et al. 2016; Suzanne et al. 2020). CE practices are critical for improving sustainability in the agri-food sector by reducing waste, reusing food products, and enhancing the efficiency of production systems (Donner & De Vries 2023). The adoption of CE strategies can transform agri-food businesses, driving the transition toward a more sustainable model of production and consumption (Schroeder et al. 2019).

Among the various frameworks that guide circular practices, the R-strategies framework proposed by Potting et al. (2017) provides a comprehensive approach to implementing circularity in business operations. This framework categorizes strategies into three groups based on their resource utilization and waste management cycle lengths, ranging from the shortest-cycle strategies such as refusal and reduction to the longer-cycle strategies such as recycling and recovery. The adoption of these strategies can help agri-food businesses transition toward more sustainable and circular models, while simultaneously mitigating the negative environmental impacts of traditional production processes.

However, while the literature extensively discusses sustainability and circularity frameworks, there remains a significant gap in the integration of these practices within the agri-food industry. The need for consistent, industry-specific sustainability and circularity assessment models is evident, yet useful metrics and practical frameworks are lacking to integrate and guide sustainability and circularity assessment in the sector (Corona et al. 2019; Sassanelli et al. 2019). Moreover, existing assessment tools often fail to capture the full complexity of circularity and sustainability in agri-food systems, highlighting the importance of developing more comprehensive, integrated models for evaluating and improving sustainability and circularity in this sector (Geissdoerfer et al. 2017).

Crucially, the adoption and disclosure of sustainability and circularity practices are deeply influenced by legitimacy theory (Suddaby et al. 2017; Weber 1978). Organizations seek legitimacy by aligning their actions with societal norms, values, and expectations, which is increasingly achieved through compliance with international standards and transparent sustainability reporting (Deegan 2002; Pellegrino and Lodhia 2012). In this context, legitimacy is not only a matter of regulatory compliance but also of ethical and symbolic alignment with stakeholder expectations (O'Dwyer et al. 2011; Suchman 1995). Thus, the development of integrated assessment models must consider not only technical and operational effectiveness but also the capacity to strengthen organizational legitimacy in the eyes of stakeholders.

Building on this perspective, there is a need to investigate how agri-food companies can rely on legitimacy theory to underpin integrated frameworks that both assess sustainability and circularity actions and support the enhancement of legitimacy as a "license to operate." To address this research gap, this paper introduces a novel self-assessment framework designed to evaluate sustainability and circularity performance in an integrated manner. The framework is developed through the theoretical lens of legitimacy and aims to answer the following research question (RQ): "How can agri-food companies assess sustainability and circularity performance for strengthening legitimacy?"

Through a detailed examination of existing literature and assessment tools, it identifies key challenges and opportunities for advancing the adoption of circularity principles and sustainability practices in the sector. By presenting a more integrated approach to both sustainability and circularity assessment called Sustainability and Circularity Assessment Model (S&C-AM), this study contributes to the growing body of research on sustainable practices in agri-food systems, while emphasizing the importance of legitimacy as a driver for effective and credible sustainability transitions. Moreover, it provides valuable insights for practitioners seeking to implement effective and comprehensive sustainability strategies. The results reveal that circularity is not always synonymous with sustainability, highlighting varying levels of commitment and integration of circular economy strategies within a sustainable business pathway, and therefore, highlighting areas for improvement and strategic opportunities.

The paper is structured as follows: Section 2 presents the background of the research. Section 3 outlines the methodology, providing an overview of the research design and the procedural flow adopted. Section 4 illustrates the main results, represented by the proposed S&C-AM, which is then applied in a multiple case study as described in Section 5. Finally, Section 6 presents the discussion, followed by the implications, limitations, and research agenda in Section 7.

2 | Background

2.1 | The Need for Sustainability and Circularity in the Agri-Food Sector

The sustainable management of the agri-food supply chain, from agricultural production to food distribution and storage, presents a major challenge for the modern world (Corona et al. 2019; Sassanelli et al. 2019). The increasing consumption of natural resources highlights the need for a more resource-efficient, effective, and sustainable economic system (Hina et al. 2023; Schaltegger et al. 2016). In this context, agricultural practices and agri-food production systems significantly impact the environment, primarily due to the numerous by-products that are commonly considered waste (Gupta and Gupta 2021). Additionally, the overproduction of agricultural waste is a global issue, making the agri-food production and processing sector one of the main contributors to global food waste (Colozza et al. 2022).

The 2024 Global Report on Food Crises highlights the scale of the problem, showing that nearly 281 million people worldwide continue to face insufficient access to nutritious food, while, each year, about 1.3 billion tons of food are wasted, corresponding to 13.8% of total production (Basiry et al. 2024; Zhang and Zhang 2024). This situation places the agri-food sector in a dual role: as a driver of massive food losses and as the subject of a significant environmental burden (Donno et al. 2024). Unlike other waste categories, food-related residues contain complex carbohydrates and bioactive compounds, representing a valuable resource for conversion into high-value applications (Pavlić et al. 2023) and an opportunity to advance circular and regenerative processes. Moreover, recent data from Istat (2023) indicate that the food, beverage, and tobacco industries are among the most proactive in adopting sustainability measures, underlining the urgency of reducing their footprint on land, resources, and social equity (Stetkiewicz et al. 2023). Altogether, these elements position the agri-food sector as a key field where circular economy approaches can provide integrated solutions to environmental, social, and economic challenges.

Given the negative impact that agri-food supply chains can have on the planet, adopting sustainable practices—such as reducing pesticide and fertilizer use, implementing renewable energy sources, and utilizing water-efficient irrigation systems

(Rugani and Lamastra 2023)—is essential to mitigate these effects (Stefanini and Vignali 2025). This effort is reflected in the strategic objectives of agri-food companies including the mitigation of greenhouse gas emissions, the conservation of natural resources, and the development of sustainable institutions and infrastructure (Sarango-Lalangui et al. 2023; Sklavos et al. 2023).

The key solution for promoting and ensuring long-term sustainability lies in the adoption of CE-based principles and practices, which seek to maximize resource efficiency by maintaining the value of products, materials, and resources for as long as possible, while minimizing waste generation (Suzanne et al. 2020; Donner & De Vries, 2023). Applying CE principles in the agri-food industry involves reducing the amount of waste generated in production systems, reusing food, and promoting recycling (Donner & De Vries, 2023) by adding value to agricultural and food by-products, recycling nutrients, and shifting toward more sustainable production and consumption models (Jurgilevich et al. 2016). Recent literature highlights several strategies through which circular economy principles are integrated into the agri-food sector. Key examples include restorative agroecological practices, such as organic farming and diversified cropping systems, which help decouple agricultural growth from resource depletion while enhancing soil health and biodiversity (Lord and Sakrabani 2019; Spina et al. 2025). Another widespread approach stands in the valorization of biomass, where residues are converted into value-added products like bioenergy, biochemicals, and feed (H. Liu et al. 2021; Spina et al. 2025). The transition toward circular strategies demands both incremental innovations (e.g., waste management improvements) and radical innovations (e.g., new governance models) for the sector, jointly transforming agri-food production and consumption (Gruchmann et al. 2021; Scandurra et al. 2023). In order to achieve a sustainability and green transition, companies have the opportunity to change their resource and process management through the application of the R-strategies of Circularity (Potting et al. 2017). These strategies guide companies in effectively creating, preserving, and recovering the value of production factors, by reducing the waste cycle length across different resource utilization phases and waste management approaches. Despite the R-hierarchy, the optimal sustainable strategy is always specific to each business context and requires a holistic approach, often combining multiple R-strategies. Moreover, CE aims to improve sustainability by reducing resource use and impacts on ecological systems (Brändström and Eriksson 2022), for example, in high-impact sustainability projects that typically integrate several R-strategies simultaneously (Potting et al. 2017). Schroeder et al. (2019) show that CE approaches can be applied as a vehicle for achieving Sustainable Development Goals (SDGs). Therefore, although the ultimate goal of CE principles is sustainable development, both concepts need appropriate and different assessment models (Esteban-Amaro et al. 2025).

2.2 | Sustainability and Circularity Assessments in Agri-Food Industry

In recent years, self-assessment of sustainability performance has gained significant traction, driven by growing social expectation and regulatory requirements for companies to measure and transparently communicate their sustainability impact to stakeholders (Paridhi and Arora 2023). The importance of pursuing sustainable development, and consequently its assessment and publication, is further emphasized at the international level through the 2030 Agenda for Sustainable Development,[1] which provides clear targets for achieving sustainable development in a holistic and integrated manner (Esteban-Amaro et al. 2025). Corporate sustainability reporting consists of the publication of documents aimed at informing about the efforts and goals achieved in the dimensions of Environmental, Social, and Governance (ESG) impacts (Purvis et al. 2019; Thies et al. 2019). In the international scenario, sustainability reporting is guided by standardized and commonly used frameworks among companies that support them in the sustainability self-assessment process. Among the currently established standards, the frameworks Global Reporting Initiative (GRI[2]), Task Force on Climate-related Financial Disclosures (TCFD[3]), Sustainability Accounting Standards Board (SASB[4]), and Global ESG Benchmark for Real Assets (GRESB[5]) represent the most widely used frameworks for company sustainability performance self-assessment, particularly within the manufacturing industries (Arkoh et al. 2024). Despite the availability of established models, sustainability reporting remains fragmented (M. Liu et al. 2024; Wijen et al. 2025), largely due to the diverse guidelines adopted across different industries and geographic regions (Siew 2015a)—such as the Streamlined Energy and Carbon Reporting (SECR[6]) used in the United Kingdom for public administration preferences.

On the other hand, several recent models have also been developed to assess circularity from different perspectives, with a strong prevalence in the manufacturing sector (Garza-Reyes et al. 2019). Among these, the Material Circularity Indicator (MCI),[7] the Circular Economy Index (CEI) (Di Maio and Rem 2015), the Longevity Indicator (Franklin-Johnson et al. 2016), the Circular Economy Indicator Prototype (CEIP) by Govindan and Hasanagic (2018), a morphological matrix introduced by N. G. Franco, Almeida, et al. (2021), the Circularity and Maturity Firm-Level Assessment Tool (CM-FLAT) proposed by Sacco et al. (2021), the Material Circularity Indicator (MCI) has been applied to agricultural systems (Rocchi et al. 2021), a framework for environmental impact evaluation proposed by Ahmed et al. (2022), and eight circularity indicators identified by de Oliveira and Oliveira (2023). Despite significant research in the manufacturing sector, recent reviews highlight a growing focus on methods such as life cycle assessment (LCA) and multicriteria decision-making (MCDM), often overlooking social and strategic dimensions (Cinelli et al. 2014; Stewart et al. 2018). This gap limits the completeness and generalizability of CE assessments (Sassanelli et al. 2019; Corona et al. 2019).

In response, recent contributions have introduced new assessment tools, encompassing both standardized and nonstandardized frameworks that integrate sustainability and circularity dimensions. Among the standardized approaches, Luthin et al. (2024) developed the Circular-Life Cycle Sustainable Assessment (C-LCSA) model, an integrated framework that combines LCA, Life Cycle Costing (LCC), Social-LCA (S-LCA), and CE to provide a quantitative evaluation of circularity and sustainability performance across industries. Hackenhaar et al. (2024) introduced the LC^3SA framework, a comprehensive LCSA-based model that also incorporates criticality and circularity assessments, while Silvestri et al. (2024) proposed a conceptual framework intersecting environmental, social, and economic sustainability indicators with LCC, LCA, and S-LCA, specifically applied to agri-food products. Other nonstandardized approaches include Ramírez-Rodríguez et al. (2024), who integrate sustainability and circularity through an Industrial Symbiosis Life Cycle perspective, focusing on resource and energy sharing among firms. Payer et al. (2024) designed a mixed-method model that evaluates seven CE dimensions and the three sustainability spheres, with particular emphasis on technological resources enabling Industry 4.0 and 5.0 paradigms. Finally, Ruggieri et al. (2024) developed a framework based on Open Data indicators across three life cycle levels (national, regional, and micro), offering a comprehensive overview of the measurement of circularity performance in the agri-food sector. Measuring sustainability and circularity performance is a complex task; consequently, the three ESG dimensions of sustainability and the levels of circularity performance need to be integrated to simplify the full assessment process (Esteban-Amaro et al. 2025). Based on the literature and the most common applications among practitioners, it is evident that the concept of circularity is addressed in a fragmented manner, highlighting the lack of a unified and validated approach to measuring a company's CE particularly in the agri-food sector (Kristensen and Mosgaard 2020). Regarding CE, the literature argues that the ultimate goal of circular practices is sustainable development (Schroeder et al. 2019), as well as that circularity is a condition for achieving sustainability goals. Because sustainability and circularity principles are connected and braided, both concepts need appropriate means of evaluation that can accurately express a company's effort in both topics (Geissdoerfer et al. 2017).

In Table 1, the application of different assessing models is shown, from which some literature gaps and a lack of integrated applications are derived.

The current state of the literature underscores a significant gap in the alignment between assessment tools and reference standards for self-assessing corporate performance in sustainability and circularity (Roos Lindgreen et al. 2022). Notably, all the models identified address either sustainability or circularity separately, never integrating both dimensions simultaneously. This highlights the urgent need for a self-assessment model for companies that simultaneously evaluates both sustainability and circularity, while also recognizing legitimacy as a sign of their commitment and dedication in both dimensions (O'Dwyer et al. 2011; Weber 1978). Although the relationship between sustainability and circularity remains unclear (Geissdoerfer et al. 2017), these aspects point to the idea that the two concepts, often treated separately, could be conceptually and strategically linked, suggesting that their joint consideration may reveal interdependencies and synergies that are otherwise overlooked.

As shown in Table 1, existing models tend to focus on one dimension at a time, failing to account for the interconnections between them. This is particularly problematic in the agri-food sector, where companies face unique challenges such as resource-intensive processes, waste management, and environmental impact. Unlike sectors like automotive, which benefit from well-established models, the agri-food industry lacks a comprehensive framework tailored to its specific needs (Siew 2015b; Kristensen and Mosgaard 2020). Developing an integrated self-assessment tool would therefore provide companies with a more holistic understanding of their performance and enable targeted improvements in both sustainability and circularity.

