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INTERNATIONAL (EUROPEAN) EXEMPLARS OF CIRCULAR PRACTICE IN THE BIOECONOMY AGRI-FOOD SECTOR

Abstract

This report examines how circular and bio-based practices are interpreted and enacted within agri-food processing companies in selected European “role-model” regions, and how these practices can inform a regional bioeconomy strategy for Ireland. An explanatory multiple-case study is developed from fifteen semi-structured interviews with upstream, branded and bio-innovation processors in Germany, France and Belgium, located within regions with dedicated bioeconomy strategies and broadly analogous agricultural conditions to Ireland. An abductive analytical strategy combines framework analysis with the Gioia method to link practitioner narratives to policy, governance, cultural and market, infrastructural and innovation-system contexts. The findings show that circular practice spans resource looping and upcycling, regenerative sourcing, surplus redistribution and new collaborative arrangements, but is constrained by fragmented policy mixes, unstable demand and logistical and infrastructural gaps. The report concludes that international exemplars cannot be transferred directly but may provide practice-based building blocks for co-designing regionally embedded circular bioeconomy pathways in Ireland.

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1. Introduction

The report examines how circular and bio-based practices are interpreted and enacted within agri-food processing companies in selected European "role-model" regions, and what lessons these practices offer for the development of a regional bioeconomy strategy in Ireland. While policy documents routinely invoke the circular economy and the bioeconomy as pillars of sustainable development, their practical meaning and implementation at company level remains heterogeneous and contested. In particular, there is a limited empirical understanding of how agri-food processors operationalise circularity across value chains, how these efforts are shaped by institutional and market conditions, and under what circumstances they generate environmentally and socially robust outcomes rather than incremental efficiency gains. Addressing this gap is central to the CoBioEcon project, which seeks to develop a regional, stakeholder-led bioeconomy strategy for Ireland that is grounded in real-world practice rather than abstract best-practice templates.

The analysis reported here focuses on agri-food companies operating in three European countries, namely Germany, France and Belgium, identified as broadly analogous to Ireland in terms of climate, agricultural profile and natural-capital structure, and as having established regional bioeconomy strategies (see chapter 3). Within these countries, the study concentrates on food and beverage processors, including small and medium-sized enterprises, that engage directly with farm-level raw material supply chains and have articulated sustainability or circularity ambitions. The aim is not to construct an exhaustive mapping of circular initiatives, but to undertake an in-depth, comparative examination of how a diverse set of companies understand and implement circular practice within distinct regional policy and innovation environments.

Empirically, the report draws on fifteen semi-structured interviews with practitioners responsible for, or closely involved in, sustainable and circular initiatives within their organisations. These interviews span three analytically distinct categories of processor: 1) upstream or ingredient processors converting agricultural raw materials into intermediate inputs; 2) branded, consumer-facing processors producing finished foods and private-label products; and 3) bio-innovation and upcycling companies that use fermentation, biotechnology or surplus-to-product transformations to create new value streams and reduce waste. This typology provides a means of exploring how position in the value chain, exposure to end-consumer demand, and degree of technological novelty, condition the form and ambition of circular practice.

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The study pursues four interrelated objectives. First, it investigates how practitioners in different organisational and regional contexts understand key concepts such as circular practice and the bioeconomy, and how they relate these to sustainable development. Second, it documents the real-world practices through which circularity is enacted across operations, supply chains and collaborations, and the pathways companies envisage for extending these practices. Third, it analyses how policy mixes, regulatory frameworks, funding instruments and innovation infrastructures enable or constrain circular initiatives, alongside the role of collaboration networks, market demand and logistics. Finally, it distils practice-based lessons on enabling conditions, mechanisms and governance approaches that can inform the co-design of regionally embedded bioeconomy strategies in Ireland.

In doing so, the report treats circular agri-food transitions as simultaneously conceptual, material, institutional and relational processes. It combines a practice-oriented, multiple-case study design with an abductive analytical strategy, linking firm-level narratives to broader policy and innovation-system dynamics. The findings are intended to inform subsequent project tasks, including the development of a baseline strategy and the design of regional innovation co-design laboratories, by providing a nuanced account of what circular practice looks like in role-model regions, for whom it works, and under what conditions it might be adapted to the Irish context.

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2. Literature Review

2.1 Conceptualising Circular Practice and the Bioeconomy in Agri-Food Systems

Emerging debates on the meaning of circular practice and the bioeconomy have produced a divergent body of work that directly shapes these concepts can be investigated empirically. At the broadest level, circular practice is promoted as an alternative to the linear “take–make–dispose” model, emphasising reduced resource extraction, extended product lifetime and closed material loops (Ghisellini et al., 2016; Geissdoerfer et al., 2017). Yet commentators have consistently emphasised that circularity functions as a broad umbrella concept with multiple, partly incompatible understandings (Castillo, 2022). Kirchherr et al. (2017) document more than a hundred definitions of circular practice and distinguish between narrow efficiency-oriented

views, business-model approaches and more transformative socio-economic framings. Korhonen et al. (2018) similarly differentiate micro, meso and macro-level interpretations, arguing that company-level optimisation can easily be decoupled from wider ecological and social concerns if it is not anchored in sustainability principles.

The bioeconomy debate exhibits a comparable conceptual fragmentation. Bugge et al. (2016) identify three dominant understandings: 1) a biotechnology vision centred on high-tech innovation and intellectual property; 2) a bio-resource vision focused on efficient exploitation of biomass across industrial sectors; and 3) a bio-ecology vision stressing ecosystem functions, agro-ecological practices and local value creation. D'Amato et al. (2017) and Vivien et al. (2019) note that the first two visions often reproduce business-as-usual growth logics, merely substituting biological feedstocks in place of fossil inputs, whereas the bio-ecology perspective aligns more closely with strong sustainability, regenerative agriculture and territorial development (Grossarth, 2025). D'Amato et al. (2017) further argue that circular practice and the bioeconomy can be configured as either complementary or competing paradigms, depending on whether they prioritise throughput growth or ecosystem regeneration.

Within agri-food systems specifically, circular practice is variously equated with waste valorisation, nutrient cycling, regenerative agronomy, alternative protein development or social redistribution of surplus (Papargyropoulou et al., 2014; Teigiserova et al., 2020). Murray et al. (2017) contend that corporate circular-economy strategies tend to privilege high-value recycling and product-design innovations, while neglecting upstream demand reduction, dietary change and questions of justice. Calisto Friant et al. (2020) distinguish between reformist narratives which engender small tweaks to the current system, technocentric narratives, which engender tech fixes, more efficiency, but is still growth focused, and transformational narratives, which is the only approach to directly engage with power relations, consumption norms and distributional outcomes. As a result, two companies may both claim to advance the circular bioeconomy while pursuing substantively different, and even contradictory, trajectories.

These conceptual divergences have methodological implications. If circular practice and the bioeconomy are treated as fixed, researcher-defined categories, there is a risk of projecting particular normative agendas onto practitioners or overlooking emergent, practice-based meanings. Conversely, a purely descriptive approach risks treating any incremental efficiency gain as circular, thereby reinforcing unhelpful iterations of the agenda. Work on discourse and socio-technical transitions suggests that how actors frame problems and solutions is itself a crucial part of transition dynamics (Hajer, 1995; Geels, 2002). Eliciting these framings is therefore

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a necessary first step in understanding the kinds of circular and bio-based futures that agri-food companies are working towards, and the tensions between competing visions.

2.2 Circular practices in agri-food companies: waste hierarchies, biomass cascades and regenerative sourcing

A second strand of literature concerns the real-world practices through which circularity is enacted in agri-food value chains. Much circular-economy work highlights strategies such as reuse, remanufacturing and recycling at the product or company level (Ghisellini et al., 2016; Geissdoerfer et al., 2017). In food systems, however, circularity is tightly coupled to material flows of biomass, nutrients and energy, making waste hierarchies and cascading use central concepts.

Food waste literature proposes hierarchies that prioritise prevention and high-value human-food uses over animal feed, material recovery, energy recovery and disposal (Papargyropoulou et al., 2014; Teigiserova et al., 2020). This hierarchy is consistent with broader circular-economy thinking which emphasises maintaining materials at their highest possible value for as long as possible (Kirchherr et al., 2017). In the bioeconomy context, cascading use describes the sequential use of biomass in multiple applications, for example, food, then feed, then material applications, and finally energy recovery, to maximise value extraction and minimise waste (Keegan et al., 2013; Stegmann et al., 2020). These frameworks have direct implications for how corporate strategies are evaluated. As such, a company that directs most side-streams to energy recovery may be less aligned with circular hierarchies than one prioritising edible upcycling or feed applications.

At the same time, agro-ecological and regenerative agriculture literatures stress that circularity in food systems cannot be reduced to post-hoc handling of waste streams. Regenerative approaches emphasise soil health, biodiversity, crop diversification and closed nutrient cycles at the field and farm scale (Tittonell, 2014; Rockström et al., 2020). From this perspective, circular practice involves re-designing farming systems and farm–processor relations so that residues and by-products are minimised or reintegrated into productive cycles, rather than simply valorised ex post. Work on territorial food systems link such practices to shorter supply chains, local processing capacity and regionally embedded value circuits (Marsden, 2012; Wiskerke, 2009).

Empirical studies of circular food initiatives illustrate a wide variety of real-world practice, these include: 1) the upcycling of surplus or cosmetically imperfect produce into added-value

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products; 2) the use of by-products in animal feed or new ingredient lines; 3) composting and anaerobic digestion; 4) regenerative sourcing standards; and 5) packaging or logistics innovations aimed at waste reduction (Schröder et al., 2019). However, several authors caution that upcycling and bio-innovation can also legitimise overproduction or excessive stocking if not coupled with demand-side change and prevention measures (Teigiserova et al., 2020; Hebrok and Heidenstrøm, 2019). This raises questions about how companies prioritise between prevention, reuse and valorisation, and how these priorities are shaped by economic and regulatory incentives. In general, the foregoing literature suggests that analysing circular practice in the agri-food sector requires attending not only to the presence of valorisation technologies, but also to where companies position themselves within waste hierarchy and regenerative sourcing logics, and to the incentives that push them towards prevention or, alternatively, towards legitimising ever-greater throughput.

2.3 Institutions, policy mixes and innovation systems in the circular bioeconomy

A growing body of work emphasises that circular and bio-based transitions are not simply the outcome of company-level decisions, but of interactions between companies, policy frameworks and broader innovation systems. Policy-mix research argues that transitions require coherent combinations of instruments, including regulations, economic incentives, information tools and network policies, that jointly support experimentation, niche development and market formation (Rogge and Reichardt, 2016; Kern et al., 2019). Fragmented or contradictory mixes can create lock-in, for example where waste legislation conflicts with food-safety rules or where agricultural policy incentivises intensification incompatible with regenerative practice (McCormick and Kautto, 2013).

Technological innovation systems (TIS) and sustainability-transition frameworks identify key system functions such as knowledge development, entrepreneurial experimentation, market formation, resource mobilisation and legitimation (Hekkert et al., 2007; Bergek et al., 2008; Geels, 2002). Studies of bio-refineries, bio-plastics and other bio-based sectors show how underdeveloped demand, unstable policy signals and classification uncertainties (e.g. whether a material is legally “waste” or “product”) can undermine these functions, slowing diffusion even when technical solutions exist (Levidow, 2015; Hansen and Coenen, 2015).

The circular bioeconomy is also increasingly framed as a field for “mission-oriented” innovation policy, where public actors set directionality towards climate, biodiversity or rural development

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goals (Mazzucato, 2018; Bugge et al., 2016). Yet critics argue that many bioeconomy strategies remain technology and export oriented, with limited attention to participation, territorial justice or power asymmetries between large incumbents and smaller actors (Levidow, 2015; Vivien et al., 2019). This tension between growth-oriented and transformation-oriented policy imaginaries filters down to company level, shaping which projects receive support and which practices are seen as legitimate. Such insights necessitate attention to how companies perceive and navigate institutional environments.

2.4 Relational, market and logistical dimensions of circular agri-food practice

Another important strand of literature highlights the relational and spatial conditions under which circular practices become feasible. Studies of networks and clusters emphasise that collaboration across companies, sectors and scales is essential for organising side-stream exchanges, shared infrastructure and learning processes (Coenen et al., 2012; Avelino and Wittmayer, 2016). Regional innovation literature shows how specialised clusters, intermediaries and brokers can facilitate knowledge flows and match-making between primary producers, processors, technology providers and public bodies (Hansen and Coenen, 2015; Truffer and Coenen, 2012). In the context of the bioeconomy, territorial embeddedness (i.e. proximity to specific biomass resources, processing facilities and markets) is a key determinant of which circular configurations are viable (Levidow, 2015; Vivien et al., 2019).

Power relations within value chains further condition circular practice. Work on global value chains and corporate power in food systems shows how large processors and retailers can set standards and terms of trade that either enable or squeeze producers, with implications for who captures value from sustainability upgrades (Gereffi and Lee, 2016; Clapp, 2016; Ponte, 2019). From a circularity perspective, procurement standards, pricing structures and contract durations may determine whether actors such as farmers for example can afford to adopt regenerative practices or invest in side-stream collection and sorting. Collaboration can therefore be a site of innovation and of contestation.

Market-demand literature complicates assumptions that consumer willingness to pay will simply reward circular products. Studies of sustainable food consumption repeatedly identify attitude–behaviour gaps, whereby consumers express concern about environmental and social issues but often default to convenience, price and habit in practice (Thøgersen, 2000; Vermeir and Verbeke, 2006; Carrington et al., 2014). Retail formats, labelling practices and broader socio-cultural

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norms further mediate how circular or bio-based attributes are perceived (Lang and Barling, 2013; Lorek and Fuchs, 2013). These dynamics shape the commercial viability of upcycled products, regenerative supply chains and alternative proteins, and may lead companies to prioritise practices that are invisible to consumers (e.g. process efficiencies) over those that require behavioural change.