3 | Conceptual Framework and Theoretical Lens

Corporate sustainability is a key topic in the literature, often viewed through the powerful lens of legitimacy theory (Weber 1978). This theory posits that organizations operate under an implicit "social contract" with society, and their continued existence and success depend on their ability to align their actions with societal norms, values, and expectations (Suddaby et al. 2017). By adopting innovative and sustainable practices, companies can actively manage this social contract, thereby strengthening their legitimacy by addressing increasing societal and environmental demands (Cho and Patten 2007; Bocken et al. 2014).

In the context of corporate sustainability practices, legitimacy comes into play through normative recognition, meaning that a company is considered legitimate if it aligns with socially accepted norms and values (Jackson et al. 2023). International standards for environmental management and sustainability reporting serve as key tools to ensure that businesses operate sustainably, reinforcing their credibility while also improving their reputation among investors and consumers (Pellegrino and Lodhia 2012; Pereira Eugénio et al. 2013; Deegan 2002; Darnall et al. 2024). Legitimacy in relation to sustainability is also discussed in the literature in terms of symbolism, where certain symbolic actions, such as merely signaling environmental concerns (O'Dwyer et al. 2011), may indicate a level of commitment to sustainability, even if they do not translate into actual initiatives within corporate operations. This approach helps companies shape a favorable public image and gain societal support (Massey 2001; Suchman 1995; Aerts and Cormier 2009; Rodrigue et al. 2013; Shahab and Ye 2018).

On one hand, large corporations gain normative and symbolic legitimacy by complying with international standards and publishing sustainability reports (Deegan 2002; Richards et al. 2023). On the other hand, many companies obtain ethical legitimacy, which derives from adherence to ethical norms (Suchman 1995). In today's context, corporate sustainability is closely linked to legitimacy, understood as compliance and acceptance by society and stakeholders. This is reinforced by research showing that companies with superior sustainability performance choose high-quality disclosures to signal their true commitment to the market, a practice aligned with voluntary disclosure theory (Hummel and Schlick 2016). Conversely, companies with weaker sustainability records may use superficial or low-quality reports to disguise their poor performance and manage public perceptions, a strategy rooted in symbolic legitimacy (Hummel and Schlick 2016). True ethical legitimacy, therefore, goes beyond compliance and is earned through substantive commitment. By engaging in rigorous sustainability assessments, companies demonstrate that their actions are driven by genuine ethical norms rather than just a legal mandate.

TABLE 1 | Sustainability and circularity self-assessment models in literature and industrial landscape.

Model	Sustainability assessment			Circularity assessment	Assessment typology	Data collection method	Sector of application	References
	1. Environmental	2. Social	3. Economic					
GRI	●	●	●	○	Mixed	Document analysis, direct measurement, survey, interview	Cross-industry	http://Globareporting.org
TCFD	◐	◐	◐	○	Mainly Quantitative	Document analysis, direct measurement, survey, interview	High-impact industries	http://fsb-tcfd.org
SASB	●	●	●	○	Mixed	Document analysis, direct measurement, survey	Cross-industry	http://gresb.com
GRESB	●	○	●	○	Mixed	Direct measurement, survey, SAQ5.0 tool	Real Estate, Infrastructure	http://gresb.com
SAQ5.0 Rating report	●	●	●	○	Mixed	Document analysis, survey, interview	Automotive, Manufacturing	http://drivesustainability.org
MCI	○	○	○	●	Quantitative	Direct measurement, document analysis, calculation tools	Manufacturing	http://Ellenmacarthurfoundation.org
CEI	○	○	○	●	Mainly Quantitative	Direct measurement, document analysis, calculation tools	Manufacturing	(Di Maio and Rem 2015)
Longevity indicator	○	○	○	●	Quantitative	Survey, calculation tools, Direct measurement	Manufacturing	(Franklin-Johnson et al. 2016)
CEIP	○	○	○	●	Mixed	Document analysis, direct measurement, survey, interview	Manufacturing, Automotive	(Cayzer et al. 2017; Govindan and Hasanagic 2018)

(Continues)

TABLE 1 | (Continued)

Model	Sustainability assessment: 1. Environmental	2. Social	3. Economic	Circularity assessment	Assessment typology	Data collection method	Sector of application	References
Strategic measurement framework and matrix	● (grey)	● (grey)	● (grey)	● (blue)	Mixed	Document analysis, direct measurement, survey, interview, calculation tool	Manufacturing, Automotive	(C. D. Franco, Nicolle, et al. 2021)
CM-FLAT	● (grey)	● (grey)	● (grey)	● (blue)	Mixed	Document analysis, direct measurement, survey, interview	Cross-industry	(Sacco et al. 2021)
MCI for LCA assessment	● (grey)	● (grey)	● (grey)	● (blue)	Mainly Quantitative	Direct measurement, document analysis	Agri-food	(Rocchi et al. 2021)
Circularity in sustainability performance	● (grey)	● (grey)	● (grey)	● (blue)	Mixed	Document analysis, direct measurement, survey, interview	Manufacturing	(Ahmed et al. 2022; de Oliveira and Oliveira 2023)
C-LCSA	● (blue)	◐ (half blue, half grey)	◐ (half blue, half grey)	● (blue)	Quantitative	Direct measurement, survey	Cross-industry	(Luthin et al. 2023)
Conceptual framework for Sustainable Development in Industrial Symbiosis	● (blue)	● (blue)	● (blue)	● (grey)	Qualitative	Document analysis, direct measurement, survey, interview	Cross-industry	(Ramírez-Rodríguez et al. 2024)
Circular Economy Monitoring Framework for Industry 5.0	● (blue)	● (blue)	● (blue)	● (grey)	Mixed	SODA, interviews, computational procedures	Cross-industry	(Payer et al. 2024)
LC^{3}SA	● (blue)	● (blue)	● (grey)	● (blue)	Mixed	Document analysis, direct measurement, survey, interview	Cross-industry	(Hackenhaar et al. 2024)

(Continues)

TABLE 1 | (Continued)

Model	Sustainability assessment 1. Environmental	2. Social	3. Economic	Circularity assessment	Assessment typology	Data collection method	Sector of application	References
Indicator Framework for Circular Agri-Food Sustainability	●	●	●	○	Mixed	Document analysis, direct measurement, survey	Agri-food	(Silvestri et al. 2024)
LCB-dashboard	○	○	○	●	Qualitative	Open data collection processes	Agri-food	(Ruggieri et al. 2024)

Companies that invest in sustainable practices and demonstrate a commitment to social and environmental well-being are more likely to maintain legitimacy and build positive relationships with stakeholders (Porter and Kramer 2006).

Many businesses gain recognition for their sustainability even without formal certification, by engaging in voluntary practices that reflect societal values. They shape their business models to support environmental causes, such as reducing carbon emissions, improving working conditions, or minimizing waste (Ellerup Nielsen and Thomsen 2018; Crossley et al. 2021).

Because companies gain legitimacy through their actions and also through the recognition of their commitment to sustainability by society, the performance reporting in sustainability and circularity fields becomes almost a necessity and consequently a strategic choice, for maintaining their legitimacy (O'Dwyer et al. 2011). This relationship can be further visualized as a conceptual framework (Figure 1) where legitimacy theory acts as the lens through which a company's sustainability and circularity assessments are evaluated, highlighting the progression from compliance to true ethical commitment.

The conceptual framework visualizes how legitimacy theory functions as a frame for understanding corporate efforts in sustainability and circularity assessments. It is structured to illustrate a clear progression from a company's actions for sustainability and circularity (input) to the strategic outcomes (outputs) of gaining, and then maintaining, legitimacy (process). The elements of the conceptual framework are:

- **Firm actions (input)**—This element represents the company's activities related to sustainability and circularity. Especially, it highlights the company's effort in the assessment of sustainability and circularity performance. This effort enables the following: (i) *regulatory compliance*, actions taken to meet legal requirements and mandatory standards, such as those imposed by EU directives or reporting frameworks; (ii) *voluntary ethical commitment*, practices that go beyond legal obligations and reflect a company's intrinsic values, including high-quality reporting and proactive circular economy initiatives.
- **Process of gaining legitimacy (process)**—This central flow demonstrates how a company's actions are perceived and recognized by society, leading to different forms of legitimacy: (i) *normative legitimacy*, gained by complying with regulations and industry standards. This results in the perception that the company is acceptable and rule-abiding; (ii) *pragmatic legitimacy*, gained by providing tangible benefits to stakeholders, such as sustainable products or improved working conditions. This leads to the perception that the company provides concrete value to society; (iii) *ethical (substantive) legitimacy*, the highest and most resilient form of legitimacy, which is earned by demonstrating a deep and verifiable commitment to the environment and society that moves beyond simple compliance. This fosters a perception that the company is reliable, responsible, and trustworthy.
- **Strategic outcomes (output)**—The final section shows the long-term benefits of an ethical approach to

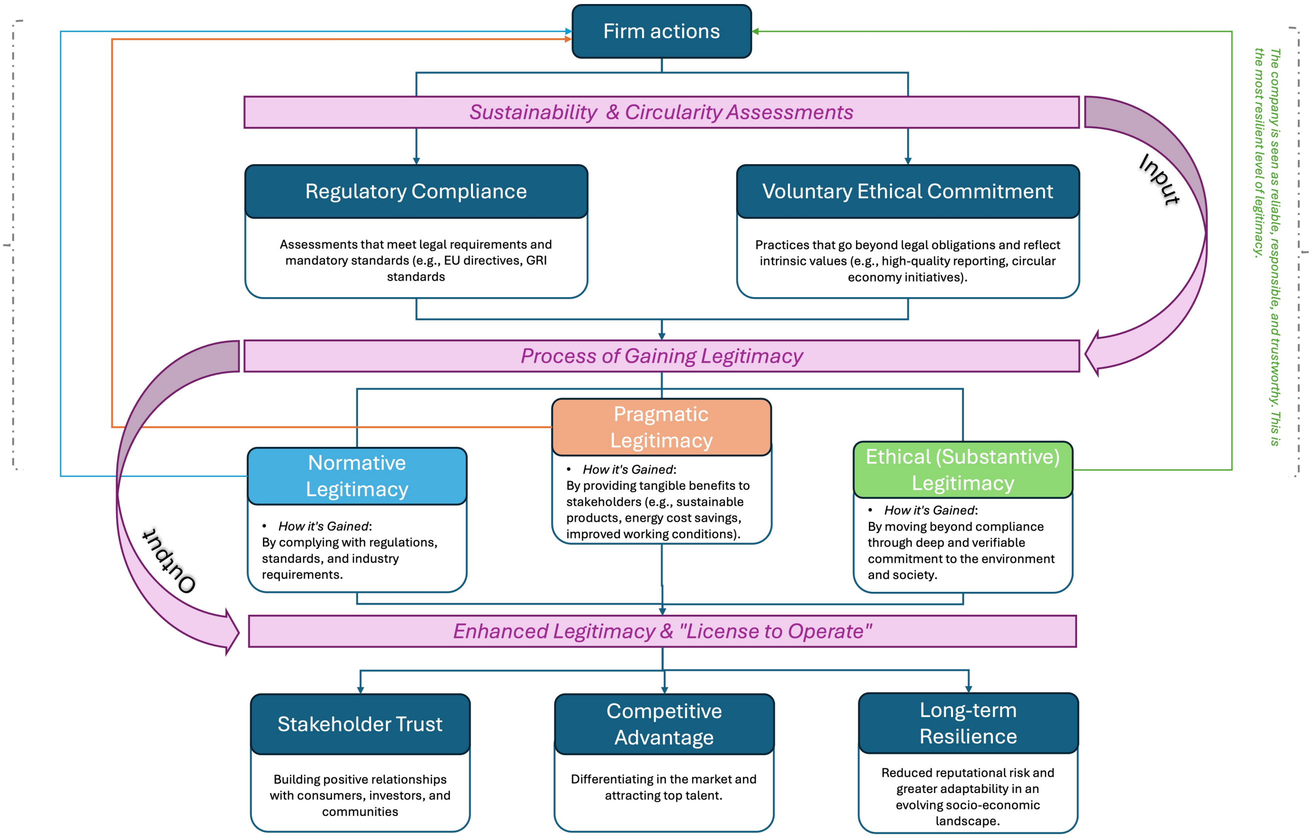

FIGURE 1 | Theoretical framework.

sustainability. Achieving enhanced legitimacy translates into a strong "License to Operate," leading to the following: (i) *stakeholder trust*: building positive, lasting relationships with consumers, investors, and communities; ii) *competitive advantage*: differentiating the company in the market and attracting top talent; iii) *long-term resilience*: reducing reputational risk and increasing the ability to adapt in a rapidly evolving socio-economic landscape.

4 | Methodology

4.1 | Research Design

This study adopts a mixed-methods research design (Figure 2) to develop and validate the proposed integrated assessment framework. The research is structured in two sequential phases.

In the first qualitative phase, using Scopus and the web as data sources, a screening of the literature and the industrial landscape enabled the identification of the 13 most referenced sustainability and/or circularity assessment models (Table 1). The application of these models in the agri-food sector was detected, as the sector plays a crucial role in the economy and food systems, highlighting the need for companies to conduct self-assessments (Abbate et al. 2023). The analysis of the selected models was carried out using a *winnowing procedure* (Creswell and Creswell 2017; Guest et al. 2012), aimed at identifying key characteristics of each model—including the specific sustainability or circularity dimension addressed, model typology, evaluation and data collection methods, and sector of application. The *winnowing procedure* allowed us to build a comprehensive frame about sustainability and circularity assessment models, in which they were compared and critically analyzed in order to detect the most recognized methods and tools for data collection and analysis in the assessment procedure (see Table 1).