Logistics emerges as a particularly critical, but often under-researched, component in this dynamic. Operations and supply-chain studies show that seasonality, perishability, batch size, storage constraints and spatial dispersion of production strongly influence the feasibility and cost of circular loops (Ahumada and Villalobos, 2009; Genovese et al., 2017; Masi et al., 2017). For perishable products, synchronising supply and processing capacity is challenging, and side-streams may degrade rapidly, limiting options for high-value applications. Hebrok and Heidenstrøm (2019) argue that institutionalised routines, packaging norms and distribution models can generate "structural food waste" that is difficult to address through isolated interventions. In general, the essence of such debates proposes that circular agri-food practice cannot be understood at the level of the company alone, but must be situated within the relational architectures, market dynamics and logistical infrastructures that condition which circular configurations are viable, valuable and for whom.

2.5 Trajectories, justice and visions of future development

Finally, an emerging literature has recently turned towards questions of justice, directionality and long-term trajectories in circular and bio-based transitions. Critiques of "weak" circular economy approaches emphasise that efficiency-oriented measures potentially entrench existing patterns of overconsumption and inequality if they do not address absolute resource use, distributional issues and political-economic structures (Lorek and Fuchs, 2013; Murray et al., 2017; Calisto Friant et al., 2020). Agri-food scholars similarly point to tensions between export-oriented, volume-driven growth strategies and goals related to rural livelihoods, dietary change and ecological regeneration (Marsden, 2012; Wiskerke, 2009; Clapp, 2016).

The notion of just transitions has been introduced to highlight that low-carbon and bio-based transformations can produce winners and losers, both within and between regions (Newell and Mulvaney, 2013; Healy and Barry, 2017). In the rural context, this raises questions about how benefits and burdens of circular bioeconomy development are distributed across different farm types, regions and social groups, and how affected actors are involved in decision-making. Participatory and co-design approaches in sustainability transitions argue that engaging

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practitioners and communities in envisioning and pathway development processes can help surface conflicts, broaden solution spaces and ultimately build ownership (Loorbach et al., 2017; Nevens et al., 2013).

2.6 Conclusion

Across these various strands of literature, approaches converge on several points. First, the concept of circular practice and the bioeconomy are contested and multi-dimensional, making it essential to elicit practitioners' own framings rather than imposing singular definitions. Second, circular practice in agri-food systems ranges from waste handling and biomass cascades to regenerative sourcing and social redistribution and must be assessed in light of food-waste hierarchies and agro-ecological principles. Third, institutional and policy environments, including regulations, support schemes and innovation infrastructures, play a decisive role in enabling or constraining such practices. Fourth, circularity is relational and spatially embedded, depending on value-chain power relations, collaboration networks, market demand and logistics. And finally, debates on justice and trajectories underscore the importance of understanding how companies envisage the future of the bioeconomy and their role within it.

The foregoing literature collectively informs the architecture of the present analysis. The core inquiry addresses conceptualisations of circular practice and the bioeconomy. The investigation of applied practice explores real-world waste, sourcing and process innovations. An institutional and policy environment block probes experiences with regulation, funding and policy mixes. Relational and market factors investigate producer relationships, networks, demand and competition, with a specific focus on logistical constraints. While concluding reflections invite respondents to articulate broader visions and perceived pathways for circular and bio-based development. In this way, the analysis is grounded in, and structured by, a literature that treats circular agri-food transitions as simultaneously conceptual, material, institutional, relational and political.

3. Methodology

3.1 Design and Rationale

The analysis adopted an explanatory multiple-case study design to generate a practice-orientated investigation of: 1) (circular) bioeconomy agri-food practice in international

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(European) 'role-model' regions; 2) the extent to which institutions and governing frameworks assist with good practice within respective regions; and 3) how such best practice can be replicated and advanced in the Irish context. As such, data collection applied a qualitative semi-structured interview approach, whereby core questions preserved cross-case comparability, supplemented by adaptive probing applied to elicit tacit, context-contingent information to inform a rigorous assessment of transferability to the Irish context. In this way, the design applied a causal approach (i.e. how and why specific practices work, for whom, and under what institutional conditions). Inference was guided by analytic generalisation whereby empirical patterns were linked (where applicable) to enabling conditions, governance instruments, and implementation pathways. Interviews were conducted with practitioners managing, or keenly interested, in sustainable activities within the respective agri-food company (see below for selection criteria) and lasted, on average, 50 minutes, and between 34-118 minutes duration. In total, 15 in-depth interviews were conducted across 3 case study regions (5 per region) (see below for case study selection) in Europe. The sample size (n = 15) was deemed commensurate with explanatory, case-orientated investigation and comparative with similar investigations (e.g. Bruni et al., 2025; Rock et al., 2025; Moursellas et al., 2023). All participants provided informed consent, were anonymised, and data were managed in accordance with institutional ethics and General Data Protection Regulation (GDPR).

3.2 Case Study Selection

The sampling frame comprised agri-food practices operating within three 'role model' European regions: Germany, France, and Belgium; identified as most analogous to Ireland and as having relevant regional bioeconomy strategies. The frame was delimited using the cross-national screening logic described in D3.1 and pertaining to: 1) countries with dedicated regional bioeconomy strategies, and 2) analogous characteristics in relation to agricultural profile (notably livestock dominance), climate (maritime temperate and adjacent types), and natural-capital structure. Figure 1 depicts the degree to which counties have incorporated regional bioeconomy strategy into their policy frameworks.

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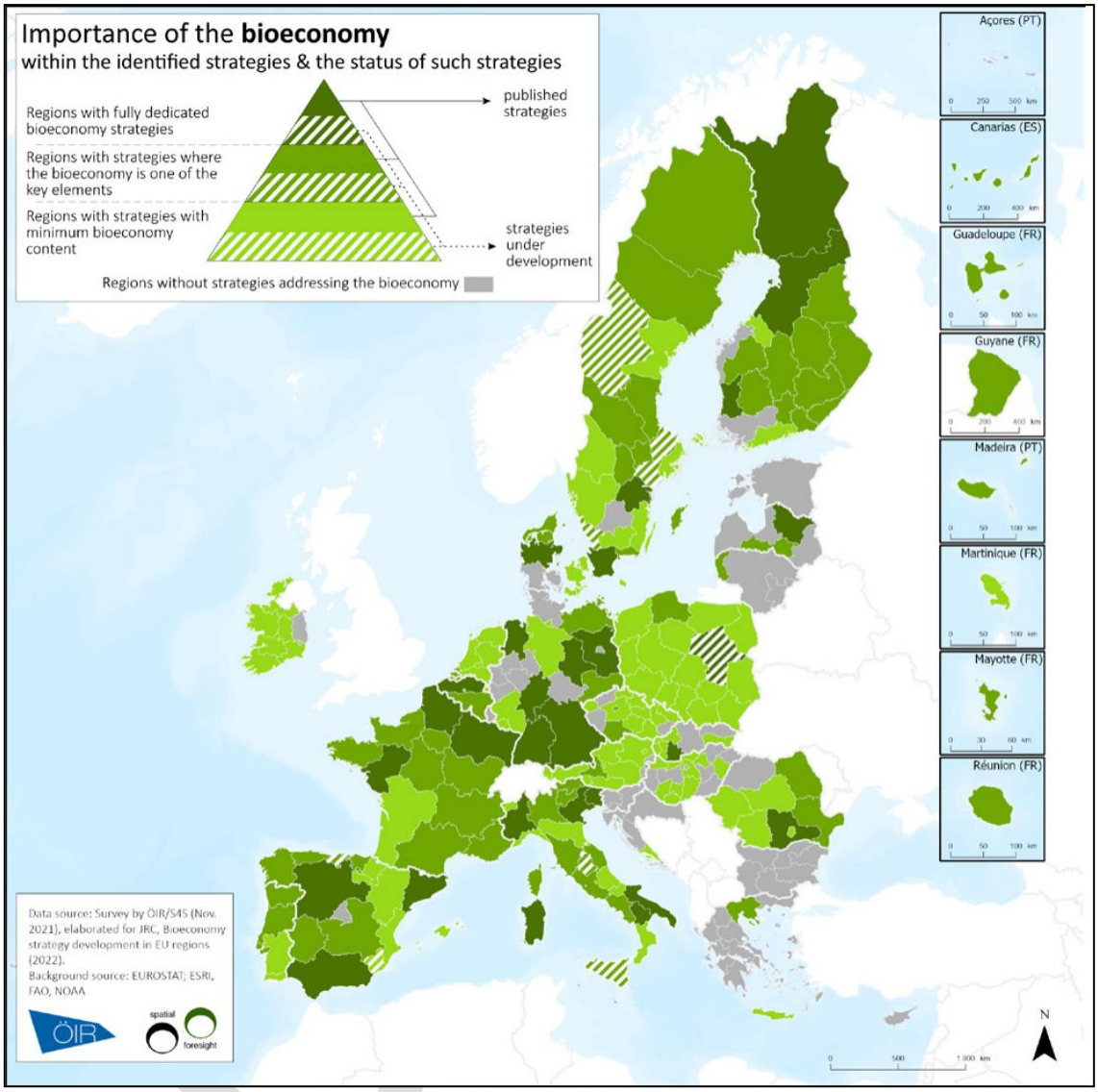
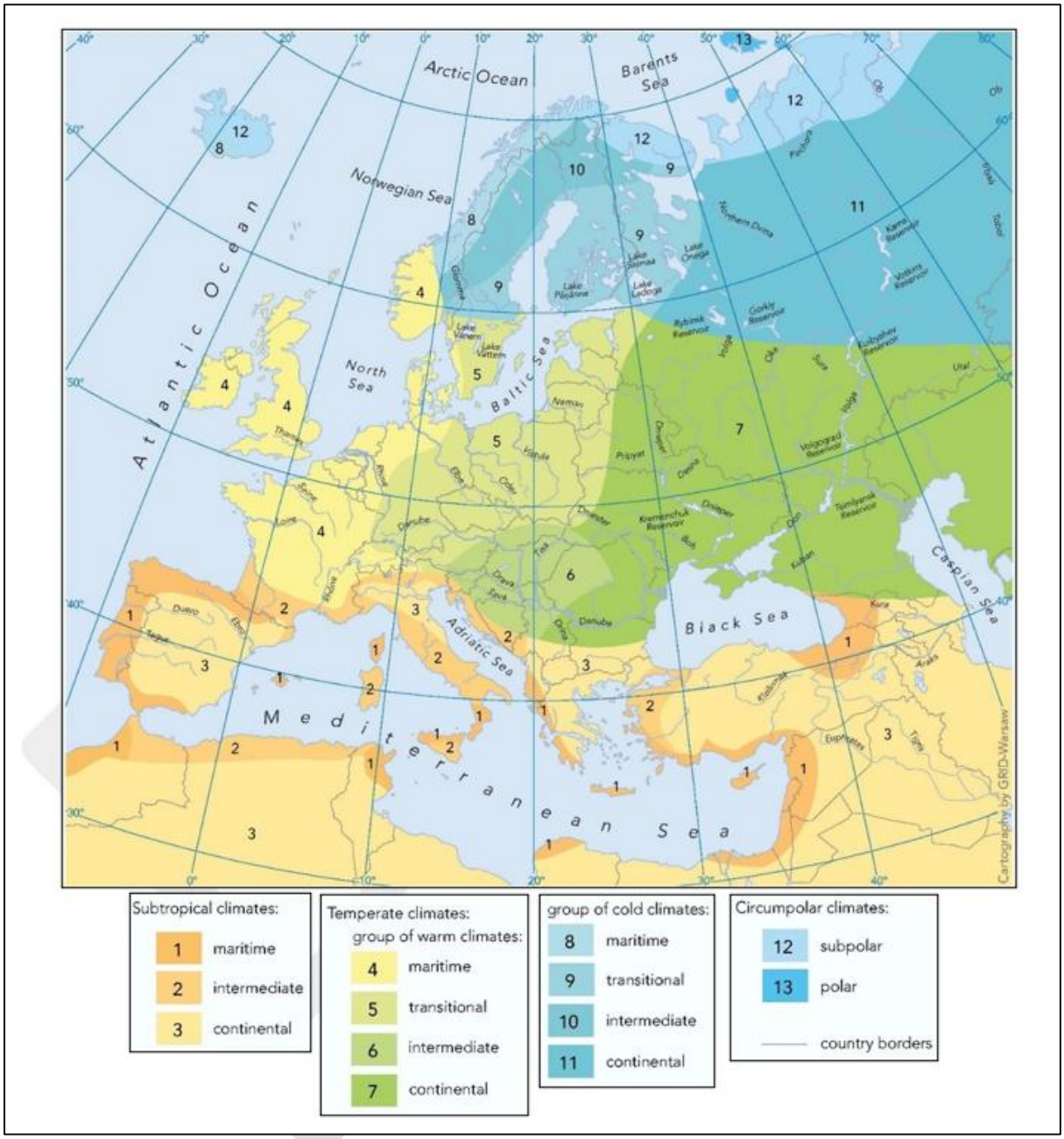
Figure 1: Regions with dedicated bioeconomy strategies EU 2022 (Source: Haarich *and Kirchmayr-Novak* 2023)



As can be seen in Figure 1, Finland, Sweden, Germany, Denmark, Latvia, Romania, Italy, France, Spain, Belgium, the Netherlands, and Slovakia have established dedicated regional-level bioeconomy strategies. With respect to agricultural profile, Finland, Denmark, Latvia, Romania, Italy, Spain, and Slovakia exhibit high proportions of crop-specialist farm systems, which contrasts with Ireland's predominantly livestock-based sector (Eurostat, 2020; 2022; 2023); these countries were therefore excluded. Of the remaining candidates, Sweden was removed due to dissimilar climate (EEA, 2002) and natural-capital (BISE, 2019) characteristics relative to Ireland. Figure 2 illustrates the main climate typologies in Europe:

Figure 2: Climate Typologies of Europe (Source: EEA, 2002; 19)



On this basis, Germany, France, and Belgium were identified as the most suitable countries for case study. Germany, France, and Belgium share a strong emphasis on livestock (akin to Ireland's predominant livestock base, distinguishing these from many Eastern and Mediterranean countries where crop-specialist farming dominates (Eurostat, 2020). Ireland's maritime temperate climate (EEA, 2002) is also shared with France, Belgium, and northern Germany. This climate commonality engenders broadly similar growing conditions, seasonal cycles, and production challenges, providing a credible basis for cross-national policy and practice learning. In contrast, Nordic regions (e.g. Sweden, Finland) or Mediterranean regions (e.g. Spain, Italy)

operate under very different climatic regimes, reducing the relevance of lessons for the Irish context. Agroecosystem dominance is another point of alignment between Ireland and case study locations, imperative in shaping a distinctive natural capital profile (BISE, 2019). Along with Ireland (67%), Germany (55%), France (56%), and Belgium (55%) also report agroecosystems as the largest share of land cover, complemented by substantial forest cover (24–32%) and relatively low wetland representation, reflecting broadly similar biodiversity baselines in which agricultural land use exerts a defining influence. While Ireland shows a higher proportion of wetlands, the overall agroecosystem dominance across the selected case study regions reinforces their comparability, particularly in understanding trade-offs between agricultural productivity, biodiversity conservation, and climate adaptation.

3.3 Data Collection

As per regional-level dedicated strategy (Figure 1 - Haarich et al., 2023) and analogous climate profiles (Figure 2 - EEA, 2002), the sampling frame for candidate agri-food companies targeted the Sachsen-Anhalt, Weser-Ems, and Brandenburg regions of Germany, Hauts-de-France, Grand Est, and Pays de la Loire regions of France, and the Flemish (Vlaams Gewest) region of Belgium. Small and medium-sized enterprises (SMEs) within the agri-food sector were prioritised for data collection as they constitute the overwhelming majority of businesses in the European agri-food system and thus are broadly representative of the sector's structure (Eurostat, 2023b). Information on candidate companies was collated across several directories (see Table 1):

Table 1: Reference Directories for Database Collation

Country	Relevant Directory / Platform	Content
Germany	ENSUN, Research Germany, RailMarket, WBA benchmark	Comprehensive company profiles and sustainability rankings
France	WBA benchmark, SURFE, F6S, RailMarket	Covers everything from organic agri-food startups to large industrial players
Belgium	WBA benchmark	Key company listings
Europe-wide	EU Agri-Food Data Portal	Useful for sector-level context and trends

Food and beverage processing companies were targeted since these entities were thought to typically engage directly with farm-level raw material supply chains and were considered more likely to pursue initiatives such as waste minimisation, by-product valorisation, and circular resource use (desired criteria for analysis). Since a primary aim of analysis was to ascertain how best practice in respective companies may be replicated and advanced in an Irish context, sustainable practice was considered a key criterion. Thus, validation of sustainability credentials

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were undertaken through scrutiny of corporate ESG disclosures and sustainability reports. In most cases, these reports provided details for relevant personnel to be contacted for interview. As previously outlined, a total of 15 interviews were conducted, 5 in each respective 'role-model' region.

3.4 Interview Guide

A semi-structured interview guide was designed around a set of themes derived from the literature discussed previously. The guide begins with basic respondent identifiers to establish organisational context, before progressing into four main areas of inquiry. The first is centred around core understandings of circularity, including the meaning of circular practice, its current manifestation within the organisation, possibilities for enhancement, and its broader applicability to the agri-food sector. The second thematic group concerned applied practices, particularly waste management, changes over time, and engagement with biorefinery processes such as anaerobic digestion (AD). The third area addressed the wider institutional and policy environment. Here, questions explored government roles in enabling or constraining bioeconomy initiatives, the range of supports and barriers encountered, funding mechanisms, regulatory influences, and perspectives on national, regional, and EU-level policy priorities. Linked to this were inquiries into the region's research and innovation capacity and the organisation's relationships with primary producers. The fourth dimension considered relational and market factors, including the advantages of producer relationships, involvement in collaboration networks, public awareness and demand, and logistical considerations such as seasonality, perishability, and spatial proximity of partners. Across all of these domains, respondents were further probed to identify perceived opportunities, supports, challenges, and barriers. The interview guide concluded with a set of reflective items on the bioeconomy, its perceived contribution to sustainable development, and possible pathways for future development. The full structure of the applied interview guide is presented in Table 2:

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Table 2: Interview Guide

Semi-structured Interview Guide – International Agri-Food Firms	
Respondent Identifiers	○ Participant and Firm Context (brief)
Core inquiry	○ Meaning of circular practice ○ Description of the organisation's circular practice ○ Possibilities for improving or extending circular practice ○ Application of circular practice to the wider agri-food sector
Applied practices	○ Waste management practices within the organisation ○ Changes in waste management practices and their drivers ○ Engagement with biorefinery processes (e.g. AD): current practices, history, and future development
Institutional and policy environment	○ Role of government in enabling or constraining regional biorefinery initiatives ○ Supports, mechanisms, and actors that enhance circular practice ○ Factors limiting or impeding circular practice ○ National and regional policy priorities for circularity and bioeconomy development ○ Perspectives on the direction of EU bioeconomy policy ○ Public funding and financial mechanisms supporting circular practice ○ Role of funding in enabling technological advancement and expansion ○ Facilitative and restrictive aspects of regulation for circularity ○ Regional research, development, and innovation landscape ○ Relationships with primary producers and their role in circular practice
Relational and market factors	○ Advantages of relationships with primary producers ○ Collaboration networks: formation, benefits, and future development ○ Factors influencing public awareness and competitiveness of products ○ Role of logistics in circular practice (seasonality, perishability, variability, storage, transport costs) ○ Geographic proximity of collaborative primary producers
Probes	○ Above probed in terms of opportunities, supports, challenges, barriers.
Concluding reflections	○ Meaning of bioeconomy ○ Contribution of the bioeconomy to sustainable development ○ Views on pathways for developing the bioeconomy

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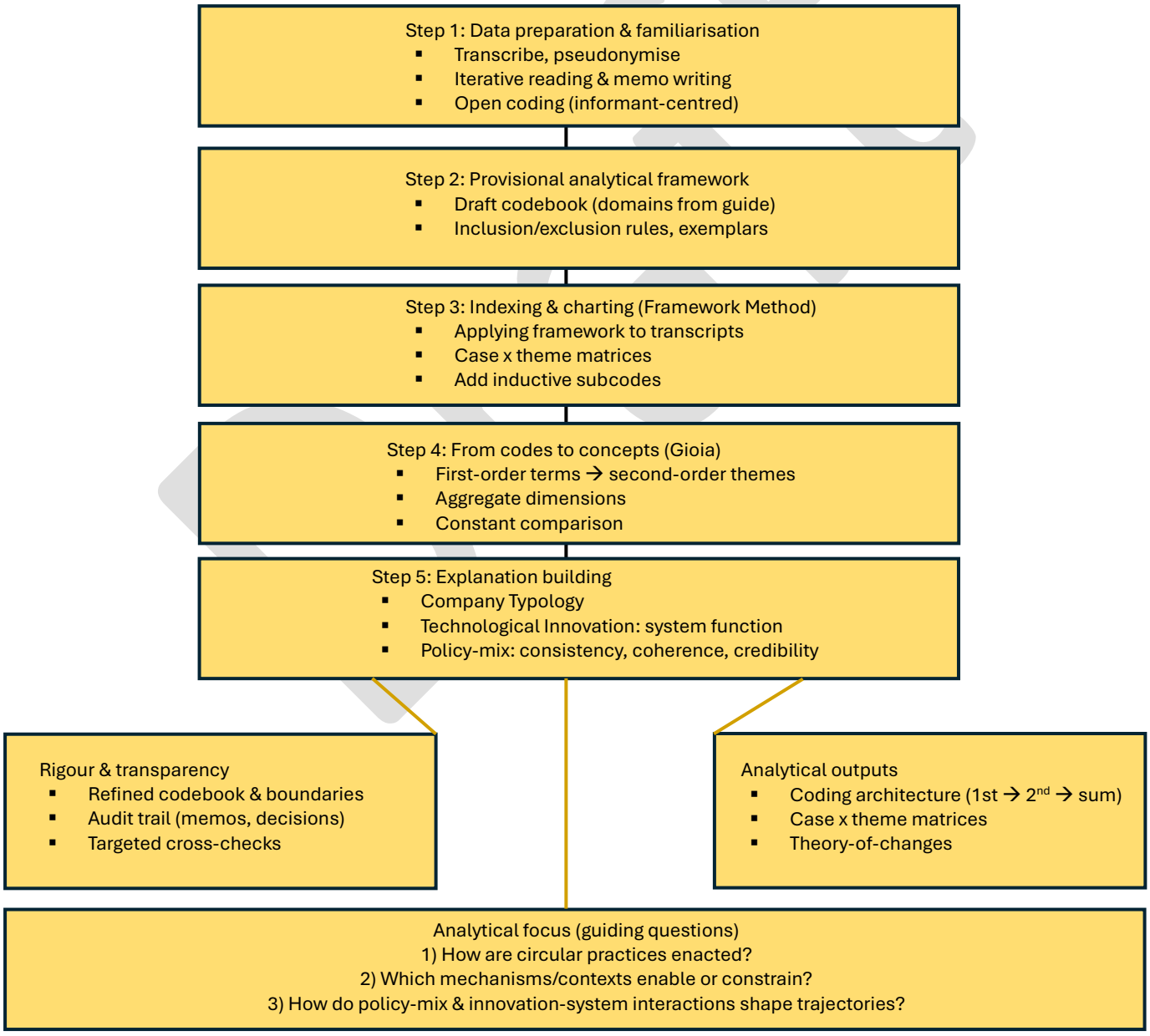
3.5 Analytical Framework

An abductive (indictive and deductive) thematic approach (Tavory and Timmermans, 2014) was applied to analyse interview material. Rather than relying solely on applied thematic coding, the study combined a framework approach (matrix-based, case by theme analysis) (Ritchie and Spencer, 1994) with the Gioia method (moving from informant terms to researcher-derived concepts and aggregate dimensions) (Gioia et al., 2013). This allowed for both deductive structuring and inductive exploration. The process followed five iterative stages as outlined in Figure 3:

Figure 3: Process Overview



First, transcripts were transcribed, pseudonymised, and reviewed through open coding and memo-writing to capture salient participant language. Second, a provisional coding framework was developed, anchored in the interview guide and relevant literature, to provide an initial set of analytical domains. Third, transcripts were indexed against this framework and charted into matrices, with new inductive codes added where novel mechanisms emerged. Fourth, codes were distilled into broader concepts using the Gioia approach, moving from first-order terms to second-order themes and finally to aggregate dimensions. Fifth, an explanation-building phase created a typology based on company characteristic. These were conceived as: 1) upstream/ingredient processors that convert agricultural raw materials into intermediate inputs for wider supply chains; 2) branded, consumer-facing processors that produce finished foods and private-label products and operate closest to retail and end-user demand; and 3) bio-innovation and upcycling processors that apply fermentation, biotechnology, or surplus-to-product transformations to create new value streams and reduce waste (see Table 3):

Table 3: Company Typology

Upstream Processor (n = 4)	Branded Processor (n = 6)	Bio-innovation Processor (n = 5)
Sugar-beet cooperative	Ready-to-eat brand producer	Fermentation start-up
Seed/purée supplier	Speciality foods exporter	Yeast-derived ingredient start-up
Grain-to-malt processor	Chilled ready-made producer	Mycelium-fermentation company
Pulse processor	Manufacturer-retailer hybrid	Circular-valoration operator
	Organic diary producer	Fermentation-led upcycling
	Chilled soups and grain-bowls	

The explanation-building phase also drew on two system perspectives, policy-mix analysis, which interrogates the coherence, consistency, and credibility of policy instruments (Rogge and Reichardt, 2016), and the Technological Innovation Systems (TIS) framework, which identifies functions such as market formation, resource mobilisation, and legitimation (Hekkert et al., 2007; Bergek et al., 2008). This abductive approach enabled the study to capture both company-level narratives and their systemic context, addressing three guiding questions: 1) how do practitioners interpret circular practice and the bioeconomy; 2) how circular practices are enacted across operations, supply chains, and collaborations; 3) which mechanisms and contexts enable or constrain these practices; and 4) how interactions within policy mixes and innovation systems shape trajectories toward circularity in the agri-food bioeconomy.

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4. Results

This section presents the empirical findings from fifteen semi-structured interviews conducted across the three 'role-model' regions (Germany, France, Belgium) and guided by the abductive analytical approach previously described. Results are organised to move from meanings to practice as well as barriers to development and enabling conditions. As such, subsection 4.1 examines practitioner understandings of circular practice and the bioeconomy; 4.2 details company-level actions and near-term development pathways; 4.3 explores institutional and policy factors; and 4.5 analyses relational and market dynamics. Throughout, cross-case comparisons were structured by processor position in terms of: 1) upstream/ingredient processor; 2) branded/consumer-facing processor; and 3) bio-innovation/upcycling processor, as previously outlined. This was done in order to determine commonalities, contrasts, and context-specific mechanisms.