Among these, the questionnaire for self-assessment and computational models for quantitative evaluation were the most referenced methods and tools for, respectively, data collection and data analysis in the sustainability and circularity assessment field. Specifically, SAQ 5.0 (Govindan and Hasanagic 2018; Drive Sustainability 2022[8]) was selected to enable the evaluation of companies' sustainability performance through simple questions that cover seven dimensions of inquiry: business management, human rights and working conditions, health and safety, business ethics, environment, responsible supply chain management, and responsible procurement of raw materials. SAQ 5.0 integrates unstructured interviews as a data collection method, enabling direct interaction with stakeholders and the capture of latent information and insights that may not be revealed through structured questionnaires alone. This approach, while requiring careful analysis and interpretation, allows for a more holistic and nuanced understanding of sustainability performance. For these reasons, this model was selected over other models recognized in the literature, due to its detailed structure also supporting multilevel evaluation of a company's sustainability score, combining both topical and overall assessments, which strengthens the

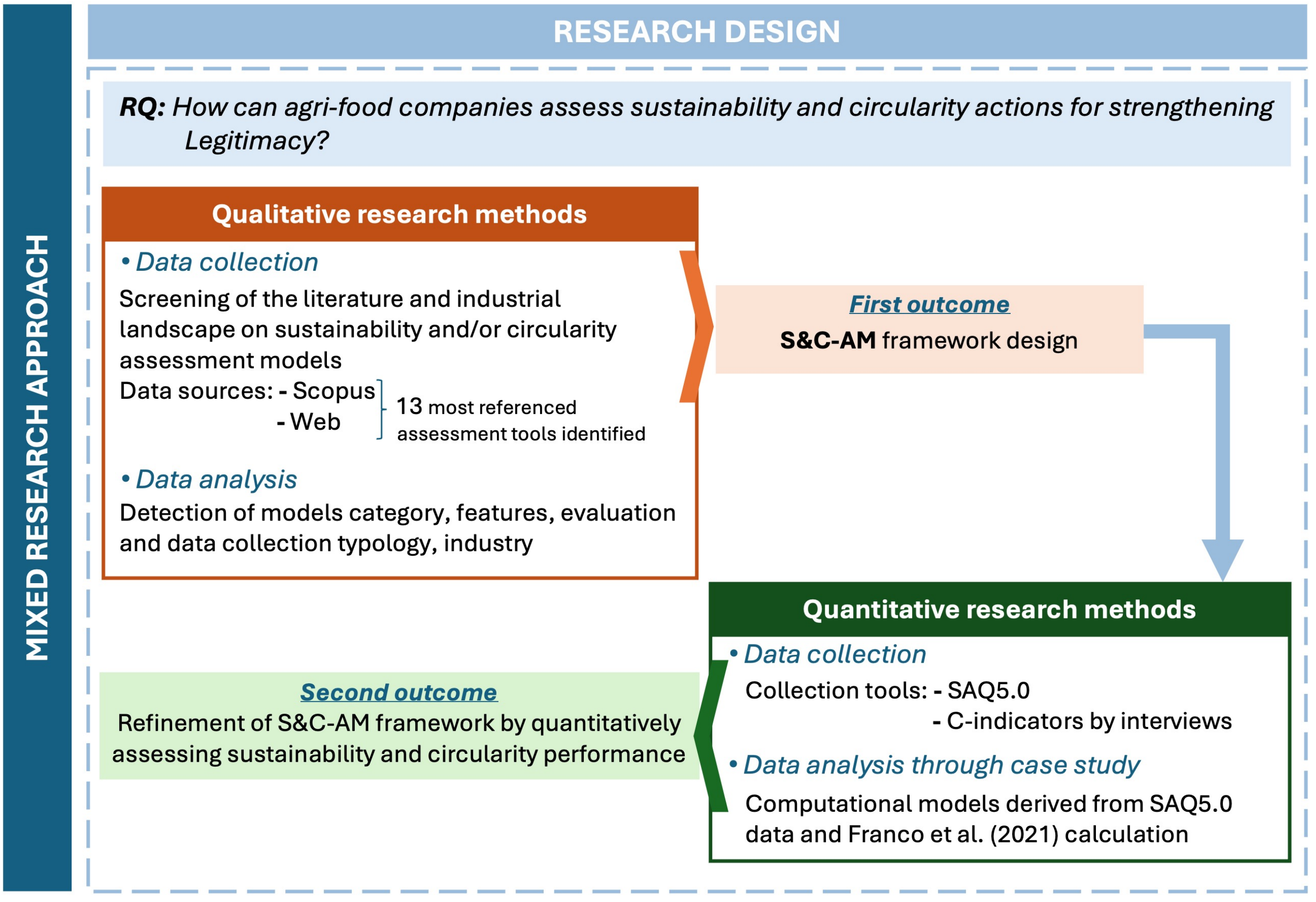

FIGURE 2 | Research design overview.

robustness, depth, and effectiveness of the whole assessment process. The choice of applying the SAQ5.0 in the agri-food sector, even if it was originally developed for sustainability assessment in the automotive industry, is justified by its prior use in similar industries and for comparable purposes. Specifically, the SAQ5.0 has been employed to evaluate sustainability in sectors that share key characteristics with the agri-food industry, which is classified under the international category of Food, Beverage, and Tobacco Manufacturing.[9] As this category falls within the broader manufacturing sector, the use of the SAQ5.0 in this study is both appropriate and methodologically sound. Moreover, given that the automotive sector is highly complex in terms of supply chains, production processes, and regulatory requirements, the transferability of the SAQ5.0 to the agri-food sector is likely facilitated by the relatively lower complexity of this industry. This suggests that the model can be effectively adapted to the agri-food context, while still maintaining its rigorous multilevel and holistic assessment capabilities. Based on the answers to the questionnaire, SAQ 5.0 enables the computation of a comprehensive percentage score (more details in Section 3.1.1), which can be an intelligible way to understand the effort of a company in sustainability transition. Additionally, to collect information related to circularity, the strategic measurement framework and matrix (N. G. Franco, Almeida, et al. 2021) was adopted. This tool evaluates the company's circularity performance through interviews focused on 38 C-indicators, grouped into 10 strategies categories (listed in Table A1 in Appendices).

The framework enables a quantitative, strategy-by-strategy assessment, as detailed in Subsection 3.1.1. The combination of the two selected assessment models, which may initially appear as separate tools, stems from the observation that the domains of sustainability and circularity could be connected through a defined or complementary relationship. This potential interconnection, often overlooked in practice, represents a conceptual area that this study aims to explore, allowing for a holistic and comprehensive evaluation that strategically intersects and overlaps both dimensions to capture their possible interdependencies. In order to define the linkages between ESG sustainable dimensions—as proposed by the SAQ5.0—and the C-indicators and related R-strategies—as proposed by the strategic measurement framework and matrix—a focus group was conducted. Specifically, five experts, consisting of two senior researchers in the management field, one consultant with self-assessment competencies, one practitioner expert in CE and one manager from the agri-food industry, were involved in the focus group to (i) identify the dimensions of the SAQ5.0 in relation to the ESG dimensions, as well as their alignment with common sustainability practices, and (ii) link sustainability practices to the R-strategies of circularity. The sessions followed a semistructured format, fostering open discussion and reflection on both theoretical and practical aspects. Participants were presented with the SAQ5.0 dimensions and circularity indicators and invited to discuss their conceptual alignment, applicability in practice, and potential synergies. Guided facilitation enabled systematic mapping of

ESG dimensions to sustainability practices, which were subsequently linked to circularity R-strategies. Notes and records of the discussions were collected, qualitatively analyzed, and synthesized to support the initial design of the S&C-AM model. This structured yet flexible approach concluded the first qualitative research phase leading to the formulation of preliminary results, represented by the design of the S&C-AM model, enabling the quantitative assessment of sustainability and circularity performance (see Section 4). This achievement supported the application of the second phase of quantitative research aimed at testing and refining the proposed model. In this phase, data collection was carried out following SAQ5.0 and the strategic measurement framework and matrix as previously described, and data analysis was performed through specific computational models, explained in the following section.

4.1.1 | Computational Models Design

The data collection tools allow the quantitative assessment of sustainability and circularity. Regarding sustainability, SAQ5.0 enabled two levels of sustainability assessment. The first assessment is more specific and involves the seven dimensions into which the SAQ5.0 is structured, assigning a percentage score to each of them. This assessment translates into a computational model the measurement scale and the rating algorithm established and already formalized by the SAQ 5.0 tool.

Considering the rating obtained from each question as:

$$\mathrm{R}_{ij} = \sum_{a=1}^{N_{ij}} \gamma_{ija}\,[\%] \tag{1}$$

where γ_{ija} is the coefficient associated with answer *a* of the *j*-th question within the *i*-th section, the *topical sustainability assessment* is evaluated as:

$$\mathrm{S}_i = \sum_{j=1}^{N_i} R_{ij}\,[\%] \tag{2}$$

with S_i representing the total rating of the *i*-th section (where $i=1,\dots,7$) and N_i is the number of questions in the *i*-th section. In this way, the assessment of each section gives a detailed analysis of the levels of sustainability in the different environmental, social, and governance domains associated with the sections.

Subsequently, an *overall sustainability assessment* can be obtained through the sum of all the topical assessments in each section, resulting in an aggregated value that represents the total rating of sustainability:

$$R_{\mathrm{tot}} = \sum_{i=1}^{7} S_i\,[\%] \tag{3}$$

The overall assessments permit placing a company within sustainability levels (from A to F in descending order), represented by a total percentage score.

Regarding circularity assessment, the following computational model is based on already theorized N. G. Franco, Almeida, et al. (2021) model and therefore inherits the statistical design and validation already presented in the study. The indicators considered were selected according to the value of their *Closeness coefficient* CC_{km}, and each one is also associated with the value w_{R_k} of the percentage weight of each R-strategy. The calculation procedure carried out enabled the obtaining of a final global percentage, corresponding to the company's level of circularity performance.

Considering the *C-indicators* IR_{km} selected, where $k=0,\dots,9$ is the index representative of the strategy, and $m=1,\dots,n$ is the subindex within the *k*-th strategy, the *weight* associated with each *C-indicator* $\mathrm{IR}_{\mathrm{km}}$ will be:

$$W_{km} = w_{R_k}\, CC_{km} \tag{4}$$

where CC_{km} is the corresponding *Closeness Coefficient* for each IR_{km}, and w_{R_k} represents the percentage weight associated to each *strategy* R_{k}. Both categories of coefficients are sourced from the calculation model proposed by C. D. Franco, Nicolle, et al. (2021). Once all the indicators within a single strategy are defined, it is possible to derivate the composite C-indicator, which is the global indicator associated to a strategy. It is obtained as follows:

$$C_{R_k} = \sum_{m=1}^{n} W_{km}\mathrm{IR}^{\mathrm{N}}_{km} \tag{5}$$

where $\mathrm{IR}^{\mathrm{N}}{}_{km}$ is the normalized value of each C-indicator within the strategy. The *global assessment of circularity* will result from the computation of the overall *Circularity Performance Index* (CPI):

$$\mathrm{CPI} = \sum_{k=0}^{9} C_{R_k} \tag{6}$$

The integration of computational steps for sustainability and circularity culminated in the overall result of the proposed model.

4.2 | Research Procedural Flow

Figure 3 shows the research procedural flow followed to address the aim of the study.

Once the RQ was defined, the steps of the qualitative research phase began with the screening of literature and industrial landscape data, which allowed the detection and selection of assessment models related to sustainability and circularity based on their field of application and relevance (first decision points). The subsequent step revealed a gap in the literature regarding the lack of assessment models capable of simultaneously evaluating both sustainability and circularity. This gap led to the design of the proposed model (third procedure step). The rationale guiding the selection process of the models considered for the design phase is detailed in the representation attached in Figure A1 of the Appendix. In that phase, the model design was conducted to outline the sustainability dimensions covered by the SAQ5.0 tool and the R-strategies of circularity that form the basis of

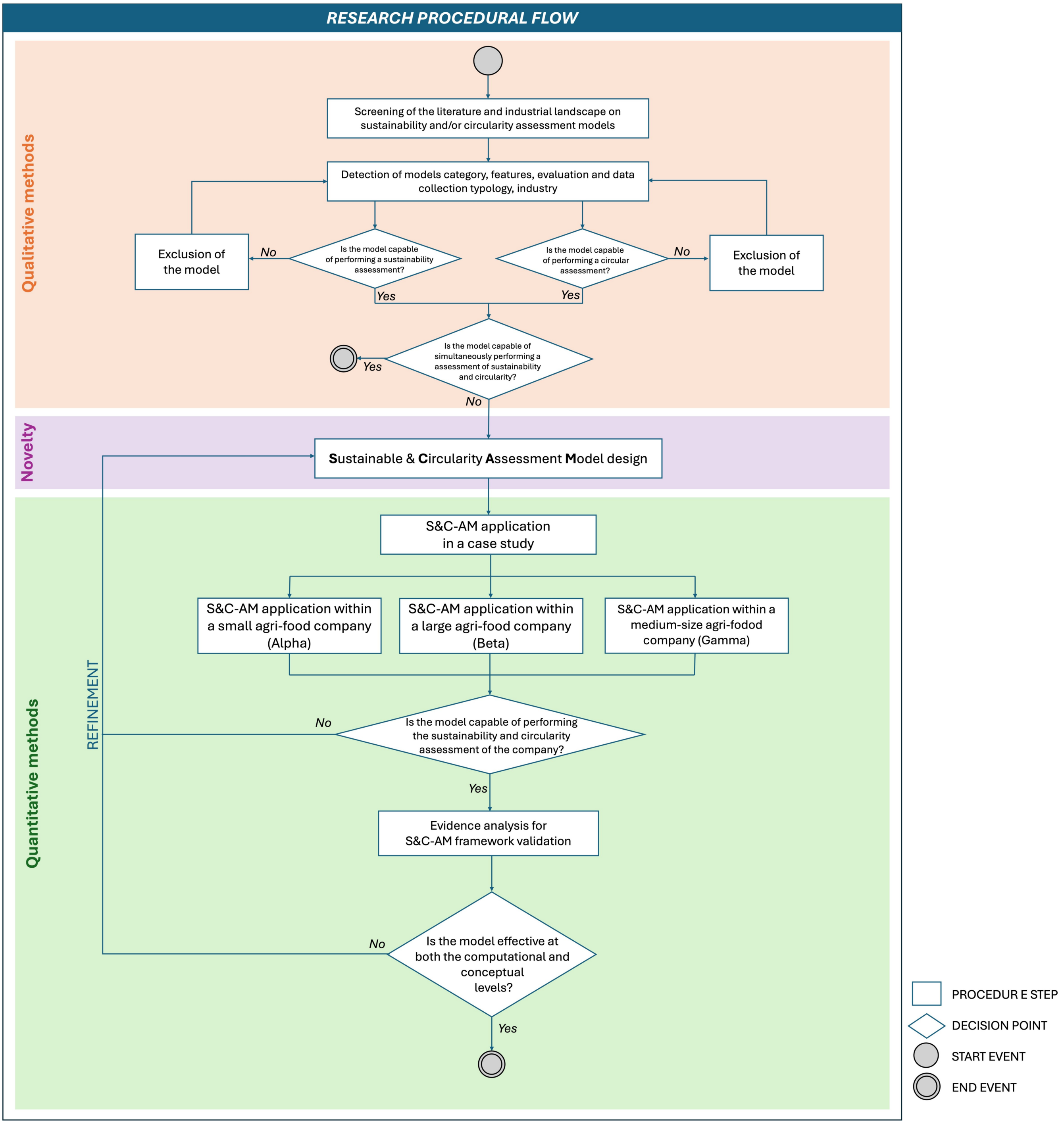

FIGURE 3 | Research procedural flow.

C. D. Franco, Nicolle, et al. (2021)'s model, connecting them with relational correspondences. In the second phase of the procedure, the quantitative research phase, with the aim of validating the model, a case study was conducted. The application of the model to three companies in the agri-food sector allowed for its analysis from a real-world perspective. The relevance of the agri-food sector, as highlighted in previous sections, underscores the need to analyze the opportunities available to companies in this field to counteract resource overuse and excessive waste generation, while pursuing the integration of sustainability-oriented practices (Abbate et al. 2023; Sahu et al. 2022). This also emphasizes the importance of assessing and evaluating their actual performance in terms of sustainability and circularity efforts. To ensure representativeness and capture the diversity of practices within the agri-food system, three case studies were selected using a maximum variation sampling strategy (Samuel and Merkebu 2025). Each case corresponds to a distinct organizational scale—a local micro-company (less than 50 employees), a small-to-medium enterprise (SME), and a large multinational corporation—allowing for a robust cross-case analysis of sustainability and circularity approaches. These cases were chosen as archetypal examples representing the primary business sizes operating in the sector, enabling us to compare the influence of organizational scale, resource availability, and market reach on the adoption and maturity of circular economy strategies. The qualitative validation of data collected from the case studies was conducted as suggested by Creswell and Creswell (2017), using two different validity procedures: member checking, conducted within an internal focus group where participants verified the accuracy of the data collected before analysis, and consultation with an external auditor to obtain an objective evaluation of the information collected and to provide important advice as an independent professional perspective.

The final step involved interpreting the results of the case study, focusing on critically examining both the computational and conceptual coherence of the proposed model, allowing for a deeper understanding of the relationship between the concepts of circularity and sustainability. Evidence from this analysis opened up to a refinement of the framework, connecting back to the structure design step for opportunities for improvement.

5 | The Proposed Sustainable Circularity Assessment Model

A framework linking sustainability practices with CE strategies was built for supporting companies in assessing their commitment to both sustainability and CE, representing the first concrete proposal of alignment between the two topics.

This framework, which is the main result of the study, was named Sustainable Circularity Assessment Model (S&C-AM), because it integrates the qualitative and quantitative evaluation of both sustainability and circularity, conceiving them as two interconnected dimensions. In doing this, S&C-AM, represented in Figure 4, leverages the ESG conceptualization of sustainability and makes top–down connections, with sustainability sections and practices considered in SAQ5.0 (described in Section 3.1.1), and R-strategies defined in the strategic measurement framework and matrix proposed by C. D. Franco, Nicolle, et al. (2021). Specifically, the first row of S&C-AM, "Sustainability dimensions," represents the three macro-dimensions of sustainability on which a company can focus its efforts. In the second row "Sustainability sections," each macro-dimension was associated, as described in Section 3, with the SAQ5.0 sections for sustainability assessment, representing how the macro-dimensions of sustainability are detailed in the areas of corporate responsibility.

Through the analysis of the SAQ5.0 questions belonging to each sustainability section, it was possible to derive different sustainability practices from them, divided into 10 macro-categories (described in Figure 4), forming the third row of S&C-AM "Sustainability practices." The fourth row, "R-strategies of CE," represents the set of CE strategies theorized by Potting et al. (2017). The transition from the sustainability sphere to the CE sphere is represented by the arrows, which link each sustainability practice to the corresponding CE strategy under which it falls. All the associations identified by means of qualitative analysis are explained in Figure 5.

The last row of S&C-AM, "C-indicators," comprises the set of circularity indicators for quantitatively assessing company efforts for each R-strategy as proposed by C. D. Franco, Nicolle, et al. (2021).

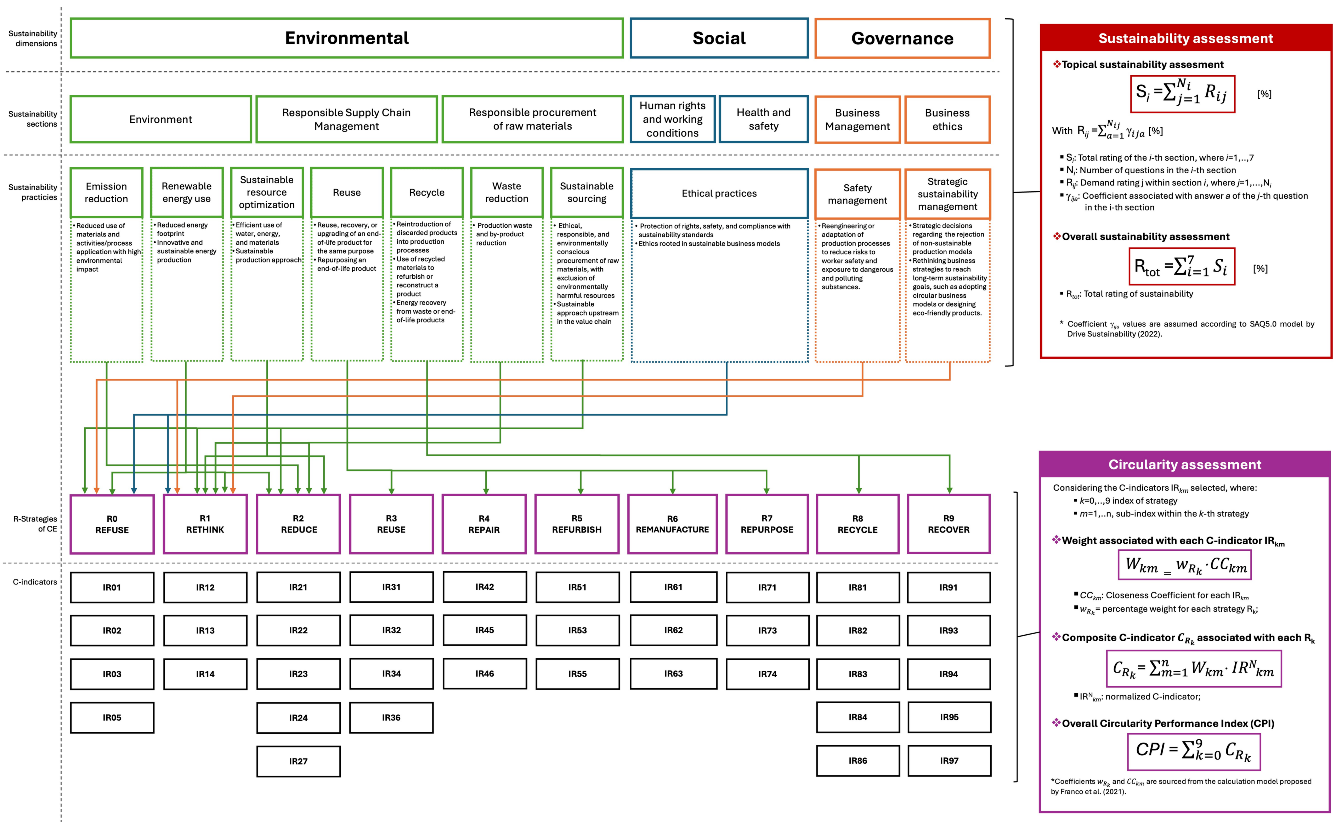

FIGURE 4 | Framework for sustainability and circularity assessment with computation mode.

As explained in Section 3.1, S&C-AM is capable of quantitatively assessing sustainability and circularity, by simultaneously considering two computational models. In the following section S&C-AM is applied in a case study composed of three agri-food companies, providing examples of implementation.

6 | Multiple Case Study

A multiple case study on three agri-food companies was conducted with the aim of applying the proposed S&C-AM. The three companies, all focused on a sustainable approach to production, are described in Figure 6.

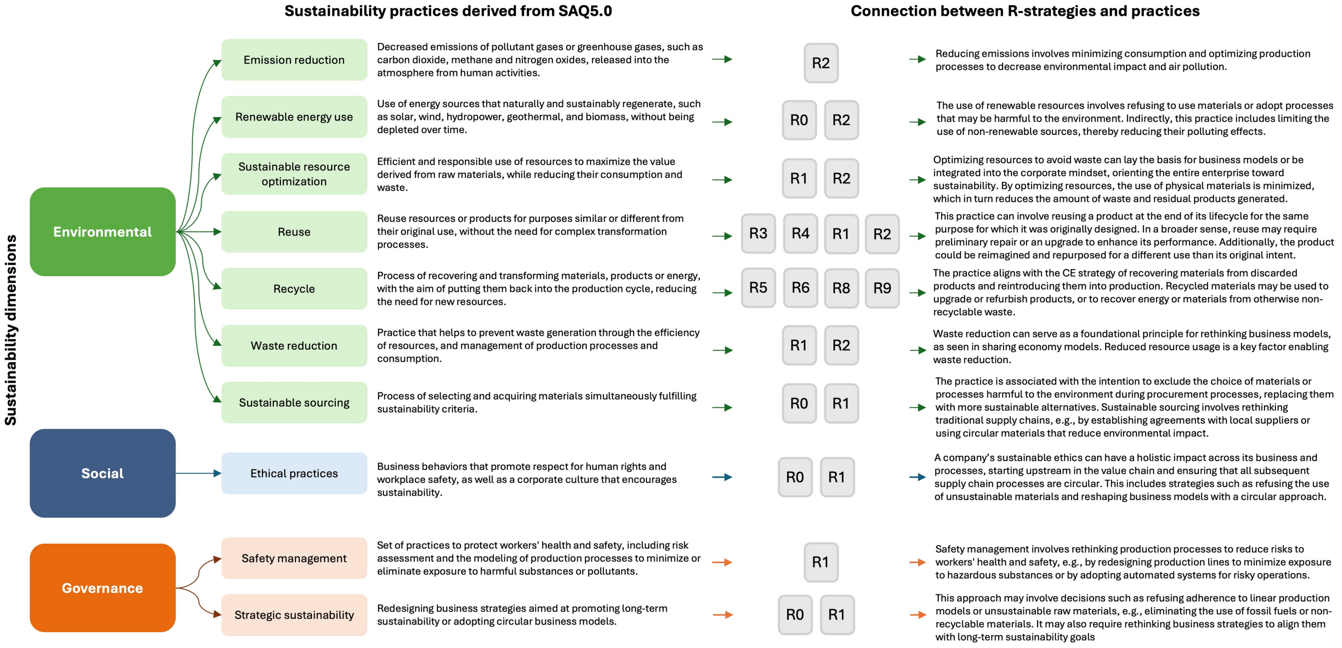

FIGURE 5 | Identification of sustainability practices from SAQ 5.0 and their associated R-strategies.

	ALPHA	BETA	GAMMA
Offering	Eggs production	Nutritional supplements, specialized medical nutrition, weight management products	Nutritional products, healthcare services, scientifically backed solutions, highly personalized meal plans
Number of employees	< 50 employees	> 5000 employees	> 50 employees
Turnover	200k dollars (2024)	4.4B dollars (2024)	5,6M dollars (2024)
Mission	To produce high-quality eggs with a strong commitment to ethical farming, sustainability, and food safety	To deliver science-based health solutions across all life stages, promoting global health and well-being	To deliver personalized nutrition and wellness solutions powered by research and technology
Sustainability effort	The company avoids chemical feed, ensures animal welfare, reuses animal waste as fertilizer, and adopts eco-friendly practices that benefit both people and the environment	The company uses renewable energy, recycled packaging, and environmental systems to reduce waste across its supply chain	The company reduces waste, sources responsibly, and limits environmental impact across its global supply chain

FIGURE 6 | Description of companies included in the case study.

6.1 | Case Alpha

Alpha is an innovative small company in the food industry, specializing in high-quality eggs that meet the growing consumer demand for sustainability, ethical farming, and superior food products. The manager of Alpha would like to discover if some of their established practices may be recognized as circular, which is why they accepted to supply the company's data for validating S&C-AM.

Based on the responses from the SAQ5.0 questionnaire, it was possible to associate the company with categories of CE strategies, classified by the R-framework according to the level of commitment and the duration of waste cycles. In Figure 6, S&C-AM was tailored on Alpha data, switching off (see element in grey color) dimension*, section*, practice*, R-strateg*, and related C-indicator* not able to represent the company as is operativity.

The results from the SAQ5.0 reveal sustainability performance characteristics primarily related to environmental and governance aspects. Regarding environmental sustainability, the company implements practices related to biodiversity and ecosystem preservation, which include the use of organic raw materials and the reduction of waste, both in terms of quantity and harmfulness. These sustainability practices fall into three specific categories of circularity strategies identified in the R-framework (Potting et al. 2017), explained below.