4.1 Understanding Circular Practice and the Bioeconomy: Practitioner Insights on Meaning, Sustainable Development, and Future Directions

At the beginning and end of each interview, participants were asked respectively what "circular practice" and the "bioeconomy" meant to them. In addition, participants were asked whether they considered sustainable development to be related to the bioeconomy, and if so how, as well how the bioeconomy should be developed in the future. These questions were deemed important since such interpretations are often contested and can be conceptually ambiguous. By analysing the participant's understanding of such concepts, it was thought that potential variation and/or misalignment between policy, academic, and practitioner discourse (Hajer, 1995) may be observed.

4.1.1 Meaning of Circular Practice (see Appendix, Table 1)

Across interviews, circular practice was interpreted as: 1) a technical–process relating to how materials and by-products are handled (7/15 interview transcripts); 2) a process related to socio-economic value and redistribution in (4/15); and 3) a broader systemic and normative shift in how agri-food systems, organisations and ecologies are understood (4/15) (see Table 4):

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Table 4: Thematic Structure of Company Circular Practice

Aggregate Dimension	Second-order Theme	Key words	Interviews
Practice-orientated	Technical-process	Material loops, by-product use, plant/processing focus.	7
	Socio-economic	Value distribution, surplus redistribution, social 'second life'.	4
Systemic-normative	Systemic & Normative	Systems thinking, organisational change, ecological cycles, regulation/values.	4

In respect to company typology, all processors (upstream (2/4); branded (2/6); bio-innovation (3/5)) tended to emphasise technical–process aspects; branded processors more often stressed socio-economic circularity (2/6) along with upstream processors (1/4); while bio-innovation companies (2/5) and branded actors (2/6) articulated more systemic and normative understandings.

For most upstream/ingredient processors (2/4 interviews), circular practice was primarily a technical question of managing material flows and process outputs. A French sugar-beet cooperative described it as reusing and "valorising the maximum of the biomass" *(Interview 2)*, recovering water embedded in beets, methanising certain streams for biogas, and re-using clean water in distilleries. Circularity here meant that biomass, water and energy are repeatedly cycled through industrial processes rather than discharged as waste. Similar logics appeared in other upstream accounts. A maltster emphasised that "waste and by-products from one processor" should be taken up by another to "make sure you use all resources as efficiently as possible" and "think in terms of cycles" *(Interview 5)* rather than single-use processes. Some branded processors (2/6) also defined circular practice in technical–process terms where they retained control over production. A dairy company stressed designing operations so that "nothing goes to waste unnecessarily" *(Interview 14)*, with by-products like whey and manure put to productive use and packaging and energy systems re-designed around closing loops. In this respect, a Belgian branded/consumer-facing processor offered a concise definition of circular practice as "the reusage of energy, machines, products in general" *(Interview 8)*, reflecting a generalised technical emphasis on re-use of assets and flows. Bio-innovation/upcycling processors (3/5) articulated the same core logic through their technologies. One company defined circular practice as "using all or most outputs of a production process to minimise waste" *(Interview 11)* by feeding mycelium with side-streams such as brewers' spent grain. Another spoke of trading bio-resources and "creat[ing] new loops so natural products remain in circulation" *(Interview 12)*. In both cases, side-streams and previously overlooked materials become central feedstocks, so that circularity is built into the business model.

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Circular practice was also framed as recirculating value and products in social and economic terms, and in respect to fair returns to farmers, donations, surplus redistribution, social enterprise logics. One upstream processor (1/4) framed circular practice as fundamentally about "money back to the farmers" and ensuring that "everybody gets the good value for work in the system" *(Interview 3)*. Here, circular practice was interpreted as the equitable distribution of economic returns along the chain, as opposed to waste management or efficiency. Branded processors (2/6) interpreted circular practice as a redistribution of surplus products and the creation of "second lives". In one interview, a ready-meal brand, constrained by co-manufacturing arrangements, focused on the level it could control; finished products and their shelf life *(Interview 6)*. Circular practice here meant that when products were close to expiry, they were not simply discarded, but used in promotions, given away, or channelled through partners so they would still be consumed. A surplus-food initiative similarly described circular practice as "giving things a second life and minimising waste, turning items into something new, adding value so as little as possible is lost" *(Interview 9)*. These accounts depict circular practice as a socially embedded, value-oriented reframing of supply-chain relations, in which surplus, products and profits are recirculated to minimise loss and redistribute benefits more fairly across actors.

A final interpretation articulated circular practice as a systemic and normative project, involving changes in governance, organisational culture and ecological relations. An upstream processor (1/4) characterised it as "choices that create feedback loops", where a decision such as improving water use affects costs and operations and "feeds back again" *(Interview 7)* into subsequent decisions. This interpretation viewed the process as less a concrete technique, and more a way of understanding how different parts of the system co-evolve. One branded processor (2/6) described it as "thinking in cycles, not just in straight line", illustrated through animals eating from the land, manure returning to the soil, and new crops growing, "very close to organic agriculture" *(Interview 13)*. A frozen-food manufacturer spoke of "designing our food system so that resources are kept in use for as long as possible" and explicitly framed circular practice as "systems thinking" and a "mindset shift as much as a technical challenge" *(Interview 15)*. One bio-innovation processor (2/5) viewed circular practice as, "a mindset across the value chain" enabled through "collaboration" and "prioritising by-product valorisation, plant proteins, packaging, and water" *(Interview 10)*. Another began from a regulatory starting point, referring to national anti-waste law and packaging targets, but quickly shifted to the internal work required to make circularity real *(Interview 1)*. They described how standard ERP systems automatically assign near-date goods to waste categories, and how enabling donation required reconfiguring software and "educating" staff in finance, supply chain, logistics and commercial departments.

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Circular practice here was not just perceived as a new procedure, but rather a programme of organisational restructuring and cultural change, triggered by, but not reducible, to regulation.

4.1.2 Meaning of the Bioeconomy (see Appendix, Table 2)

Participants interpreted the bioeconomy in three main ways: 1) as bio-based substitution and innovation, centred on replacing fossil resources with biological ones (6/15 interviews); 2) as a circular and sustainable economic system that respects ecological limits (6/15); and 3) as a more normative and contested socio-political project, concerned with how the concept is framed, grounded and governed (3/15) (see Table 5):

Table 5: Thematic Structure of Bioeconomy Concept

Aggregate Dimension	Second-order Theme	Key words	Interviews
Biobased economic transformation	Biobased substitution & innovation	Renewable biological resources, bio-based processes, new biomaterials.	6
	Circular economic system	Loop economy, sustainability, regeneration, ecological limits.	6
Normative & socio-political	Socio-political project	Concept ambiguity, local loops, independence, socio-political project.	3

In terms of company typology, bio-innovation processors tended to emphasise bio-based substitution and innovation (4/5), with one upstream (1/4) and one branded processor (1/6) respectively interpreting the bioeconomy concept in this way; branded processors (4/6) in particular, but also upstream processors (2/4) more frequently stressed circular and sustainability framing; while a smaller subset across upstream (1/4), branded (1/6) and bio-innovation (1/5) processors articulated more normative, people and place-centred understandings of the bioeconomy.

For six interviewees, the bioeconomy primarily described a shift in the resource base and technological model of production, from fossil and synthetic inputs to living, renewable biological resources and bio-based processes. An upstream processor (1/4) described it as “an economy that is organised around biomass instead of fossil resources” *(Interview 2)*, starting from sugar beet and other agricultural residues and turning them into a portfolio of products such as sugar, alcohol, bioethanol, feed, energy and even CO_2, while reducing water and fossil energy use. While a branded/consumer-facing processor (1/6) offered a concise definition of the bioeconomy as “an economy driven by natural or renewable products” *(Interview 8)*. Apart from these, the substitution and innovation perspective was most often interpreted by bio-innovation processors (4/5). For one such company, the bioeconomy was a “major part of the future,

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replacing chemical solutions with biology" *(Interview 11)*. Another innovation processor defined it as "an economic model that seeks to valorise living and renewable biological resources, rather than relying on petrochemicals or synthetic materials" *(Interview 1)*, linking this directly to their use of microorganisms and biotechnology to produce food without additives. Other bio-innovation actors stressed the opportunity to create new bio-based raw materials and products with lower impacts. A French bio-innovation interviewee viewed the bioeconomy as the chance "to generate raw materials for everyday products … that have less impact but generate equal or greater value for the economy" *(Interview 4)*. Another talked about working with "nature-based resources as the obvious default" *(Interview 10)* and designing systems around them. In these six interviews, the bioeconomy was framed as a techno-economic substitution project; using biological feedstocks and processes to deliver familiar or novel products, generate new value streams, and reduce dependence on fossil resources.

A second group of six interviews understood the bioeconomy primarily as a circular and sustainable economic model, closely linked to environmental limits, ecosystem services and green transition agendas. An upstream Belgian processor (2/4) described it as "assigning a value to every aspect of the environment" *(Interview 5)*, recognising the financial implications of degraded soil or nitrate pollution, and thus the need to safeguard ecosystem services. For another upstream processor, the bioeconomy was akin to the EU Green Deal, "an economy functioning in a loop, with decisions along the chain favouring the greenest option and feeding back into further decisions" *(Interview 7)*. Branded/consumer-facing processors (4/6) emphasised sustainable food systems and circularity. One reflected that the term is "vague" but, to them, meant "sustainable food, circularity, and using natural resources responsibly", explicitly invoking "growing within the boundaries of what natural resources can sustain" *(Interview 6)*. Another branded processor defined the bioeconomy in concrete terms as "turning leftovers into new, longer-lasting products, an enabler of circular economy" *(Interview 9)*. Other branded processors developed a more explicitly regenerative and territorial framing. A German dairy company saw the bioeconomy as "rethinking how we produce, use, and reuse biological resources, in a way that respects ecological boundaries while still supporting human wellbeing and economic activity", treating the farm as "part of a living ecosystem" *(Interview 14)* where grass, cows, soil, waste and energy are interconnected. A frozen-food manufacturer described the bioeconomy as "shifting away from a fossil-based, linear system toward one that's rooted in biological resources, not just as raw materials, but as part of a living, regenerative cycle" *(Interview 15)*, emphasising ecological balance, support for rural economies, and the need to design out waste and return value to soils, ecosystems and communities. In these accounts, the

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bioeconomy is less about specific technologies and more about re-organising the economy within ecological limits, often through loops, regeneration and recognition of environmental externalities.

A smaller but analytically important subset of interviews (3/15) treated the bioeconomy as a contested, normative and socio-political concept, raising questions about its meaning, scope and who it serves. One upstream processor (1/4), when asked what the bioeconomy meant, replied: "Bioeconomy? Is it linked to the organic? I would say bioeconomy would be linked to organic. But it's maybe because biologic in France stands for organic" *(Interview 3)*. Here the term is loosely equated with organic agriculture, highlighting linguistic ambiguity and the potential for misalignment between policy and practitioner understandings. Another respondent focused on the way multiple goals are bundled into bioeconomy narratives. A German bio-innovation processor (1/5) described it as a "long-neglected part of the economy with huge potential in terms of innovation, independence, ecological gains", acknowledging that it "bundles many desirable goals, though the journey is long and ongoing" *(Interview 12)*. This positioned the bioeconomy as a strategy combining technological, ecological and geopolitical aspirations. A branded processor (1/6) offered a people and place-centred interpretation. For them, the bioeconomy is "about finding solutions that are not based on fossil inputs, but on renewable materials, like food waste, plants, compost, and using them in a way that keeps the cycle going", but it "should also include farming, food systems, and small local loops" *(Interview 13)*, such as composting, reusable packaging and shorter supply chains. Here, the participant explicitly cautioned that the concept should not remain "only in Brussels or in labs", but "has to work for farmers, small businesses, and communities" *(Interview 13)*. Across these interviews, the bioeconomy was framed as a normative project whose meaning is still being negotiated; a distinction that can transition between organic agriculture, high-tech biorefineries, and local circular practices, and that risks becoming abstract or overly technocratic if it is not grounded in everyday realities. The emphasis here was less on specific resource shifts or circular practices, and more on who defines the bioeconomy, whose interests it reflects, and how it can be anchored in particular territories and communities.

4.1.3 The Bioeconomy and Sustainable Development (see Appendix, Table 3)

Across the interviews, participants saw a clear connection between the "bioeconomy" and "sustainable development", but in different ways. As such, three main themes emerged: 1) the bioeconomy as a pathway for sustainable development (8/15); 2) the bioeconomy as

conditional, with risks of burden-shifting and greenwashing (4/15); and 3) the bioeconomy as part of a broader socio-ecological and territorial justice agenda, linking environmental goals to people, places and everyday practices (3/15) (see Table 6):

Table 6: Thematic Structure of Bioeconomy/Sustainable Development Relationship

Aggregate Dimension	Second-order Theme	Key words	Interviews
Pathway to SD	Bioeconomy as driver	Driver; renewable resource base; regional development; cycles.	8
Conditional / Critical	Conditional & risk of burden-shifting	Governance; risks repeating fossil-economy; monocultures.	4
Socio-ecological & territorial	Socio-ecological & territorial	Local loops; fairness; behavioural change; consumption practices.	3

Eight interviewees interpreted the bioeconomy as a necessary driver of sustainable development, particularly prevalent amongst upstream (3/4) and bio-innovation (4/5) processors. For these actors, biological resources and circular biological processes constitute the foundation of future sustainable economies. An upstream processor argued that "if you have a thriving bioeconomy, then your economic development should be in a sustainable direction" *(Interview 5)*. Bio-innovation companies went further, describing the bioeconomy as "absolutely indispensable" for sustainability because "nature already runs circular systems… translating those biological cycles into industry is key" *(Interview 11)*. Another saw the bioeconomy as "the material base… bio-based flows must play a major role" if current consumption is to remain sustainable *(Interview 12)*. One branded participant (1/5) stated that the bioeconomy "directly relates" to sustainable development, drawing on Doughnut Economics and framing the bioeconomy as operating "within planetary boundaries" *(Interview 6)*. Across these interpretations, the bioeconomy was viewed as structurally necessary for achieving sustainable development goals, whether through innovation, renewable feedstocks, bioprocessing or regionally rooted value creation.

A second set of actors stressed that the bioeconomy–sustainable development relationship is not automatic, with this perspective most prevalent amongst branded processors (3/6), and to a lesser extent, bio-innovation processors (1/5). As such, four interviewees emphasised that bio-based systems can either support or undermine sustainability, depending on governance, land use, values and scale. A branded processor warned that the bioeconomy "fits together… but only if we keep the focus on the bigger picture, not just technology or growth", arguing that narrow profit-driven bioeconomy models risk repeating past mistakes such as biofuels displacing food production *(Interview 13)*. Another branded processor

described the potential for the bioeconomy to become “another form of industrial production… monocultures, intensive processing, long-distance shipping”, which would “repeat the mistakes of the fossil economy” *(Interview 14)*. A frozen-food manufacturer stated that substituting inputs without ecological integrity merely “shifts the environmental burden” (*Interview 15)*. An upstream processor stressed conditionality more succinctly; “It depends how you use it” (*Interview 4)*. This theme highlights a critical tension; the bioeconomy can either enable sustainable development or undermine it, depending on how ecological, social and economic boundaries are managed.

A final group of three interviews framed the link between the bioeconomy and sustainable development through local ecosystems, social equity and everyday consumption practices. For these actors, sustainable development emerges when bio-based activities reinforce regional resilience, fair value capture and community-scale loops. One branded processor (2/6) described the bioeconomy as “an important part, less material loss, new materials/processes from old ones, contributing to social and environmental goals” *(Interview 9)*. Another linked sustainability to consumer practices: “more people buying second-hand, using Too Good To Go… but online shopping increases emissions” *(Interview 8)*. An upstream processor (1/4) described the bioeconomy as a looped “Clean Deal”, where green choices become the default and produce “a domino effect across sustainable development” *(Interview 7)*. These participants emphasised that sustainable development is not only the outcome of substitution or technology, but of local value loops, socio-ecological feed-backs and place-based decision-making.

4.1.4 Practitioner views on developing the bioeconomy (see Appendix, Table 4)

Across the interviews, participants offered a wide range of reflections on how the bioeconomy should be developed. One respondent stated that they had “no idea” *(Interview 3)*, but the remaining interviewees articulated clear expectations and priorities. Among these fourteen substantive responses, three main orientations emerged: 1) systemic and governed development, focused on policy, coordination and economic incentives (6/14); 2) innovation- and viability-driven development, emphasising research, infrastructure and market deployment (4/14); and 3) societal and everyday transformation, centred on consumption, local actors and behavioural change (4/14) (see Table 7):

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Table 6: Thematic Structure regarding views on Developing the Bioeconomy

Aggregate Dimension	Second-order Theme	Key words	Interviews
Systemic & Governance	Governance and Incentives	Policy shifts; ecosystem accounting; incentives.	6
Innovation & Viability-driven	Innovation, Research & Deploy	R&D; sandboxes; funding; pilots; market access; economic viability.	4
Societal Transformation	Demand, local & everyday practice	Consumption change; local loops; small actors; decentralisation.	4

* One interviewee did not discuss.

Under this first theme bioeconomy development was framed as a project that depends on coherent governance, stable rules and aligned incentives. This perspective was most common amongst upstream processors (3/4), and to a lesser extent branded (2/5) and bio-innovation actors (1/6). Upstream processors called for a "big policy shift" and the integration of ecosystem and environmental accounting into financial systems so that legislation can "level the playing field" for ecosystem and carbon markets *(Interview 5)*. Others stressed the need to make "the green option… the natural, obvious choice because it's financially sensible", arguing that profitability is key to triggering a "domino effect across sustainable development" *(Interview 7)*. A branded processor called for better translation of research into practice, stronger coordination among actors, and public sensitisation so that consumption reduction can accompany innovation, "ensure research translates into practice; coordinate actors… more public sensitisation; and embrace 'less is more.'" *(Interview 9)*. While another branded processor added that bioeconomy development must be integrated across climate, energy, food and waste policy, with regulations aligned so that "waste from one sector can become a legal and safe input for another" *(Interview 15)*. Finally, a bio-innovation processor emphasised systemic coordination, stating that the bioeconomy should be developed through "a systemic approach: multiple problems, multiple answers" that plans streams across food, feed and energy, aligns actors, and "avoids siloed projects" under stable policy frameworks *(Interview 10*). For these interviewees, the core task of development concerned designing governance and market conditions that made bio-based and circular options viable, attractive and systematically coordinated.

A second group of interviewees emphasised innovation, research and economic viability as central mechanisms for bioeconomy development. This perspective was most prevalent amongst bio-innovation processors (4/5). One bio-innovation actor argued that sectors such as textiles should "valoris[e] more sustainable fibres, not just using synthetic ones" and pointed to promising innovations like microalgae-based biofuels *(Interview 1)*. Several stressed the need to "support foundational research, fast/iterative market testing in safe

regulatory sandboxes, and bold policy", coupled with early-stage funding, access to laboratories and pilots, and later-stage regulatory environments that do not "subsidis[e] incumbents over innovation" *(Interview 11)*. Another innovation actor insisted that the bioeconomy must "make it pencil out costs", calling for more holistic, cross-disciplinary research and better data to support investment decisions *(Interview 12)*. Others focused on more immediate market conditions, suggesting that the bioeconomy should be developed by "making it easier to sell and use the products generated by companies in this ecosystem" and by funding those willing to work in it *(Interview 4)*. Together, these accounts presented bioeconomy development as a process of nurturing innovation ecosystems, reducing bureaucracy, and ensuring that bio-based solutions can compete economically.

The third theme framed bioeconomy development as a matter of societal change, everyday practices and territorial justice. This approach was primarily adopted by branded processors (4/6). As such, branded actors stressed the need to reshape consumption and diets, with one suggesting that governments should "reduce livestock farming, starting with cows" by removing beef from public-sector menus, thereby shifting habits and demand *(Interview 6)*. Another argued that people should "buy only what they need", with public investment encouraging "fewer cars per family" and affordable public transport *(Interview 8)*. A branded organic retailer argued that development should "start with everyday things; how we grow food, how we use waste, how we support local supply chains", and insisted that small producers, cooperatives and regional actors need more accessible support, simpler rules, better networks and space to experiment *(Interview 13)*. A branded dairy processor similarly called for regional and decentralised bioeconomy models, investing in local composting, farm-based energy systems and cooperative logistics that keep value in the region and avoid dependence on long supply chains, "supporting regional and decentralised bioeconomy models… investing in smaller-scale, community-based solutions… local composting, farm-based energy systems," *(Interview 14)*. They also highlighted the need for integrated policies and stronger public understanding, making the bioeconomy visible through schools, procurement and labelling. In such accounts, developing the bioeconomy was as much about changing social practices and empowering local actors as it is about technological innovation or high-level strategies.

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4.2 Circular Practice within the Company, Pathways for Development and wider Sectoral Uptake

The following section turns from meanings (Section 4.1) to practice. As such, section 4.2 demonstrates what companies report doing at the current time in terms of circular practice (4.2.1), how they plan to extend those circular practices inside the factory gate (4.2.2), and how such approaches might diffuse across the wider agri-food system (4.2.3). The analysis is organised consistently with the processor typology used previously, upstream/ingredient processors, branded consumer-facing processors, and bio-innovation/upcycling processors, so that similarities and distinctions in emphasis are visible.

4.2.1 Company Circular Practice (see Appendix, Table 5)

In respect to company circular practice, three main approaches were discussed: 1) resource looping and upcycling within production (6/15 interviews); 2) regenerative farming and supply-chain circularity (5/15); and 3) relational, trade and collaborative approaches that enable circularity across networks and markets (4/15) (see Table 7):

Table 7: Thematic Structure regarding Company Approach to Circular Practice

Aggregate Dimension	Second-order Theme	Key words	Interviews
Operational & Value-chain Circularity	Resource looping & upcycling	Side-streams; whole biomass; by-products; loops; upcycling to food.	6
	Regenerative & Supply-chain	Organic/regenerative farming; crop rotation; farm–factory links.	5
Relational	Relational, trade & collaborative	Surplus redistribution; waste avoidance; sustainable trade.	4

Six interviewees, predominantly bio-innovation processors (4/5) and to a lesser extent, upstream (1/4) and branded (1/6) processors, described company circular practice as redesigning production so that materials and energy are kept in circulation and “waste” becomes a feedstock. An upstream processor highlighted practice that recovers all water contained in beets, methanising certain fractions to biogas to return, “thousands and thousands of cubic metres” of clean water to farmers via irrigation networks, alongside efforts to dehydrate beet pulp and use it as boiler fuel to generate all process steam in one plant (*Interview 2*). A branded processor described pursuing incremental loops such as reusing part of truffle production waste in new batches “within regulations and specifications” even where food safety was thought to constrain reuse (*Interview 8*). Bio-innovation processors similarly

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stressed side-stream valorisation and cascading uses. One French company stated that, "we were created around circularity, around the will to bring value to what was perceived as waste, or products that were not used to their full potential in human food. Starting with spent brewers' yeast, which we upcycle to create ingredients that are non-bitter compared to the usual spent yeast, making it available again for a human food palate" (*Interview 4*). Another French bio-innovation processor framed its whole model around using 100% of the biomass and avoiding the protein-extraction model that "waste[s] the rest" of the legume (*Interview 1*). By fermenting whole legumes, buying "rejected" chickpeas from farmers and supermarkets and working on bulk and reusable packaging, the participant described aiming to reduce both upstream and packaging waste. Another innovation processor described, "start[ing] from nature-based resources and side streams, not from 'virgin' inputs", prioritising "food-first, then feed, then energy" and splitting single streams across multiple uses (*Interview 10*). Another described feeding fungi with brewers' spent grain, using the entire biomass as food and "competing with biogas" by converting low-value energy side-streams into higher-value food (*Interview 11*). Across these accounts, circular practice emerges as a deliberate re-engineering of production systems so that side streams and residues are recast as cascading, multi-purpose resources, maximising material and energy retention while displacing more linear, wasteful models.

A second set of companies discussed circular practice in farming systems and long-term supply-chain relationships. This approach was most commonly described by branded (3/6) and upstream processors (2/4). A French upstream processor discussed working with 200 farmers who grow rotation crops for the company, including linseed, millet, and poppy, followed by wheat, sugar beet and others, so that "the rotation works well for them" agronomically as well as commercially (*Interview 3*). A maltster upstream processor described its "big emphasis on regenerative agriculture", focusing on returning organic matter and nutrients to soils, while routing limited malting by-products to animal feed and investing in heat and energy recovery (*Interview 5*). Branded processors similarly framed circular practice as starting on the farm. A German branded actor discussed being "very focused on organic farming" and crop rotation, with "animals and plants working together, not separate", underpinning soil health and biodiversity, with downstream measures including food-sharing donations, waste separation to biogas or compost, reducing mono-material packaging and generating renewable energy with heat recovery in logistics and buildings (*Interview 13*). Another innovation processor noted that their milk produce was sourced from organic family farms operating "within closed-loop systems" of rotational grazing, composting and nutrient

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cycling, with the dairy itself minimising waste via heat recovery, sending whey to feed or energy, and shifting to recyclable mono-materials for yoghurt and milk products (*Interview 14*). Another branded processor likewise described circularity as something "integrated into everything we do", including close collaboration with vegetable growers using long-term contracts, joint work on varieties and harvesting methods to reduce pre-factory waste, and exploring loops such as returning digestate from anaerobic digestion back to farms (*Interview 15)*. These accounts position circular practice as a whole-system, farm-centred endeavour, built on long-term, regenerative supply-chain relationships that close nutrient, energy and material loops from soil to processing and back again.

A final group of four interviewees emphasised relational and enabling dimensions of circular practice, such as social surplus, trade and collaborative innovation, rather than strictly internal operations. These were again prominent amongst branded processors (2/6) and to a lesser extent upstream (1/4) and bio-innovation (1/5) processors. One upstream processor discussed improving the sustainability of ocean and road freight, choosing certified options and sourcing more sustainable products, with circular practice framed as "deliberate choices that tilt operations toward environmental, economic, and social sustainability" and supported by a Sustainability Manifesto and sector-wide visions *(Interview 7)*. For a branded ready-meal processor, the primary mechanism was the final product, "the only thing I can control is the final product", so the focus is on choosing environmentally conscious co-manufacturers and avoiding waste in finished goods *(Interview 6)*. While another branded processor described part of their circular practice as like running "a large food-surplus project", collecting retailer surplus each morning and redistributing it to social organisations in the afternoon (*Interview 9)*. One bio-innovation processor discussed "connection first", assembling cross-functional teams that bring together biology, farming, design and product engineering to generate circular solutions, reflecting a view that circular practice arises from coordinated expertise rather than isolated company-level action *(Interview 12)*. These accounts portray circular practice as an outward-facing, relational endeavour, grounded in purposeful choices, redistribution and collaboration, where cross-actor coordination and social surplus are mobilised to enable circularity beyond the boundaries of individual companies.