- R0—Refuse. The company's operations are driven by the goal of making the farming environment as natural and livestock friendly as possible. For this reason, it deliberately avoids and prohibits the use of chemical feed and pharmaceuticals, aligning with refusal strategies that eliminate harmful substances from the environment.
- R1—Rethink. As an opportunity for rethinking the business (Potting et al. 2017), the R1 strategy is recognized in the Alpha case, since the company has built its business model upon circular and sustainable principles that establish an ethical foundation and orient its overall approach to operations and decision-making. The company bases its entire production on sustainability principles, fostering governance and a corporate mindset committed to full ecosystem respect. This strategy is also evident in its approach to responsible sourcing of laying hens, which are rescued from intensive farming and given a new life in a natural environment. This reflects a fundamental rethinking of the company's procurement process and resource management.
- R2—Reduce. A well-implemented and deeply integrated code of conduct, as adopted by the company, actively drives the reduction of waste and resource consumption. This strategy, embedded within the company's operations, promotes responsible practices and efficient resource management, ensuring long-term sustainability and positive environmental impact. Their efficient resource management emerges through the recovery of hens from intensive farms, their breeding under organic conditions without antibiotics, and the circular use of natural resources, including manure as fertilizer, which minimizes waste and optimizes inputs.

The data collected through the SAQ5.0 tool allows the quantitative assessment of the sustainability level of the agri-food companies. Company Alpha is classified at sustainability Level F, the lowest on the scale, with a score of 19.55%. This overall sustainability assessment indicates an insufficient level of sustainability, highlighting a lack of adherence to minimum regulatory requirements and industry standards. Delving into the topical assessment, some more structured aspects emerge: Section A—Corporate Management records the highest value at 14%, followed by Section G—Responsible Sourcing of Raw Materials, which reaches 6% (Figure 7). These findings suggest that, although the overall sustainability level is critical, there are areas with potential for improvement that can be addressed.

Circularity performance was analyzed by the application of the proposed assessment model, which has provided the collection of data in order to populate the needed C-indicators for each R-strategy applied by the company, according to the previous qualitative evaluation. Results identified a score of 37,12% that represents the circularity performance of the company (Figure 8).

6.2 | Case Beta

Beta is a leading global player in the health and nutrition sector, dedicated to delivering scientifically backed products that enhance the well-being of individuals worldwide. With a deep commitment to innovation and sustainability, Beta is at the forefront of promoting healthier lifestyles through its scientifically advanced offerings. Due to its constant research from a sustainable perspective, the Beta head of business intelligence chose to participate in the validation process of the S&C-AM.

Company Beta shows an effort in all three dimensions of sustainability, with the application of almost all the sustainability practices identified.

This aspect is also evident in its approach to CE, where multiple R-strategies are implemented and can be directly linked to the company's sustainability practices.

- R0—Refuse. The company avoids the use of materials with a high environmental impact or those that are highly

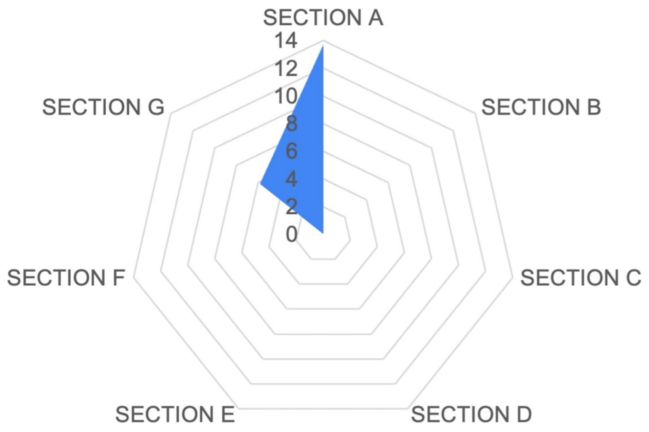

FIGURE 7 | Topical assessment for company Alpha.

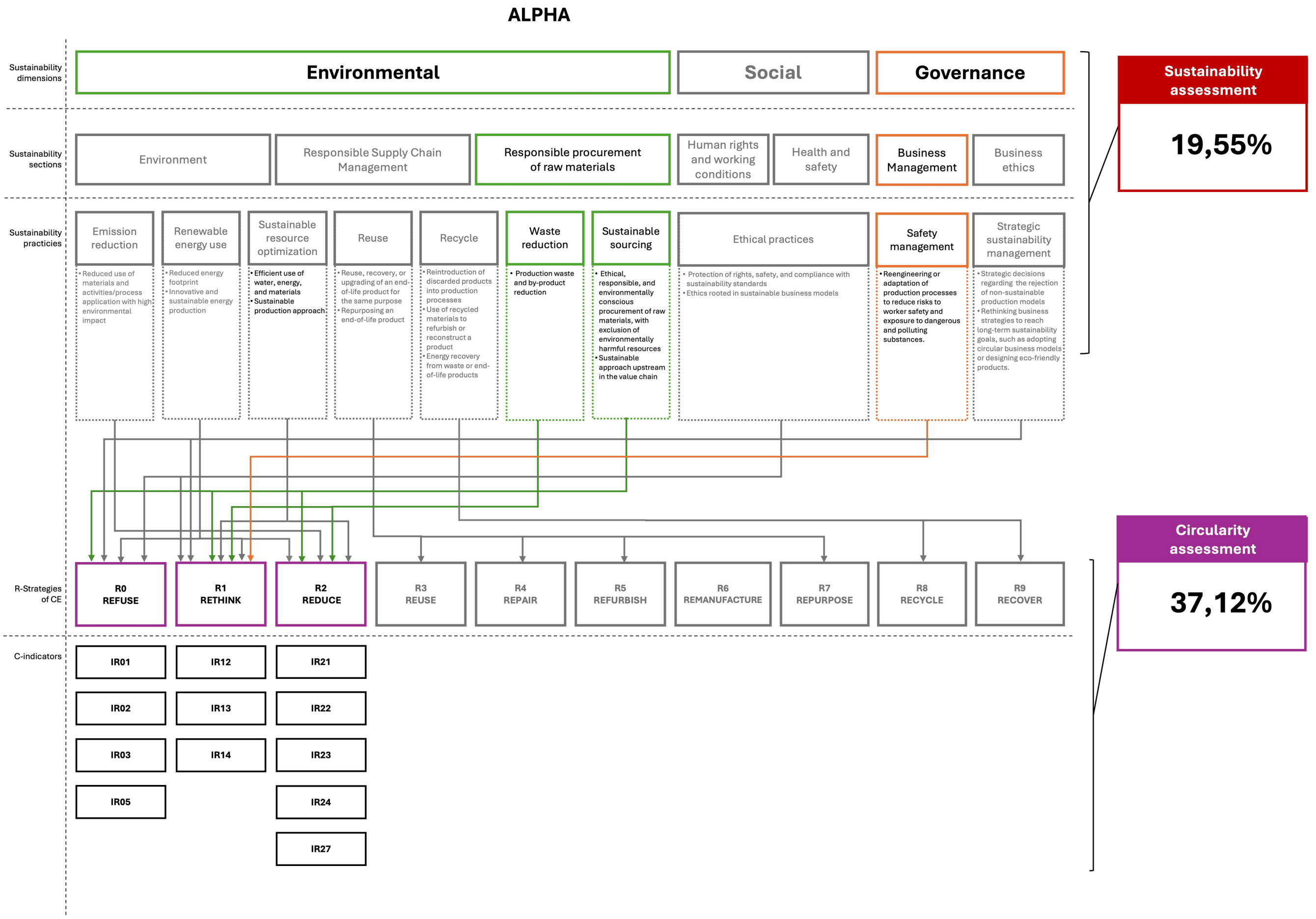

FIGURE 8 | Alpha quantitative assessments for sustainability and circularity.

harmful to the environment in all its production processes. This strategy is implemented to ensure that the materials selected for production are sustainable and environmentally friendly, reducing its ecological footprint and preventing environmental damage that could result from their disposal.

- R1—Rethink. The company's rethinking of its production lines is one of its key CE practices, driving a decarbonization process and significantly reducing greenhouse gas emissions across the entire production chain, supported by the transition to renewable energy sources.
- R2—Reduce. The reduction of high environmental impact resources, particularly energy, is driven by an environmental management system aimed at minimizing impacts in a holistic manner. This system fosters a comprehensive approach to sustainability, addressing resource use, efficiency, and environmental protection across all the supply chain.
- R8—Recycle. Recycling is a core practice within the company, embedded in its environmental policy. The main objective is to process waste materials from product packaging, which are collected and repurposed to produce new packaging made from recycled materials.

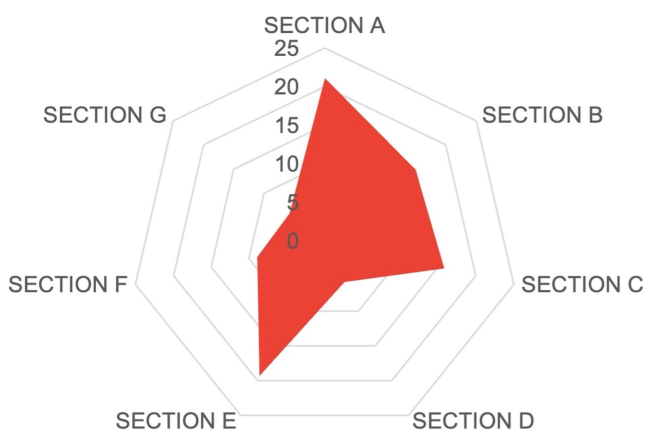

FIGURE 9 | Topical assessment for company Beta.

- R9—Recover. This strategy is integrated into the energy management system, which features a specialized energy recovery process that embodies the principles of CE. In particular, by converting production residues and waste streams into usable energy within its large-scale facilities, the company reduces dependence on external energy sources and lowers overall environmental impact, closing loops in line with circular economy practices.

From SAQ5.0, the company achieved superior results in terms of quantitative sustainability assessment, reaching a percentage of 91.78% and positioning itself in Level B. This result demonstrates full compliance with the requirements and standards set by the SAQ5.0, reflecting the company's strong commitment to environmental, social, and ethical practices. The topical assessment (Figure 9) also highlighted remarkable performance, with significant scores in Sections A (21%), B (15%), C (16%), and E (19%), further emphasizing alignment with sustainability principles across all its aspects.

The computational model led to an evaluation of circular commitment for Beta, which shows an intermediate score of 46.03% (Figure 10).

6.3 | Case Gamma

Gamma is a global leader in the health and wellness industry, with a strong focus on creating innovative and sustainable solutions for consumers., specializing in nutritional products, healthcare, and well-being services. The company recognizes the importance of responsible sourcing, reducing waste, and contributing positively to the communities in which it operates. This is the motivation that led the Gamma manager to share the company's data to obtain a score able to represent sustainable innovation company efforts and reflect on the possibility to increase circular practices.

Company Gamma is positioned at an intermediate level of sustainability, demonstrated by a particular focus on social sustainability, aimed at human safety and health.

Regarding CE practices, three categories of strategies have been identified.

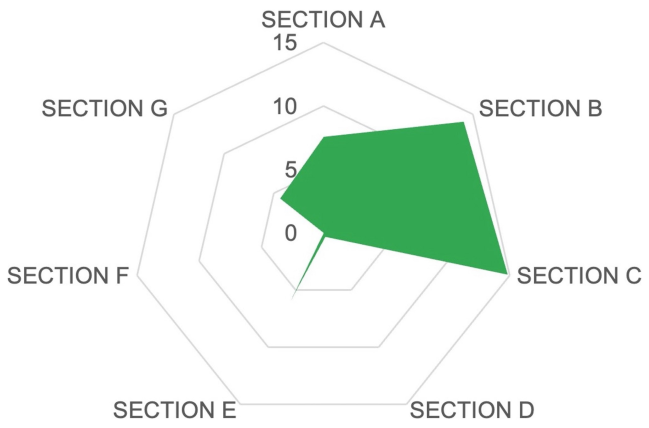

FIGURE 11 | Topical assessment for Gamma company.

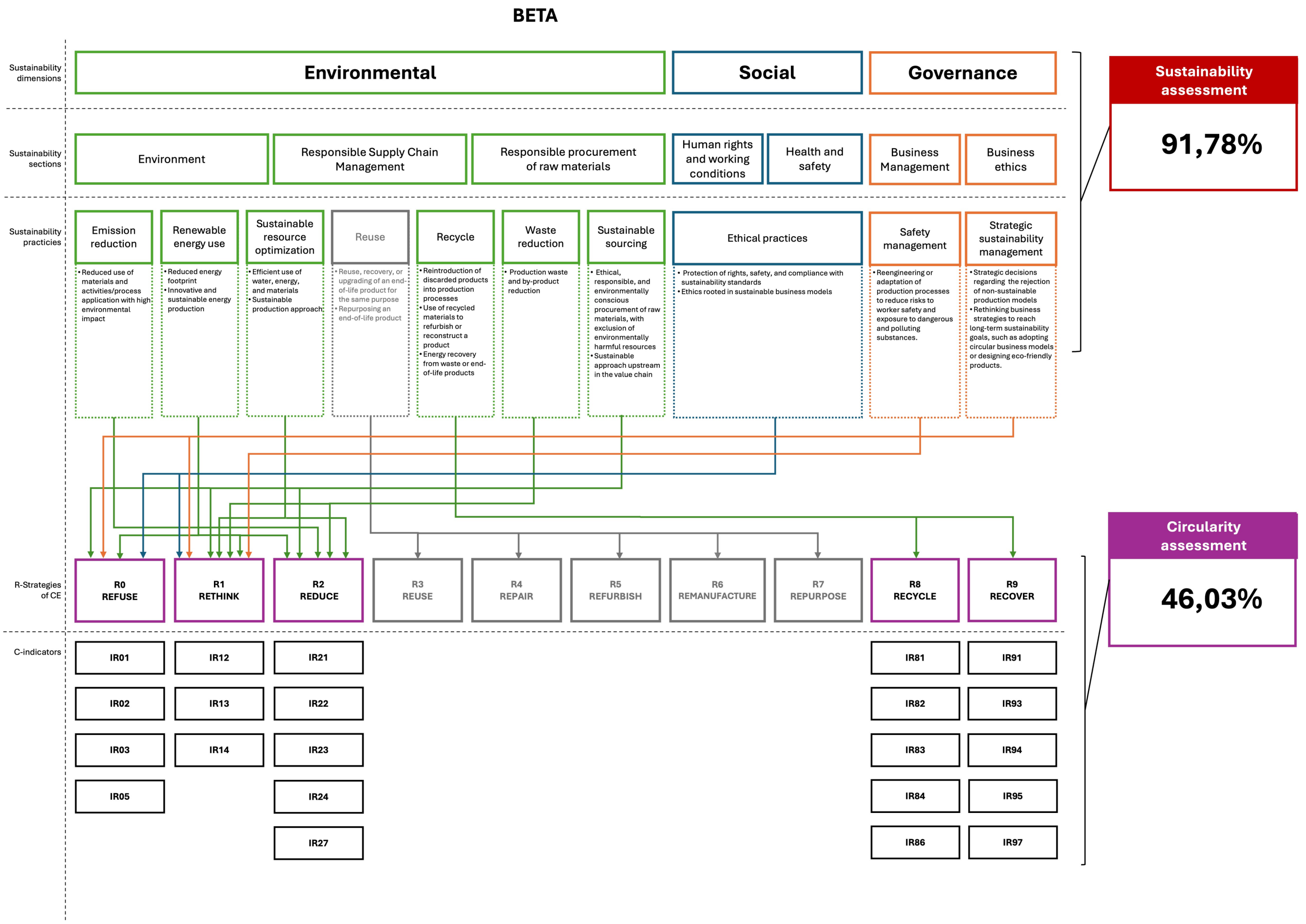

FIGURE 10 | Beta quantitative assessments for sustainability and circularity.

- R0—Refuse. The company excludes the use of certain materials within its processes that, in the form of waste, would result in a high environmental impact, giving them a significant role in terms of circularity.
- R1—Rethink. The waste reduction, used as a foundation of corporate ethics, encourages a fundamental re-evaluation of business models to minimize waste generation at the source, promoting more sustainable value creation and consumption patterns.
- R2—Reduce. Among the services provided by the company is the development of highly personalized meal plans tailored to each individual customer, also supported by the use of AI tools. This contributes to the optimization of food consumption for each person, leading to a significant reduction in food waste as a result.

From SAQ5.0 evaluation, the company achieved an overall percentage of approximately 47%, placing it at sustainability Level D. This score reflects an intermediate level of sustainability, resulting from the adoption of some of the required measures, but with critical areas needing improvement. The topical assessment (Figure 11) highlights the company's commitment in the specific areas of Sections A (8%), B (14%), and C (15%), with relatively insignificant percentages in the remaining four sections. This indicates a greater focus and dedication from the company on areas related to governance, human and labor rights, as well as health and safety.

Simultaneously, the application of the computational model of circularity assessment led to an evaluation of 35.78% reflecting the evaluation of the company's circular approach through R0, R1, and R2 strategies (Figure 12).

7 | Discussion

7.1 | Within-Case Discussion

The application of the S&C-AM to the three companies (Alpha, Beta, and Gamma) provides valuable insights into their distinct approaches to sustainability and circularity. From a theoretical perspective, the S&C-AM synergistically integrates the concepts of sustainability and circularity, serving as a framework for a holistic vision of sustainable approaches and circular practices aimed at reducing environmental impact. The implementation of these practices can be incorporated into managerial strategies aligned with the circularity approach, described through the R-strategies, highlighting the level of circular commitment they represent.

From a practical perspective, S&C-AM served as a tool to identify the companies' positioning regarding their sustainability practices and their alignment with CE strategies. The S&C-AM application within the case study also highlighted practices that have not yet been implemented by the companies, as well as potential connections between existing sustainable practices

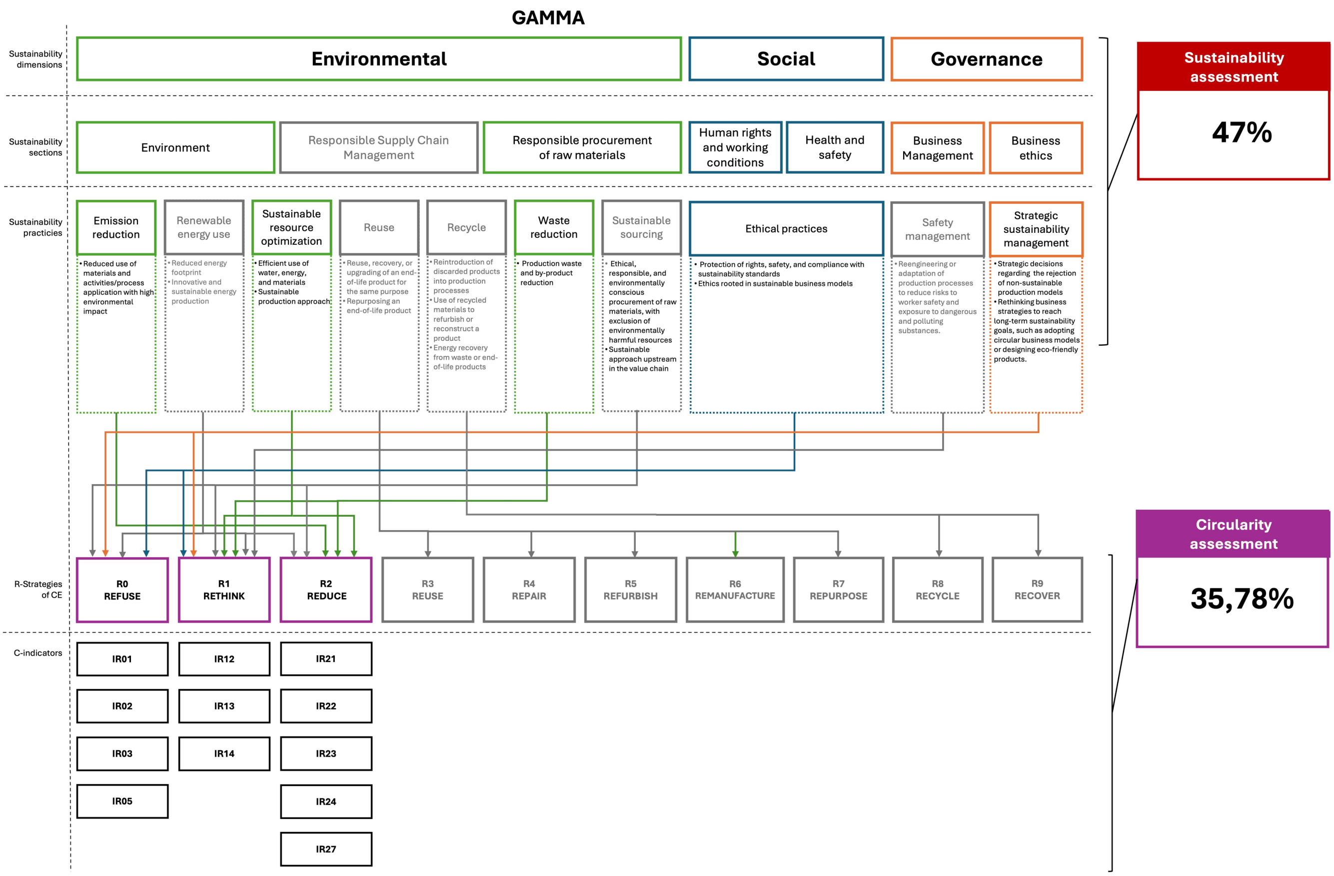

FIGURE 12 | Gamma quantitative assessments for sustainability and circularity.

and R-strategies. These "empty connections" represent potential areas for improvement, offering opportunities to enhance their overall assessment.

Alpha's emphasis on sustainable agricultural practices and its commitment to values that reflect societal norms demonstrate strong ethical legitimacy. The company is actively working to reduce waste and improve working conditions. From a conceptual perspective, the SAQ5.0 responses show that company Alpha demonstrates a commitment to environmental and governance sustainability. It implements three out of the 10 circularity strategies. What did not emerge from the SAQ5.0 but is evident from general information about the company's operations is that it also implements the strategy R7—Repurpose. Their main application is the reuse of animal waste, which is repurposed within the park's natural environment as organic fertilizer. The company could also leverage the opportunity to integrate new CE strategies, such as adopting the R8—Recycle strategy for packaging materials. These materials are currently the only type of waste with a long lifecycle, and incorporating a recycling process for them would further align the company with sustainable practices. It should also be noted that Alpha primarily focuses on the upstream part of the supply chain (as it is involved in production and farming). This is consistent with the CE strategies it has implemented, most of which are related to activities occurring upstream in the value chain that promote shorter waste cycles and reflect a more efficient and intelligent production system. The quantitative assessment reveals that Alpha has achieved a low score in sustainability, while demonstrating a greater commitment to circularity strategies. These results reflect its business approach, which prioritizes biodiversity and soil health, yet lacks alignment with recognized standards—hence the lower sustainability performance score. The absence of formal certifications and standardized reporting undermines its normative legitimacy.

Company Beta achieved remarkable results in both sustainability and circularity, demonstrating a holistic approach to these issues. Specifically, Beta's high quantitative sustainability score (91.78%), which places it at Level B, primarily reflects a strong focus on normative legitimacy. The company's adherence to global standards and regulations, as measured by the SAQ5.0 questionnaire, earns it stakeholder acceptance. From the qualitative analysis of the SAQ5.0 responses, the R3—Reuse strategy did not emerge, even though it is one of the product management strategies in which the company is actively engaged. The reuse of materials is integrated into the company's formal environmental policy, as evidenced by the reuse of packaging with refill options that extend the life cycle of packaging materials. Because Beta operates at multiple levels of the supply chain, the CE R-strategies adopted are seamlessly integrated into all stages of the production system. This demonstrates a strong and consistent commitment to circular and sustainable practices, ensuring a positive impact across the entire value chain. According to the quantitative assessment, it achieves the highest level of sustainability performance, showing consistent engagement across all sustainability dimensions and implementing a broad range of practices. However, the lower circularity score (46.03%) suggests a gap between its public-facing, symbolic actions and the full implementation of circular practices on a large scale. This illustrates how a large, market-leading company may prioritize meeting normative expectations without fully translating them into concrete, substantive actions.

Company Gamma's performance (sustainability score of approximately 47% at Level D and circularity score of 35.78%) reflects a balance between pragmatic and ethical legitimacy. The company's strong focus on social sustainability, particularly human safety and health, and its emphasis on sustainable practices like reducing waste through personalized meal plans, demonstrate an alignment with ethical norms and a commitment that resonates with stakeholders. However, its limited circularity actions suggest that an ethical focus alone may not be sufficient to achieve high performance in circularity, highlighting a need for more comprehensive strategies beyond its primary ethical focus. Regarding the quantitative assessment, Gamma shows a good balance between sustainability and circularity commitment, with significant room for improvement on both fronts. Although it applies only three out of the 10 R-strategies, its circular practices are highly impactful and reflect a circular mindset embedded at the core of its business model.

7.2 | Cross-Case Discussion

The comparative analysis of the three case studies provides a more nuanced understanding of the relationship between sustainability, circularity, and legitimacy. Beta, with its high sustainability score and relatively lower circularity score, exemplifies a focus on normative legitimacy. Its strong performance on the SAQ5.0, which is heavily based on regulatory standards, confirms its ability to meet and report on compliance-driven sustainability metrics. This is consistent with the voluntary disclosure approach, which suggests that companies with superior performance will use high-quality disclosures to signal their true commitment to the market. However, its lower circularity score reveals a critical gap. Despite having the resources and scale to implement large-scale initiatives, its challenges in fully applying circular models expose a disconnect between symbolic, public-facing actions aimed at sustainability and their deep, operational implementation. The complexity of managing a large-scale supply chain and the environmental impact inherent in its massive production processes contribute to this relatively lower circularity score compared to its sustainability performance. In contrast, Alpha and Gamma prioritize a different path, emphasizing pragmatic and ethical legitimacy. Gamma's performance reflects a balance between symbolic and ethical legitimacy, aligning with ethical expectations through a focus on local and sustainable food. This resonates with Suchman's (1995) concept of ethical legitimacy, which is earned through substantive, verifiable commitment beyond legal mandates. Similarly, Alpha's strong commitment to sustainable agricultural practices, though lacking formal certification, is a powerful symbol of its dedication to land care and biodiversity. Its higher circularity score compared to its low sustainability score reflects this approach, where practices that align with CE principles are prioritized over formal regulatory compliance. The findings highlight a critical difference in how companies operationalize their commitment. While Beta leverages its scale to achieve normative legitimacy through formal reporting and compliance, Alpha and Gamma build legitimacy through more intrinsic, values-based practices. However, the lack of a structured, normative approach to sustainability in Alpha's case limits its potential to strengthen its overall legitimacy in the eyes of regulatory bodies and a wider range of stakeholders.

In conclusion, the case studies demonstrate that the pursuit of legitimacy can manifest in different ways, from a compliance-driven approach (Beta) to a values-based one (Alpha and Gamma). The S&C-AM tool, by providing an integrated assessment of both sustainability and circularity, helps expose this distinction and move companies beyond mere compliance and symbolic gestures toward a genuine integration of sustainable and circular practices. This comprehensive approach is essential for building and maintaining resilient ethical legitimacy in the modern business landscape.

7.3 | Validating the Conceptual Framework

The conceptual framework posits that companies achieve legitimacy through the following three distinct pathways: normative, pragmatic, and ethical. The empirical evidence from the case studies on Alpha, Beta, and Gamma provides concrete examples that validate this theoretical model. The findings reveal that companies prioritize these dimensions differently, and this choice directly impacts their performance in sustainability and circularity.

7.3.1 | Normative Legitimacy: The Case of Beta

Beta's case serves as a prime example of achieving legitimacy primarily through the normative pathway. Its exceptionally high sustainability score (91.78%), derived from the SAQ5.0 questionnaire, confirms its full compliance with regulatory standards and industry requirements. This aligns with the framework's definition of normative legitimacy, where a company is seen as acceptable and rule-abiding by adhering to established norms. This compliance-driven approach, while effective in gaining external approval from a wide range of stakeholders, did not fully translate into a high circularity score. Beta's challenges in implementing circular models across its global supply chain highlight a potential "legitimacy gap." This shows that meeting formal, compliance-based expectations does not always equate to a deep, operational commitment to all facets of sustainability.