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4.2.2 Pathways for Enhancing Circular Practice (within the Company) (see Appendix, Table 6)

Across the 15 interviews, companies identified multiple ways in which their circular practice could be improved or extended. These clustered into two main trajectories: 1) deepening resources and nutrient circularity within production systems (7/15); and 2) addressing systemic constraints and enabling conditions (8/15) (see Table 8):

Table 8: Thematic Structure regarding Pathways for Enhancing Circular Practice

Aggregate Dimension	Second-order theme	Key words	Interviews
Deepening resources	Deepening resource & nutrient circularity	Water/energy reduction; valorisation; regenerative sourcing	7
Systemic Pathways	Data, infrastructure, incentives & capacity	Packaging and logistics; regulatory and price support	8

When discussing pathways for enhancing circular practice within the company, seven interviewees amongst branded (3/6), upstream (2/4) and bio-innovation (2/5) processors discussed technical and biophysical improvements to circular practice. For these companies, the main scope for enhancement lies in further reducing water and energy use, expanding side-stream and by-product valorisation, and closing nutrient loops between factories and farms. An upstream sugar-beet processor, despite already advanced circular measures, still saw scope to "continue… to reduce… water consumption" and highlighted the need for "new technologies" such as wider deployment of carbon capture at distilleries to decarbonise production and reuse CO_2 as a product *(Interview 2)*. An upstream maltster pointed to regenerative sourcing as the main frontier, stating that expanding the share of barley from regenerative systems would significantly strengthen their circular profile *(Interview 5)*. Other companies emphasised side-stream technologies and nutrient recovery. A branded chocolate and truffle producer described working daily to reduce waste and "recuperate as much as possible during production", but recognised that this is "not always easy" *(Interview 8)*. A branded dairy processor identified "one of the biggest opportunities… in nutrient recovery", in terms of residues such as fine milk particles and low-grade whey that could be cycled back into the organic farming system if investment and regulatory approval could be secured *(Interview 14)*. Similarly, a branded frozen-food processor highlighted interest in improving "the valorisation of by-products", but noted that this depends on access to processing technologies that are both food-safe and economically viable at scale *(Interview 15)*. A yeast-based bio-innovation processor noted that "90% of what we use to produce is upcycled", but

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suggested that improvement lies in “making sure that we use everything generated during yeast processing in a useful way” *(Interview 4)*. Another bio-innovation company stressed that its “side-stream technology is advanced but not yet scaled”, with “matching species to side streams” remaining a key opportunity for future research and application *(Interview 11)*. Across this trajectory, enhancement was understood as pushing existing loops further, e.g. tightening water and energy efficiency, broadening side-stream utilisation, and strengthening nutrient cycles between processing and primary production.

Eight interviewees (2/4 upstream, 3/6 branded, 3/5 bio-innovation) emphasised that enhancing circular practice rested, less on new technologies, and more on systemic enablers such as packaging and logistics, data and digital systems, market incentives, willingness to pay, and targeted support for smaller actors. An upstream ingredient processor proposed “push[ing] circularity deeper into our own sourcing criteria”, giving sustainability more weight alongside quality and price to shift practices in the supply base *(Interview 7)*. Economic and institutional conditions were also seen as critical. Another upstream processor stated that circular practice “could be improved if the end consumer… [and] industry are really, really ready to pay for that”, observing that customers often “made some claims they want to have it, but they are not ready to pay for it” *(Interview 3)*. A branded ready-meal producer pointed to packaging and lack of in-house capacity, suggesting that “free consulting support from local government… even an hour to review what I’m doing and point out missed opportunities” would help *(Interview 6)*. Another branded processor talked about wanting to “reduce the share of surplus that ends up as biomass” by receiving donations earlier and having a “waste-fee structure that rewards donating rather than dumping”, alongside “more stable funding and smarter logistics tools” *(Interview 9)*. In this respect, information and data barriers were repeatedly mentioned. A branded dairy processor emphasised digitalisation to track inputs, waste and energy flows to identify inefficiencies, and argued that they could “do more” by working “closer with suppliers to redesign the whole chain”, expanding reusable crates, and improving digital systems to track waste, deliveries and returns” *(Interviews 13)*. A bio-innovation processor called for “better data sharing”, noting that marketplaces try to match materials and needs but “data exchange is hard, especially when product composition touches trade secrets” *(Interview 12)*. Another bio-innovation processor saw “packaging and logistics” as “one obvious area” for improvement, expressing a desire to move towards reusable containers but noting that current infrastructure and life-cycle trade-offs made this difficult without cooperation from packaging associations, logistics partners and canteens *(Interview 1)*. Another bio-innovation processor stressed the need to “scal[e] and stabilis[e]

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the flows we work with", cooperating with suppliers to standardise by-product streams so that more robust and replicable processes can be designed *(Interview 10)*. These accounts indicate that many companies saw organisational, informational and economic constraints, rather than technical possibilities alone, as fundamental barriers to enhancing circular practice. Improvements were deemed to require both deepening resource loops and adjusting the enabling environment in which those loops were supposed to function.

4.2.3 Wider Application of Circular Practice across the Agri-Food Sector (see Appendix, Table 7)

Across the fifteen interviews, participants saw substantial scope to extend circular practice beyond respective companies to the wider agri-food system. Responses clustered into two main orientations: 1) sector-wide resource and waste circularity, focused on what should happen to biomass, food, nutrients and packaging across the chain (7/15); and 2) enabling frameworks, coordination and incentives, emphasising governance, infrastructure, regulation and culture (8/15) (see Table 9):

Table 9: Thematic Structure regarding Pathways for Enhancing Circular Practice

Aggregate Dimension	Second-order theme	Key words	Interviews
Sector-wide resources	Sector-wide practices & resource management	Food-waste; regenerative ag.; valorisation; life-cycle packaging.	7
Enabling Framework	Governance & infrastructure	Regional governance; hubs; regulation; mindset.	8

When discussing the ways in which circular practice could be more widely applied in the agri-food sector, seven interviewees focused primarily on what should happen to materials across the agri-food system. This perspective was dominant amongst bio-innovation processors (4/5), and to a lesser extent branded (2/6) and upstream (1/4) processors. Such companies emphasised composting and soil health, food-waste prevention, by-product valorisation, regenerative practices and life-cycle aware packaging choices. A maltster argued for "widespread take up of regenerative agriculture", urging farmers to "consider food production as part of a systems framing", with co-benefits between dairy and arable enterprises and attention to wider environmental impacts *(Interview 5)*. A branded processor used the example of switching from glass to PET bottles to show that intuitive choices can be misleading, since glass is heavier and more energy-intensive to recycle; they argued for more life-cycle-based decisions in packaging *(Interview 8)*. Food waste and packaging were also key

concerns. Another branded ready-meal company described "huge amounts of food waste in the back rooms" of supermarkets and called for practical solutions such as publicly funded refrigerated transport to enable redistribution, arguing that margins are too thin for retailers to solve this alone *(Interview 6)*. A bio-innovation processor also emphasised food waste, "given that 30% of food is lost or wasted, there's huge potential… short-term focus should be on…waste" (Interview 11). Another bio-innovation actor argued that circular practice could be scaled by "do[ing] more composting and better valorise what's currently considered waste", since "not everything that's grown is used" and much could be turned into compost or other secondary uses rather than relying on chemical fertilisers *(Interview 1)*. Several respondents highlighted by-products and side-streams as a major opportunity. Another innovation processor observed that while some "first movers" already sell their by-products, "there is still hesitation about using them directly in food and formulations," and suggested that normalising this step could create value "for everyone" *(Interview 4)*. One innovation actor emphasised that many regions already return compost to fields, but that "big gaps remain in nutrient sourcing (e.g., manure flows) and reducing transport volumes", pointing towards more efficient nutrient and logistics cycles *(Interview 12)*. These perspectives frame the wider application of circular practice as a systemic reorganisation of material flows, prioritising soil health, food-waste prevention, by-product valorisation, life-cycle-aware packaging and more efficient nutrient and logistics cycles across the agri-food system.

A slightly larger group of interviewees (8/15) stressed that circular practice can only be applied more generally if framework conditions, such as governance, infrastructure, regulation, price signals and mindsets, are reshaped to support it. This perspective was most prevalent amongst upstream (3/4) and branded (4/6) processors, and to a lesser extent bio-innovation (1/5) processors. One upstream processor argued that circular practice requires thinking "at the level of the region", with local governance structures that optimise energy use, waste separation, data collection and by-product valorisation across multiple companies, rather than each company working in isolation *(Interview 2)*. Another called for more communication so "everybody understands what could be possible" *(Interview 3)*. Policy, incentives and regulation were repeatedly highlighted as levers and barriers. Another upstream processor argued that to trigger a "domino effect" across agri-food, the framework must make the "green option… the most profitable and least risky", so that circular choices become the default rather than a value-driven exception *(Interview 7)*. A branded processor suggested that laws should require "prevention and reuse for human consumption first, across the chain from farm to fork, before animal feed or biomass", backed by pay-for-waste schemes and obligations on

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auctions and retailers to enable donation *(Interview 9)*. Another branded processor emphasised that cooperation between farms could be stronger; for example, straw or manure from one holding meeting soil or energy needs on another, with suggestions that "local platforms or hubs" could make such exchanges workable (*Interview 13)*. Others suggested regulatory changes to prioritise prevention and reuse, to remove legal obstacles to donation and re-labelling, and to shift from waste-avoidance toward resource-valorisation logics in permitting, taxation and procurement *(Interviews 15)*. Some respondents underlined the importance of mindset, communication and standardisation. One branded actor stated that circular practice "should be more normal, not just something for organic or niche companies", but that this requires "more thinking on system level, not only inside one company" and a shift away from linear logics of efficiency, low price and speed *(Interview 13),* while others proposed common packaging standards and stronger regional innovation networks to enable knowledge-sharing and peer learning *(Interviews 14)*. One bio-innovation processor argued that circularity "isn't a single-company topic", and that building value-chain collaboration between growers, processors, logistics, technology providers and markets is essential *(Interview 10)*. These accounts suggest that scaling circular practice depends less on isolated industry-level initiatives than on reshaping regional governance, regulatory and market frameworks, infrastructures and mindsets so that collaborative, resource-valorising circular choices become the default rather than the exception.

4.3 Institutional and Policy Environment (see Appendix, Table 8)

Section 4.3 addresses the wider institutional and policy environment. Here, questions explored government roles in enabling or constraining biorefinery initiatives, the range of supports and barriers encountered, funding mechanisms, regulatory influences, and perspectives on national, regional, and EU-level policy priorities. Linked to this were inquiries into the region's research and innovation capacity and the organisation's relationships with primary producers.

Across interviews, the institutional and policy environment surrounding circular practice and the bioeconomy was seen as both enabling and constraining. Three dominant themes were identified based on the primary emphasis in each interview: 1) targeted funding, incentives and intermediary supports that partially enable circular practice (6/15 interviews); 2) regulatory complexity and governance silos that keep systems largely "linear" (6/15); and 3)

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gaps in scaling support and a sense that policy still favours large, high-tech players over everyday food-system circularity (3/15) (see Table 10):

Table 10: Thematic Structure regarding Institutional and Policy Environment

Aggregate Dimension	Second-order Theme	Key words	Interviews
Partial Support Architecture	Funding, incentive, supports	Grants, clusters, standards, knowledge platforms	6
Structural Constraints	Regulation, waste, governance silos	Food-safety rules, labelling, fragmented ministries, admin	6
	Scaling gaps, big-player bias	Scale-up, SME disadvantage, implementation gap	3

When discussing the institutional and policy environment, six interviewees highlighted targeted public funding, incentives and intermediary organisations as crucial, if partial, supports for circular practice. This perspective was common amongst branded (3/6) and bio-innovation (3/5) processors. In Belgium, a branded plant-based company pointed to regional incubators, while insisting that "governments need to put their money where their mouth is… implement plant-based, circular food in schools and hospitals" to build stable demand *(Interview 6)*. Another branded processor described working through a patchwork of time-limited subsidies and municipal co-funding, tied to the social organisations they serve *(Interview 9)*. While a German branded processor highlighted the need for "funding instruments that are accessible to SMEs, not just big corporates with full-time grant writers", alongside occasional state and EU grants for energy efficiency and packaging innovation *(Interview 14)*. A French bio-innovation start-up contrasted a visionary municipal methanisation and district-heating project with the reality that "most of the support goes to well-established companies… we've applied for a national eco-design grant" (*Interview 1)*. Another French bio-innovation processor emphasised the role of the *Bioeconomy for Change* cluster as "a network that provides help, networking and lobbying for a viable bioeconomy", helping them access potential clients for side-streams *(Interview 4)*. A Belgium bio-innovation processor stressed the importance of programmes such as Circular Wallonia and regional calls that fund SME pilots, arguing that future policies must be "more systemic and less siloed" *(Interview 10)*. These accounts suggest that while targeted funding, procurement and intermediary support can de-risk experimentation and broker markets for circular practice, current arrangements remain patchy, time-limited and skewed towards incumbents rather than systemic, SME-accessible transformation.

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A second group of six interviews highlighted regulatory complexity, waste classification rules and governance silos as major barriers to circular practice. This focus was shared chiefly amongst upstream (3/4) processors, and to a lesser extent, branded (2/6) and bio-innovation (1/5) processors. An upstream French sugar-beet processor explained that installing new methanisation capacity requires "two or three years of administrative papers", even though policy rightly prohibits dedicated energy crops and pushes towards residue valorisation *(Interview 2)*. Another upstream processor noted that microbiological contamination makes it "very difficult to reuse the material in the feed industry", with fermentation sometimes the only feasible route *(Interview 3)*. For a Belgian upstream processor, stringent labelling and food-donation rules mean that non-compliant products are often destroyed rather than relabelled, despite being safe *(Interview 7)*. While a Belgian branded processor described how well-intentioned packaging rules can backfire, forcing them to discard "a lot of packaging" when label-size requirements change *(Interview 8)*, with another branded processor emphasising the absence of a "unified framework that says: 'Here is what we mean by circular practice, and here is how all levels of government will support it'" *(Interview 13)*. One German bio-innovation processor emphasised "waste status" as a "major hindrance", whereby once a material is classified as waste, new companies "often cannot use it" even in safe, logical processes *(Interview 12)*. Across these cases, regulation is experienced as a double-edged sword: necessary for food safety and environmental integrity yet written from a linear product-versus-waste mindset and split across ministries (agriculture, environment, waste, food safety), which together limit the creation of new loops and raise the transaction costs of collaboration.