7.3.2 | Pragmatic and Ethical Legitimacy: The Cases of Alpha and Gamma

In contrast, Alpha and Gamma's cases illustrate how companies can build legitimacy through pragmatic and ethical approaches. Both companies demonstrate a commitment to practices that resonate with their values and provide tangible benefits to stakeholders, even if they fall short on formal compliance. Gamma shows a clear focus on pragmatic legitimacy by offering personalized meal plans that reduce food waste for its customers. This provides a direct, concrete benefit that aligns with stakeholder values. Concurrently, its emphasis on social sustainability, such as human safety and health, reflects a commitment to ethical norms. While Gamma's overall scores are intermediate, its practices validate the framework's idea that a values-based approach can foster a positive perception and build stakeholder trust.

Alpha's business model provides compelling evidence for its pursuit of ethical legitimacy. Despite its low sustainability score (19.55%) due to a lack of formal certifications, its higher circularity score (37.12%) is a result of practices like repurposing animal waste as organic fertilizer. These actions are driven by a genuine commitment to environmental stewardship and biodiversity, going beyond legal mandates. This validates the framework's assertion that ethical legitimacy is earned through a deep, verifiable commitment to the environment and society. The lack of a structured, normative approach, however, limits its ability to strengthen its legitimacy in the eyes of regulatory bodies and a wider range of stakeholders, as defined by the framework.

The comparability of Alpha's and Gamma's legitimacy profiles, despite the vast disparity in their organizational scale and resources, is a particularly critical observation. We suggest this similarity arises because both firms utilize pragmatic and ethical dimensions as a strategic substitute for extensive normative compliance, albeit for different reasons. For Alpha, the intrinsic ethical commitment is often a matter of necessity and local embeddedness, where simple, resource-efficient circular practices (like local resource sharing) naturally align with ethical stewardship, compensating for the lack of budget or expertise for formal certifications. Conversely, Gamma, possessing ample resources, makes a deliberate strategic choice to invest heavily in highly visible, customer-centric pragmatic benefits (e.g., waste reduction through personalized products) and social ethics (e.g., employee health). This investment in direct, values-based action allows Gamma to quickly secure market and customer legitimacy, potentially bypassing the slower, more resource-intensive bureaucratic processes of full normative compliance favored by Beta. This finding implies that legitimacy is decoupled from organizational scale when firms prioritize intrinsic values and direct stakeholder benefits over formal institutional adherence. This suggests that the S&C-AM tool effectively reveals nuanced pathways to achieving legitimacy that are overlooked when considering size and compliance scores alone.

In conclusion, the case studies validate the conceptual framework by demonstrating that the pursuit of legitimacy can manifest in different ways. While Beta leverages its scale to achieve normative legitimacy through formal reporting, Alpha and Gamma build legitimacy through more intrinsic, values-based practices. The S&C-AM tool helps expose this distinction, providing a comprehensive assessment that moves beyond mere compliance toward a genuine integration of sustainable and circular practices.

7.4 | Positioning S&C-AM in the Current Landscape of Self-Assessment Models

S&C-AM provides a holistic self-assessment model for sustainability and circularity, offering companies a unified approach to evaluate these two areas, which have never been measured together in existing literature (Roos Lindgreen et al. 2022) (see Section 2.2). In order to compare the proposed framework with other widely recognized models, a comparison visualization is provided in Figure 13.

IBM[10] presents a comparison of the main sustainability self-assessment standard models, analyzing their relevant dimensions: environmental, social, and governance, with the addition of four specific areas outside the environmental sphere—carbon, energy, waste, and water. Among the models referenced by IBM, the four most common (already mentioned in Sections 2.2) are included, while others, due to their more limited scope of application either by sector or geographical location, are excluded from direct relevance.

The comparison reveals that only two models (GRI and SASB) fully meet the evaluation criteria across all the most important dimensions, although their assessments are strictly focused on sustainability. The proposed model, while fully addressing three of the seven dimensions, allows for a comprehensive sustainability assessment, in addition to a circularity evaluation—this unique feature distinguishing it from other models. The sustainability practices assessed for each dimension are detailed, with corresponding indicators used to quantify performance in each area. This highlights the added value and novelty of the proposed model, as it integrates circularity within sustainability and vice versa, facilitating a comprehensive assessment of a company's sustainable and circular status. In particular, it is relevant for agri-food companies facing significant sustainability challenges, aiming to sustain strong performance within a positive-trending economy (Zhang and Zhang 2024; Pavlić et al. 2023) A set of guidelines designed to support companies in independently applying and implementing the proposed framework is provided in Figure A2 of the Appendices.

8 | Implications and Potential Future Research Streams

This study makes a significant contribution to both the academic and practical understanding of sustainability and CE integration. By proposing a novel framework (S&C-AM) that links existing assessment tools with CE principles, the research offers valuable insights for scholars and managers alike.

8.1 | Theoretical Viewpoint

The study's findings extend beyond simple data analysis, offering several philosophical and conceptual advancements regarding the theoretical frameworks used. These advancements are grounded in the empirical evidence from the case studies and refine the understanding of legitimacy theory in the context of sustainability and the circular economy.

8.1.1 | Reframing Legitimacy: From Compliance to Authenticity

The most significant philosophical contribution is a challenge to the traditional view of legitimacy. While normative legitimacy (compliance with regulations) is a well-established concept, the study's results highlight its limitations as the sole indicator of a firm's true commitment. The case of Beta demonstrates that a company can achieve high normative legitimacy through reporting and adherence to standards without fully integrating transformative circular practices. This exposes a "legitimacy gap" where outward-facing compliance does not necessarily reflect deep, operational change. Conversely, the case of Alpha provides a compelling argument for the importance of ethical legitimacy. Despite a low sustainability score due to a lack of formal certifications, its higher circularity score is earned through

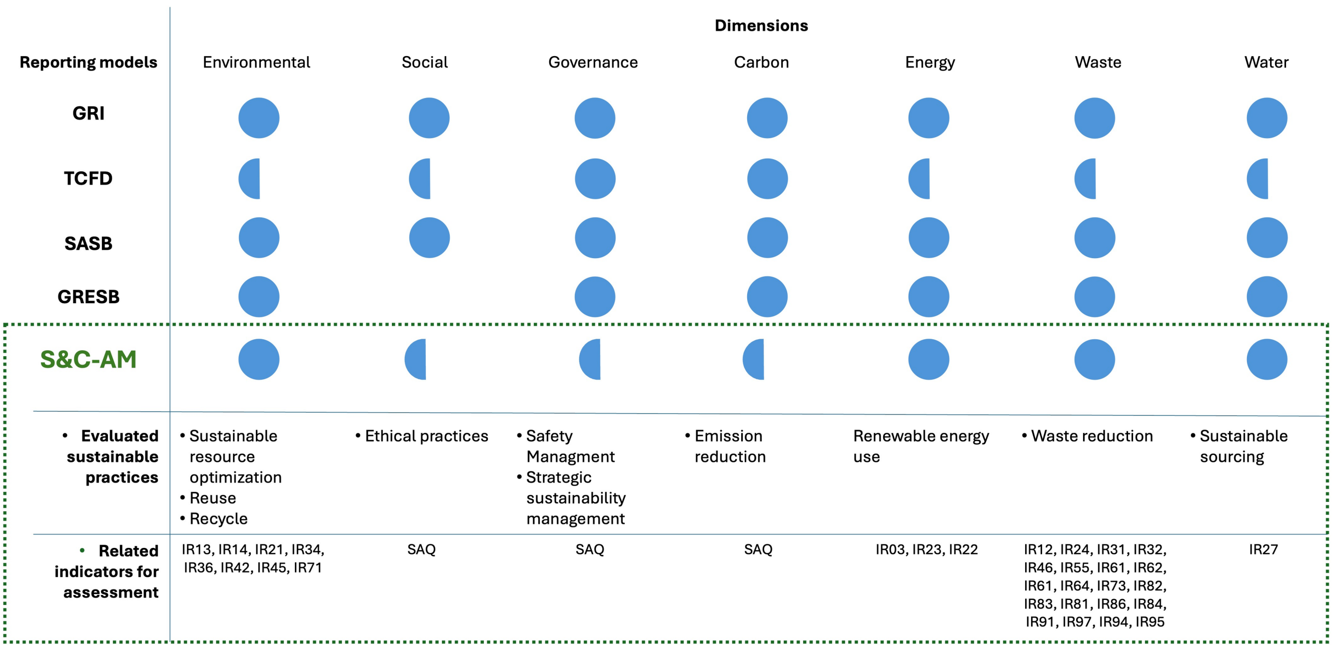

FIGURE 13 | Comparison of the main sustainability self-assessment models and the proposed SCAM.

a genuine, values-based commitment to waste repurposing and biodiversity. This suggests that ethical legitimacy, driven by intrinsic values, is a more authentic indicator of a company's commitment.

8.1.2 | Circularity as a Proxy for Ethical Commitment

While sustainability assessments often measure adherence to rules and standards, the operational and systemic nature of circular practices (R-strategies) requires a deeper, more substantive engagement. The evidence shows that companies like Alpha, which embed circularity into their core business model, are demonstrating a level of ethical dedication that transcends mere compliance. This reframes the relationship between the two concepts, arguing that while sustainability can be a goal of compliance, a true circular mindset is a strong indicator of a company's ethical foundation.

8.1.3 | The S&C-AM Framework as a New Conceptual Lens

The S&C-AM framework itself is a key conceptual advancement. It serves as an integrative lens that moves beyond the binary question of "Is circular also sustainable?" to a more nuanced analysis. It allows researchers and managers to visualize how different approaches to legitimacy (normative, pragmatic, ethical) lead to varying levels of sustainability and circularity performance. The model illustrates that a company's strategic choice—whether to focus on external validation through compliance or on internal, values-driven actions—will directly impact its ability to achieve a genuine integration of sustainable and circular practices.

A list of potential theoretical research streams is shown in the following Figure 14.

8.2 | Practical Viewpoint

From a practical standpoint, the study offers actionable insights for agri-food companies seeking to enhance their sustainability and circularity performance.

- *Integrated evaluation and strategy*—The integration of the SAQ5.0 questionnaire results with the R-strategies framework provides a structured and holistic approach. Managers can use this model to precisely identify existing gaps in their current practices and opportunities for improvement. This combined approach allows companies to move beyond strategies solely on normative compliance, encouraging a more proactive and transformative adoption of resource efficiency, waste reduction, and by-product valorization.
- *Focus on substantive commitment*—The evidence from the case studies shows that an emphasis on intrinsic, values-based practices, such as the reuse of organic waste or the reduction of food waste, is a crucial indicator of a true commitment to sustainability and circularity. Managers are encouraged to invest in these concrete actions rather than limiting themselves to formal reporting efforts, as it is these practices that build stakeholder trust and strengthen corporate reputation in the long term.

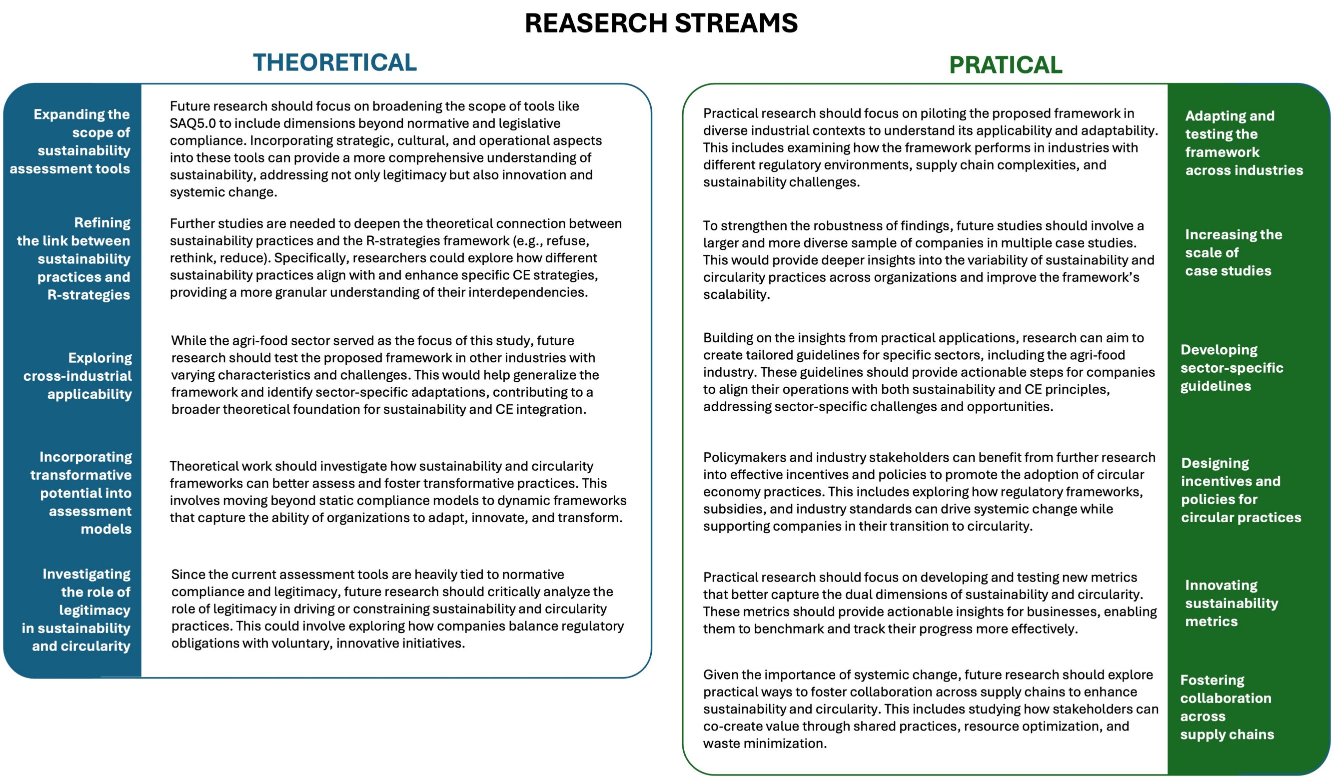

FIGURE 14 | Theoretical and practical research streams.

- *Systems perspective and collaboration*—The research also underscores the importance of adopting a systems perspective. Managers must recognize the interconnectedness of supply chains and the need for collaborative efforts to achieve circularity. Partnerships along the value chain are therefore encouraged to co-create value, share resources, and minimize waste.
- *Normative and Sectoral Support*—The study's findings also offer guidance for policymakers and industry stakeholders. To promote systemic change, it is recommended to design incentives, regulations, and standards that align with the principles of the circular economy and support companies in their transition.