Finally, three interviews from upstream (1/4), branded (1/6) and bio-innovation processors (1/5) stressed structural gaps in scaling support and a broader political–economic bias towards large, high-tech actors. An upstream maltster argued that there "needs to be some kind of bridging finance" and farmer subsidies to make regenerative, circular practices viable while private markets for environmental goods develop *(Interview 5)*. A branded frozen-food processor similarly reflected that existing funding is "good for exploring ideas and testing them, but it's not well structured for implementation at scale", particularly when physical infrastructure or cross-sector collaboration is needed *(Interview 15)*. A German bio-innovation company, while acknowledging strong early-stage support, described the scale-up "valley of death" and noted that "late-stage bioeconomy needs more public co-financing", as traditional venture capital expects software-like timelines *(Interview 11)*. These accounts resonate with wider critiques in the dataset that national and EU bioeconomy strategies tend to prioritise bioplastics, biofuels and industrial biotechnology, while local nutrient loops, decentralised

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biorefineries and everyday food-system circularity remain under-supported. The result is an uneven transition in which SMEs carry disproportionate risk when attempting to move promising pilots into mainstream practice.

4.4 Relational and Market Factors shaping Circular Practice

Section 4.4 considers relational and market factors, including the processor relationship with primary producers, involvement in other collaboration networks, market conditions (including public awareness and demand), and logistical considerations such as seasonality, perishability, and spatial proximity of partners.

4.4.1 Relationships with Primary Producers (see Appendix, Table 9)

Relationships with primary producers ranged from deeply embedded, multi-decade partnerships to almost complete absence of direct contact. As such, two main patterns emerged: 1) partnership-based producer relationships that actively underpin circular practice (10/15); and 2) indirect, association, or intermediary mediated relationships, where primary production is central in principle but more distant in practice (5/15) (Table 11):

Table 11: Thematic structure concerning Relationship with Primary Producers

Aggregate Dimension	Second-order Theme	Key words	Interviews
Relational Infrastructures	Partnerships supporting Circularity	Long-term contract; premiums; co-production; nutrient loops.	10
	Indirect or Intermediary Links	Cooperatives; clusters; certification; limited direct contact.	5

Most companies described direct, partnership-oriented relationships with farmers or grower groups, framed as essential to securing appropriate biomass, managing surpluses and co-developing circular solutions. This description was common amongst upstream (3/4) and branded (5/6) processors, and to a lesser extent, bio-innovation (2/5) processors. A French upstream sugar-beet processor stressed that “our relationship with farmers is really at the core of everything, because we are a cooperative, the farmers own [the company]. They are not just suppliers; they are the shareholders and the people we work for” *(Interview 2*). In this context, circularity was enacted via water and nutrient loops, and water recovered from beets was returned through irrigation networks; and with sustainability premiums from customers channelled to farmers to support regenerative practices. A French seed processor emphasised

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regular meetings with farmers to motivate them to grow specific seeds, noting that direct connection "makes sense" to customers by providing a transparent story and cost efficiency "with no intermediate" (*Interview 3*). Another upstream processor described sourcing barley via grain merchants rather than directly yet used premiums and a partnership with a company called "Soil Capital" who develop, "a tailored plan[s] for each farm that allows farmers to receive practice-based payments … and then to generate carbon certificates" (*Interview 5)*. Branded actors also emphasised long-term, values-based partnerships. A German processor stated that relationships with producers are "one of the main parts of how we work", with most products coming from German organic farms and long-term partnerships built on "a lot of trust" *(Interview 13)*. These relationships were said to involve joint planning of crop choices and support for conversion to organic, alongside maintaining fair prices so farmers can invest in soil health, biodiversity and smarter waste use. A dairy branded processor described its relationships with farmers as "central to how we operate, and… a big part of why we're able to pursue circular practices at all" (*Interview 14)*. Working exclusively with organic dairy farms on fixed contracts above conventional prices was said to provide stability for farmers to adopt closed-loop nutrient cycles and diverse rotations. A frozen-food branded processor similarly highlighted that most vegetables come from contracted growers in northern Germany via "long-term relationships… in some cases going back more than a decade" (*Interview 15*). Other branded processors linked producer relationships strongly to surplus and waste valorisation. A plant-based branded processor described working with a partner farm, testing bean crops, "they grow red beets and asked if I could develop a recipe to use them, since they often have excess. That's a way of adjusting my product offering to reduce waste" *(Interview 6)*. A branded initiative pays a small amount for farm-level surpluses and transforms it into longer-shelf-life products, describing this as ethically important and as creating "a direct channel for surplus absorption and product transformation" *(Interview 9*). Two bio-innovation processor described close, purpose-driven relationships with primary producers as essential to their circular approach. One such actor stated that, "we have a very close relationship with producers. For one, we buy legumes that would otherwise be discarded, what the retail sector rejects due to calibration issues (for example, chickpeas that are too small). By doing that, we help reduce waste and add value at the farm level" *(Interview 1)*. Another innovation processor described more "personal and complex" ties with farmers, for whom circular collaboration is relatively new *(Interview 12)*. The latter requiring "trust-building and mutual understanding," but offering advantages such as early visibility into problems and ideas, more secure supply, and better joint process improvement. Accounts portray farmer relationships not as transactional sourcing arrangements but as long-

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term, co-productive partnerships through which circular practices around biomass, surplus management and resource looping are made technically feasible, economically viable and socially legitimate.

A second group of actors reported limited or largely indirect relationships with primary producers, even while recognising that farm-level practices are critical for circularity. This description was most common amongst bio-innovation (3/5) processors, and to a lesser extent upstream (1/4) and branded (1/6) actors. One upstream processor emphasised being "careful not to speak out of turn on farmer-specific policies", maintaining "friendly association-to-association relations" and acknowledging that "most dairy emissions occur at farm level" *(Interview 7)*. While a branded processor noted that it does not deal directly with farmers for chocolate, instead depending on suppliers, and pays extra for Fair Trade or Rainforest Alliance certification, "hoping the money reaches farmers" but unable to verify this *(Interview 8)*. A French bio-innovation processor acknowledged "not really" having relationships with primary producers *(Interview 4)*, and a fermentation-based processor stated that it does "not directly" work with farmers *(Interview 11)*, instead sourcing side streams from processors. In these cases, circular practice was framed around industrial residues, with primary production treated as a contextual backdrop rather than a relational arena. A Belgian innovation processor discussed increasingly including primary producers in its value-chain projects, often via cooperatives, and viewed this as making projects "more robust" and keeping processors "close to raw-material realities" *(Interview 10)*, yet relationships were said to remain largely mediated through project structures rather than direct commercial ties. Accounts suggest that where relationships with farmers remain distant or project-mediated, circular practice tends to be enacted through industrial residues and certification schemes, limiting companies' leverage over farm-level change and the traceability of circular benefits.

4.4.2 Wider Collaboration (see Appendix, Table 10)

Across interviews, companies and organisations described dense but uneven collaboration ecosystems that extended beyond primary producers. Two main patterns emerged: 1) collaboration networks as enabling infrastructures for circular practice, innovation and funding (7/15 interviews); and 2) constraints, uneven participation and future collaboration needs (8/15).

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Table 12: Thematic Structure regarding Wider Collaboration

Aggregate Dimension	Second-order Theme	Key words	Interviews
Wider Collaboration Ecosystem	Collaboration as Enabling Infrastructure	Clusters; consortia; research partnerships; funding access.	7
	Uneven Participation & Future Needs	Time/capacity limits; silos; need for hubs, digital platforms & cross-sector.	8

Seven interviewees discussed how wider collaborations were critical for advancing circularity, providing access to knowledge, partners, funding and policy voice they could not generate alone. This perspective was commonly described amongst upstream (3/4) and bio-innovation (3/5) actors, and to a lesser extent, branded (1/6) processors. A French upstream processor stressed that, "beyond the cooperative and local industrial ecology platform", we are, "involved in several other forms of collaboration networks at local, national and European level", to help coordinate farmer relationships, irrigation schemes and residue logistics around factories *(Interview 2)*. An upstream maltster described collaborations with "research institutions and various different universities", where farmers using "low-carbon fertiliser receive premiums and generated carbon certificates", illustrating how research–industry partnerships can underwrite farm-level circular transitions *(Interview 5)*. While a dairy upstream processor highlighted long-standing relations with FAO and WTO, noting that the main benefit of these links is visibility, "being cited and footnoted at global level," and keeping trade's contribution to sustainable food systems on the agenda *(Interview 7)*. Branded and organic companies also framed networks as crucial for technical problem-solving and shared compliance. A Belgian branded processor discussed being part of Choprabisco and FEVIA and undergoing, "BRC/IFS and retailer audits"; these bodies were described as keeping the company, "inform[ed] on regulations and [sectoral] changes," and providing a recognised framework for quality and safety *(Interview 8)*. A French bio-innovation company described participating in the *National Council for Food Resilience* and in associations on sustainable packaging, seaweed and aquatic foods, describing this as "a community of professionals working on circular economy models and building resilient, local food systems, from farm to fork" and emphasising access to industry knowledge, networking and shared innovation challenges *(Interview 1)*. Another innovation actor described being embedded in *Bioeconomy for Change*, *Protein France* and incubator networks, joined through startup contests and memberships; these were said to provide "contacts with industrial players, potential customers, and R&D people… and help reviewing grant applications" by highlighting relevant funds and offering legal and funding advice *(Interview 4)*. While a Belgian innovation processor reported being in a "dozen EU consortia focused on circularity and nutrition", with benefits

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including, “cascade funding for SMEs, new partnerships, and faster knowledge transfer back to members” *(Interview 10)*. Accounts depict collaboration networks as critical enabling infrastructures for circular practice, expanding companies’ access to knowledge, partners, funding and policy influence, and thereby amplifying their capacity to drive system-level change.

Alongside these benefits, some processors emphasised that current collaboration landscapes are resource-intensive, uneven and often project-dependent, which constrains their ability to support long-term circular transitions. This emphasis was most common amongst branded (5/6) processors, and to a lesser extent, bio-innovation (2/5) and upstream (1/4) processors. A French upstream processor described collaborations as “a lot of time-consuming energy… for us it’s not fun” *(Interview 3)*. A Brussels plant-based branded processor observed that networks can duplicate efforts and argued for “more events in English, and better cooperation between organisations”, while noting that expansion to France, the UK and pan-European platforms such as EIT Food would require additional effort *(Interview 6)*. A German branded processor remarked that smaller partners, especially farmers and small suppliers, “don’t always have the time or staff to take part in these networks”, suggesting digital tools or shared platforms to make participation easier *(Interview 13)*. While another branded processor emphasised that improvement “requires dedicated time and resources for relationship-building and clearer funding expectations”, as partners often assume services are free, which undermines sustainable collaboration models *(Interview 9)*. A branded frozen-food processor also argued for “more permanent platforms or frameworks” to sustain momentum after projects end, envisioning a regional “circularity hub” where businesses, researchers and policymakers could meet regularly, share data, co-develop pilots and coordinate infrastructure use *(Interview 15)*. One branded processor observed that many networks “still operate a bit in silos, dairy stays with dairy, cereals with cereals”, and called for government-facilitated collaboration hubs that bring together diverse companies, tech providers, municipalities and logistics companies to tackle circular challenges jointly, including cross-border collaboration with similar regional models in neighbouring countries *(Interview 14)*. Other actors stressed project-based fragility and funding dependence. A German bio-innovation processor described the “Blue Economy” regional network, requiring, “more market-driven, self-sustaining business ties beyond project funding” *(Interview 12)*. A fermentation-based bio-innovation company emphasised hurdles related to “mapping who has what, protecting IP, and heavy contracting costs”, calling for more standardised collaboration frameworks to make such partnerships feasible for startups *(Interview 11)*. Accounts suggest that without more inclusive, permanent and standardised collaboration

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frameworks, the current patchwork of resource-intensive, project-dependent networks risks excluding smaller actors and limiting the durability and systemic reach of circular transitions.

4.4.3 Market Conditions (see Appendix, Table 11)

Public awareness, demand, price sensitivity and competitiveness were seen as tightly coupled forces shaping the viability of circular and bio-based business models. While most companies reported growing interest in "better" food, this was tempered by low or fragmented public understanding of their specific products or circular practices, and by intense price pressure in mass-market and business-to-business (B2B) contexts. Two main patterns emerged: 1) segmented public awareness and B2B invisibility (6/15 interviews); and 2) price-sensitive demand, affordability constraints and uneven state support (9/15).

Table 13: Thematic Structure regarding Market and Operational Conditions

Aggregate Dimension	Second-order Theme	Key words	Interviews
Market Visibility, Demand & Competitiveness	Public Awareness	Limited awareness, confusion; limited campaigns; trust issues.	6
	Demand, price & support	Affordability; premium vs discount; public procurement; labelling.	9

Six interviewees emphasised that public awareness of their products, and of the circular practices underpinning them, is highly uneven, often confined to niche segments or absent altogether. This was particularly the case for bio-innovation (3/5) processor, branded (2/6) processors, and to a lesser extent, upstream (1/4) processors.