9 | Limitations

This study, while providing valuable insights into the relationship between sustainability, circularity, and legitimacy, is subject to several limitations that should be considered:

- Limited sample size and generalizability: The research is based on a multiple case study of only three companies in the agri-food sector. While this approach provides deep, nuanced insights into each case, the findings are not generalizable to the entire industry or to companies of different sizes or in other sectors. Future research should apply the framework to a larger, more diverse sample to validate the findings on a broader scale. This would lead to validating the proposed framework not only at the conceptual level but also with statistical significance.
- Tool-related biases: The sustainability assessment relied on the SAQ5.0 questionnaire, which was originally developed for the automotive industry. Although its use was justified due to shared characteristics with the manufacturing sector, the tool primarily evaluates sustainability in relation to normative legitimacy and regulatory standards. This focus may not fully capture the qualitative and less formal commitments of a company, as demonstrated by the case of Alpha, where a key circular practice (R7—Repurpose) was not captured by the questionnaire.
- Self-assessment bias: The framework proposes a self-assessment model, which can introduce a bias into the data. The information provided by the companies themselves may be influenced by their desire to present a positive image, potentially overstating their sustainability and circularity practices. This inherent risk in self-reported data could impact the accuracy of the overall assessment.
- Limited scope of circularity practices: The study's circularity assessment is based on the 10 R-strategies of the proposed framework. While comprehensive, this framework may not encompass all possible circular practices, especially those that are highly innovative or specific to emerging industries.
- “Empty connections” as a limitation: The study highlights “empty connections” as opportunities for improvement. However, these also represent a methodological limitation, as the S&C-AM model may identify practices that are theoretically possible but not yet economically or operationally feasible for the companies, thus presenting a potential bias toward an idealized, rather than a realistic, state of circularity.

10 | Conclusions

This study explored how agri-food companies can assess sustainability and circularity actions in ways that improve performance while also strengthening legitimacy with stakeholders. To address this challenge, an integrated framework was developed by combining the SAQ 5.0 with a circularity-oriented matrix, enabling the simultaneous evaluation of both domains. The findings show that the framework not only supports technical assessment but also acts as a mechanism of legitimation, helping companies connect sustainability practices with circular strategies and communicate their commitment more convincingly. In doing so, it highlights that sustainability and circularity can reflect different forms of commitment—from compliance-oriented to ethically grounded—thus positioning S&C-AM as a new conceptual lens to interpret these dynamics.

In the following points, we outlined some reflections about potential contributions of the study to the extant knowledge on the themes.

Enhancing legitimacy and commitment—A self-assessment tool also serves as a mechanism for companies to demonstrate their legitimacy and commitment to sustainability and circularity. By aligning their practices with recognized standards and frameworks, companies can showcase their dedication to meeting ESG criteria. This is particularly important in the agri-food sector, where stakeholders, including consumers and policymakers, increasingly demand transparency and accountability from corporate practices. Such a tool would not only help companies measure their progress but also communicate their efforts effectively to external stakeholders, enhancing their reputation and competitive advantage.

Driving systemic change in the agri-food sector—The agri-food sector is uniquely positioned to benefit from an integrated self-assessment tool due to its critical role in addressing global sustainability challenges, such as food security, resource depletion, and climate change. By providing companies with a structured framework to evaluate their circularity and sustainability efforts, the tool can drive systemic change within the sector. It encourages companies to adopt practices that reduce waste, optimize resource use, and promote regenerative approaches, ultimately contributing to the transition toward a CE.

Encouraging continuous improvement—Finally, a self-assessment tool fosters a culture of continuous improvement by enabling companies to track their progress over time. By providing clear metrics and benchmarks, the tool helps companies identify gaps in their practices and prioritize actions to enhance their sustainability and circularity performance. This iterative process supports long-term strategic planning and aligns with broader sustainability goals, such as those outlined in the United Nations SDGs.

Overall, the research highlights that sustainability and circularity, though often treated separately, can be strategically linked to provide a more holistic vision of corporate responsibility. Therefore, the explorative nature of this study allowed us to say that, maybe, "circular is not always also sustainable"; however, to definitively address this key point, scholars in this field could focus their efforts on further investigations.

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Endnotes

[1] https://sdgs.un.org/2030agenda, accessed March 24, 2025.

[2] https://www.globalreporting.org/, accessed March 24, 2025.

[3] https://www.fsb-tcfd.org/, accessed March 24, 2025.

[4] https://sasb.ifrs.org/, accessed March 24, 2025.

[5] https://www.gresb.com/nl-en/, last accessed March 24, 2025.

[6] https://secr.uk/, last accessed April 10, 2025.

[7] https://www.ellenmacarthurfoundation.org/material-circularity-indicator, last accessed March 15, 2025.

[8] https://www.drivesustainability.org/wp-content/uploads/2022/12/SAQ-5.0_DS-Format_IT_clean.pdf, last accessed February 27, 2025.

[9] https://unstats.un.org/unsd/classifications/Econ/Detail/EN/27/C, last accessed October 28, 2025.

[10] https://www.ibm.com/it-it/topics/esg-reporting, last accessed April 7, 2025.

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TABLE A1 | C-Indicators associated to R-strategies for the circularity measurement (N. G. Franco, Nicolle, et al. 2021).

R-strategy	ID	C-indicator	Metrics	Closeness coefficient (CC_{km})	Strategy percentage weight (w_{R_k})
R0 Refuse	IR02	Substitution of hazardous substances	% of hazardous substance substituted	0.32	0.25
	IR03	Substitution of nonrenewable energy	% of renewable energy consumption	0.32	
	IR05	Substitution of nonvirgin materials	% of virgin material consumption	0.22	
	IR01	New business models adoption	% of revenue from new business models adoption	0.14	
R1 Rethink	IR14	Shared use	Number of users by product (n)	0.38	0.20
	IR12	Product take-back	% of products taken back	0.36	
	IR13	Critical materials	% of critical materials	0.36	
R2 Reduce	IR21	Raw materials intensity reduction	% of reduction in materials consumption per production unit	0.25	0.19
	IR23	Energy consumption reduction	% of reduction in energy consumption	0.25	
	IR27	Water consumption	% of reduction in water consumption	0.25	
	IR24	Waste generation reduction	% of reductions in waste generation	0.16	
	IR22	Energy intensity reduction	% of reduction in energy consumption per production unit	0.09	
R3 Reuse	IR36	Ownership time	Average time of ownership	0.27	0.11
	IR31	Reuse rate	% of reused products	0.26	
	IR32	Product take-back	% of recaptured products	0.26	
	IR34	Reuse business model	% of revenue from reuse business models adoption	0.22	
R4 Repair	IR46	Potential repair	% of products successful repaired	0.42	0.08
	IR45	Repair business model	% of revenue from repair business models adoption	0.29	
	IR42	Critical material	% of critical content	0.29	
R5 Refurbish	IR55	Refurbishment potential	% of products successfully refurbished	0.41	0.06
	IR51	Product take-back	% of reclaimed products to refurbishment	0,31	
	IR53	Refurbishment business model	% of revenue from refurbish business models adoption	0.28	
R6 Remanufacture	IR62	Remanufacture effectiveness	% of remanufactured products	0.46	0.05
	IR63	Remanufacture business model	% of revenue from remanufacturing business	0.31	
	IR61	Product take-back	% of product reclaimed for remanufacturing	0.23	
R7 Repurpose	IR74	Total weight of waste diverted from disposal	% of secondary raw materials consumption	0,48	0.03
	IR71	Secondary raw materials	% of total of nonvirgin materials or components	0.36	
	IR73	Nonhazardous waste diverted from disposal	% of nonhazardous waste used repurpose	0.16	

(Continues)

TABLE A1 | (Continued)

R-strategy	ID	C-indicator	Metrics	Closeness coefficient (CC_{km})	Strategy percentage weight (w_{R_k})
R8 Recycle	IR82	Recycling rate for waste streams	Recycling rate for waste streams (%)	0.29	0.02
	IR83	Waste generation	% of residual waste	0.22	
	IR81	Overall recycling rates	Overall recycling rate (%)	0.17	
	IR86	Trade in recyclable materials	% of diverted from disposal	0.17	
	IR84	Material take-back	% of new materials required for recycling	0.15	
R9 Recover	IR93	Energy recovery	Recovered energy (MJ or multiples)	0.23	0.02
	IR91	Waste diversion from landfills	% of waste diverted from disposal to energy recovery	0.20	
	IR97	Raw materials input	% of new materials required for recovery	0.19	
	IR94	Hazardous waste directed to disposal	Total weight of hazardous waste diverted from disposal (metric tons)	0.19	
	IR95	Nonhazardous waste directed to disposal	% of nonhazardous waste used for energy recovery	0.19	

Table B. Glossary

life cycle assessment. LCA is a term referring both to a concept and a tool for evaluating the environmental impacts and resource use of a product throughout its entire life cycle, from raw material extraction, production, and use, to waste management, including disposal and recycling (Finnveden et al. 2009).

Sustainability self-assessment. Sustainability self-assessment is a process or tool that helps an organization evaluate its current sustainability practices and performance across key areas like environmental, social, and governance (ESG) factors to identify strengths, weaknesses, and priorities for developing a strategic action plan (Process Factory 2024).

Sustainability strategies. They represent a broader approach of companies that integrates sustainability as a key element in strategic business decisions, guiding the development of technologies, processes, and business models (Voinea et al. 2021).

Sustainability practices. They refer to concrete actions aimed at reducing environmental impact and promoting social and economic sustainability throughout the production cycle (Lopes et al. 2022).

Sustainability performance. Quantification of an organization's total economic, environmental, and social impacts, assessed through performance indicators derived from its policies, decisions, and actions, providing a basis for evaluation, reporting, and decision-making (Büyüközkan and Karabulut 2018).

Regenerative processes. Regenerative processes are practices that minimize resource use and waste by keeping materials and energy in closed loops through reuse, repair, remanufacturing, and recycling (Gualandris and Madonna 2025).

R-strategies/R-hierarchy. R-strategies, sometimes referred to as the R-hierarchy, are a set of approaches developed to achieve less resource and material consumption in product chains and make the economy more circular, minimizing waste and environmental impact (Potting et al. 2017; Velenturf and Purnell 2021).

Corporate Sustainability Reporting. Is the disclosure of an organization's environmental, social, and economic performance to stakeholders, providing transparency, tracking progress, and supporting decision-making (Siew 2015b)

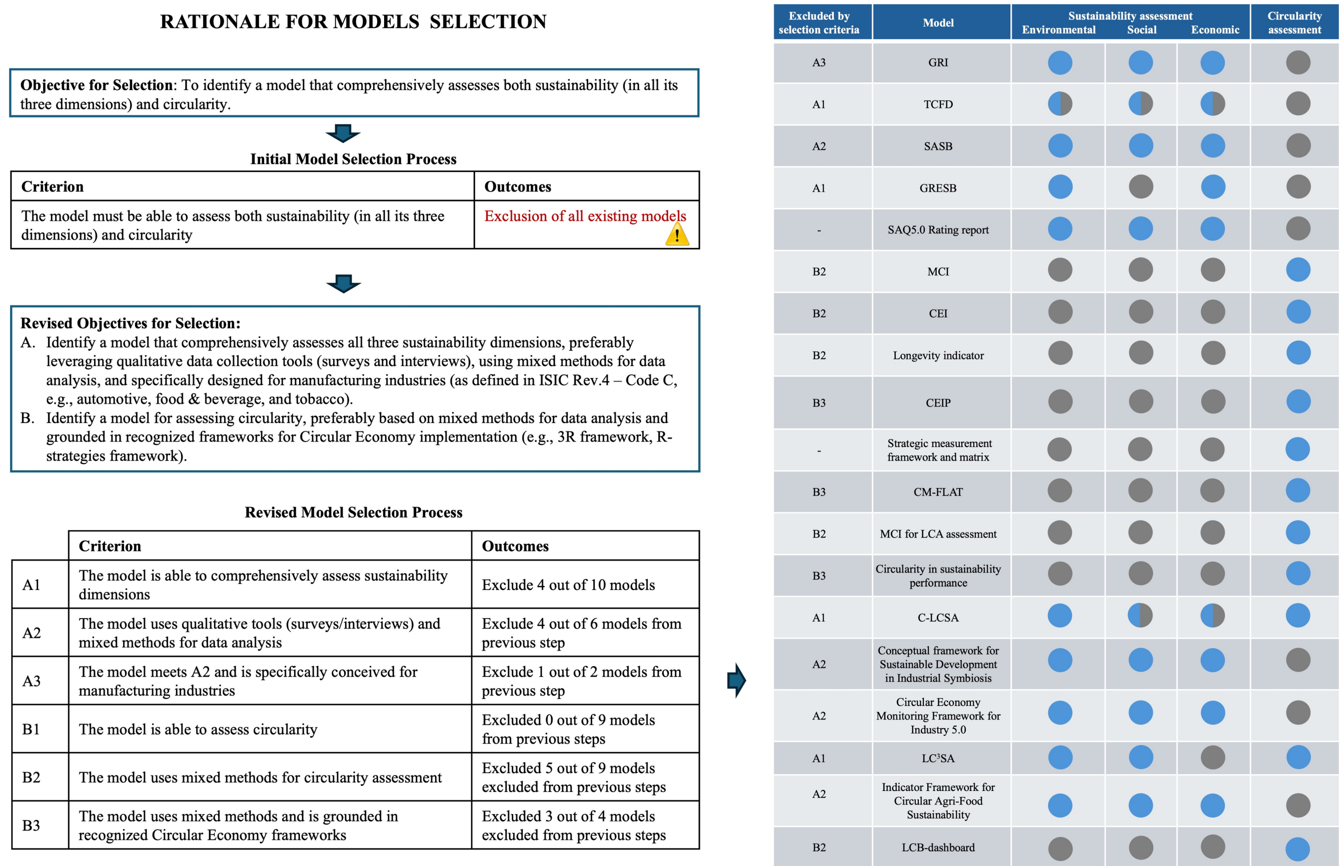

FIGURE A1 | RatioCnal for models' selection process.

FIGURE A2 | Guidelines for practical application of S&C-AM.