A French upstream sugar-beet processor stressed that the general public never encounters the company as a brand, "they see sugar or soft drinks. From the consumer side, awareness of how that sugar is produced, water recycling, residues to fertiliser, carbon capture, is very low. People mostly judge on price, and sugar is expected to be cheap and identical whether it comes from France or Brazil" *(Interview 2)*. One branded processor, stated that, "awareness is growing but not universal" *(Interview 9)*, while another emphasised how the company is "quite well known in Germany" for clean, additive-free products, yet awareness of "packaging recyclability, CO_2 footprint, or waste reduction" is "still more limited", with many consumers misunderstanding how to sort technically recyclable packaging or distrusting recycling systems altogether *(Interview 15)*. Several bio-innovation processors focused on a gap between general public knowledge and sectoral debates. A French alt-protein company noted that public awareness of overfishing and of the wastefulness of conventional protein

extraction ("purify and extract only the protein, discarding the majority of the biomass") is "still quite low", known mainly within a small sustainability-focused sub-public *(Interview 1)*. A French yeast-based innovation processor reported "not [being] a Business-to-Consumer (B2C) company", relying instead on *Protein France* and similar networks to run public opinion surveys on yeast, algae and insects as alternative proteins, observing a "positive evolution" but still limited mainstream familiarity *(Interview 4)*. A German bio-innovation processor described public awareness and demand as "near zero", adding that state-led awareness efforts "don't meaningfully affect our price competitiveness" *(Interview 12)*. Accounts suggest that public awareness of circular production, resource recovery and alternative proteins remains partial, uneven and weakly translated into purchasing criteria, offering limited demand-side reinforcement for companies' circular efforts.

Nine interviewees emphasised that even where interest and awareness existed, price-sensitive demand and affordability constraints dominated purchasing decisions, with implications for how circular products could be positioned, with some pointing to a limited but potentially important role for the state in shaping demand and creating fairer competitive conditions. This perspective was prevalent amongst upstream (3/4) and branded (3/6) processors, followed by bio-innovation (2/5) processors. Several actors reported growing demand for "better" products tightly coupled to intense price pressure. A French upstream seed processor observed "more and more demand for the type of product that we produce, because it is connected to health, nutrition, and going 'back to the basics'", but also "more and more competition" from brokers buying full containers, meaning the company must position itself as a premium supplier based on quality and analysis *(Interview 3)*. An upstream maltster likewise described "lots of demand" in a "very price-sensitive industry", with the core challenge being "getting customers to pay a premium" for more sustainable grain *(Interview 5),* while another upstream processor stated that, "people care about what they can afford at the shop. Public awareness of our association's services is low" *(Interview 7)*. Likewise, a Belgian plant-based branded processor saw "growing intent to eat products like mine, but wallets lag behind intent", noting that visibility is still low and that ingredient prices and consumer affordability depend on leveraging partnerships with larger producers and benefiting from their scale *(Interview 6)*. Commodity price volatility was said to further complicate circular ambitions. A branded confectionery processor emphasised that dramatic increases in cocoa prices, driven by ageing plantations and climate impacts, have made truffles "almost a luxury product", illustrating how global markets can override or destabilise circular initiatives by suddenly shifting products into higher price brackets *(Interview 8)*. A

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German branded processor described a core, trust-based customer group, but noted that demand is now "more sensitive", "people want to buy responsibly, but they also look at the price. So, the challenge is to stay affordable but still stick to our principles" *(Interview 13)*. A dairy branded processor similarly reported that awareness is strong within a certain segment, but demand has become "much more fragile" as inflation drives customers to reduce organic purchases, "with inflation and general uncertainty, even long-standing organic customers are becoming more price-sensitive; they buy our products less frequently, switch to cheaper organic or retailer own-brand lines, or drop some organic items from the basket altogether" *(Interview 14)*. A Belgian bio-innovation processor summed up the tension succinctly, "stated demand rose in recent years, but recent economic pressures push consumers to lowest price at purchase. That makes circular offerings harder to position, competitiveness and affordability are critical" *(Interview 10)*. A bio-innovation fermentation processor company reported being "well known within the food industry" while "consumer brand awareness is only beginning" and explained that although they "price meat-alternatives at parity with market leaders, Germany's ultra-low food prices and retailer pressure make margins tight" *(Interview 11)*. Accounts underscore that while interest in "better" and more circular products is growing, price-sensitive demand and volatile commodity markets continue to dominate purchasing decisions, constraining how circular offerings can be positioned and reinforcing calls for state-led measures to shape demand and create fairer competitive conditions.

4.4.4 Logistics (see Appendix, Table 12)

Across the interviews, logistics was repeatedly described as a critical, if often under-acknowledged, determinant of whether circular and bio-based models can function in practice. Among the thirteen interviews that explicitly discussed logistics, two main themes emerged: 1) temporal and material constraints in logistics, centred on seasonality, perishability and variability (7/14); and 2) logistics design and infrastructure for circular practice, focused on storage, cold-chain energy, routing and transport choices (7/14). These concerns cut across upstream, branded and bio-innovation actors, but with different emphases depending on whether processors handled fresh, frozen, dried or highly processed materials.

Table 14: Thematic Structure in respect to Logistics

Aggregate Dimension	Second-order Theme	Key words	Interviews
Temporal & Material Constraints	Seasonality, Perishability & Variability	Harvest peaks; fresh-product; risk of waste.	7

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Logistics design & Infrastructure	Design, Storage & Transport Efficiency	Cold storage; distance; digital tools; coordinate.	6

* Two interviewee did not discuss.

Seven interviewees foregrounded seasonality, perishability and material variability as defining logistical constraints with direct implications for circularity; commonly emphasised by branded (3/6) processors, followed by upstream (2/3) and bio-innovation (2/4) processors Upstream processors highlighted strong seasonal patterns and campaign-based operations. A French sugar-beet cooperative stressed that "logistics are absolutely central to our model", explaining that factories run from late September to January and that in a few months they must "bring in 7–8 million tonnes of beet, process them quickly, and handle all the outputs" *(Interview 2)*. This campaign structure was said to shape plant sizing, energy demand and the feasibility of certain circular projects (e.g. pulp-to-steam boilers that only make sense where distilleries run year-round). An upstream seed processor similarly described being "linked to the harvest of the farmers", with peak seasons when new seeds arrive in late August–September and again when on-farm storage is emptied in May–June *(Interview 3)*. These peaks were said to require sufficient reception, storage and processing capacity, and influence how far seeds could be sourced while remaining competitively priced. A branded processor noted that, "truffles are seasonal, shipped May to December in containers and trucks. Lemon juice is year-round", creating contrasting logistical scenarios within the same company *(Interview 8)*. Several branded actors emphasised freshness and perishability. A German branded processor described seasonality and perishability as "big challenges"; "some things, like local vegetables, are only available for part of the year, so we need flexible logistics to bring them in when they're fresh and also make sure we can still offer something when they're out of season" *(Interview 13)*. A dairy branded processor emphasised how "perishability is a major factor" in handling fresh milk and dairy, with very short windows to process, package and deliver meaning that "any delays or mismatches in the chain can lead to waste, which directly undermines our circular goals" *(Interview 14)*. Bio-innovation processors stressed material variability and time-critical intermediates. One fermentation-based innovation actor reported no agricultural seasonality but noted that "some intermediates are unstable (≤24h), so co-location or tightly synchronised handoffs are crucial" between pharma-style fermentation partners and food processors *(Interview 11)*. A German bio-innovation processor described logistics as a "big factor" because companies accustomed to petroleum-like inputs "expect button-press consistency", whereas bio-resources "vary by season, quality, and volume" *(Interview 12)*. Accounts suggest that circular ambitions are inextricably shaped by the temporal and material specificities of agri-food logistics, with seasonality, perishability and

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feedstock variability imposing hard constraints on feasible loops and demanding more flexible, tightly synchronised chains.

A second group of seven interviews focused on how logistics systems are designed and managed in respect to storage, cold chain, routing, and transport modes, and how these choices support or undermine circular ambitions. This focus was prevalent amongst branded (3/6) processors, followed by bio-innovation (2/4) and upstream (1/3) processors. An upstream dairy processor explained that their long-distance export uses dried products, limiting perishability concerns, whereby they try to choose greener options in ocean freight and road haulage where possible, though choices depend on destination, “it’s mostly ocean freight and road haulage; [we] try to choose greener options where possible” *(Interview 7)*. A branded frozen-food processor stressed that dealing primarily with frozen foods makes the logistics system “quite energy-intensive, especially in terms of cold storage and refrigerated transport” and that “every inefficiency… has both an environmental and a financial cost.” This was said to have driven investment in route optimisation, load planning and more energy-efficient cold stores, “we’ve invested… in optimising routes, improving load planning, and upgrading our cold storage facilities” *(Interview 15)*. Other branded processors underlined route optimisation, collaboration and platform-based solutions. A plant-based ready-meal producer described managing perishability through promotions and giveaways, while leveraging a production partner’s existing distribution network “to avoid redundant trips”, thereby reducing both costs and emissions *(Interview 6)*. Another branded processor described logistics as “central”, involving, “daily retailer pickups, thermal boxes, cold storage, and digital registration” *(Interview 9)*. A French bio-innovation processor noted that if they want to replace fish, they must offer products in similar formats (fresh or frozen), implying future investment in cold storage and freezing infrastructure with significant energy costs. They contrasted this with their dried legume raw materials, which are “ideal” because they can be stored for long periods at ambient temperature, reducing refrigeration needs, “legumes are actually ideal… dried and can be stored… at ambient temperature” *(Interview 1)*. Another bio-innovation processor noted that, “we have to be close to brewers, making sure they have good storage, food safety, and food grade levels” *(Interview 4)*. Accounts underscore that advancing circularity in logistics depends less on reducing movement per se than on redesigning storage, cold chains and routing so that energy intensity is minimised, existing networks are leveraged and product formats align with low-waste, low-carbon flows.

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5. Discussion

5.1 Meaning of Circular Practice

The findings indicate that agri-food processors articulated circular practice through three partially overlapping lenses; first as a technical–process, second as a socio-economic process, and third as a systemic–normative process, with a clear dominance of the first. This pattern reflects wider debates in the circular economy literature, where circularity is frequently operationalised as the optimisation of material and energy loops at company level, while broader questions of social justice, value distribution and institutional change remain comparatively underdeveloped (Kirchherr et al., 2017; Geissdoerfer et al., 2017; Korhonen et al., 2018). The prevalence of technical–process framings, particularly amongst upstream and bio-innovation actors, aligns with more narrow conceptions of the circular economy that prioritise resource efficiency, by-product valorisation and incremental eco-efficiency within existing production regimes (Ghisellini et al., 2016; Lacy and Rutqvist, 2015).

At the same time, the identification of socio-economic circularity, centred on fair returns to farmers, surplus redistribution and socially oriented reuse pathways for products, points towards an emergent concern with distributive and relational dimensions that are largely absent from mainstream corporate circularity narratives (Gregson et al., 2015; Hobson, 2016). These practices resonate with calls for a just or socially inclusive circular economy that embeds equity, livelihoods and social enterprise logics within circular strategies, rather than treating social outcomes as secondary co-benefits (Calisto Friant et al., 2020). In this respect, branded processors' emphasis on donations, surplus absorption and value recirculation suggests that, at least for some actors, circular practice intersects with ethical sourcing and social responsibility agendas, albeit often framed as pragmatic responses to waste rather than explicit justice-oriented programmes.

The systemic–normative interpretation, most prominently observed amongst branded and bio-innovation companies, described circular practice in terms of systems thinking, mindset shift and cross-organisational change, aligning closely with transformational or holistic circular economy discourses (Murray et al., 2017; Calisto Friant et al., 2020). Here, circular practice is not merely a set of techniques but a reorientation of organisational routines, information systems and inter-company relations, often triggered by, but also extending beyond, regulatory requirements. The examples of reconfiguring ERP systems for donation, reorganising internal departments and cultivating feedback loops across farms, processors and logistics actors

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indicate movement towards a socio-technical transition logic, in which circularity is understood as a multi-level restructuring of practices, infrastructures and governance arrangements (Geels, 2002). However, the fact that such systemic framings are a minority view underlines the continuing hegemony of efficiency-oriented, micro-level interpretations in the agri-food sector.

Taken together, these interpretations suggest that circular practice is best conceptualised as a contested and multi-scalar construct, spanning material flows, socio-economic relations and institutional–cognitive change. The co-existence of these framings within and across company types supports the argument that circular economy discourse is heterogeneous and internally fragmented, comprising utilitarian, reformist and more transformative strands (Kirchherr et al., 2017; Calisto Friant et al., 2020). For policy and governance, this implies that interventions focused solely on technical process improvements risk reinforcing a weak circularity that optimises existing linear models, whereas leveraging the more systemic and socio-economic interpretation requires value-chain governance, redistribution mechanisms and organisational learning. Future research should therefore examine how these different meanings are negotiated within value chains and regulatory arenas, and under what conditions more systemic–normative understandings can move from the margins to the mainstream of agri-food circular practice.

5.2 Meaning of the Bioeconomy

Results indicated that agri-food companies envisioned the bioeconomy as: 1) bio-based substitution and innovation; 2) circular–sustainability; and 3) a more explicitly normative socio-political project. The techno-economic framing of the bioeconomy as biomass-based substitution and biotechnological innovation, particularly among bio-innovation processors, aligns with the bio-technology and bio-resource visions that emphasise biomass valorisation, new value chains and competitiveness (Bugge et al., 2016; Priefer et al., 2017). By contrast, the six interviews that emphasised the bioeconomy as a circular, regenerative economic model resonate with the bio-ecology vision and with work that situates the bioeconomy alongside green and circular economy agendas, where ecological limits, ecosystem services and territorial regeneration are central rather than derivative concerns (D'Amato et al., 2017; Ramcilovic-Suominen and Pülzl, 2018).

The differentiation by company type is theoretically relevant. Bio-innovation processors' strong orientation towards substitution and technological novelty reflects high-tech, innovation-led growth narratives dominant in EU and national bioeconomy strategies, whereas branded and upstream processors more frequently embeded the bioeconomy in sustainable food systems,

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soil health and local loops. This pattern supports arguments that the bioeconomy functions as an umbrella term under which growth-oriented, efficiency-focused and ecologically grounded trajectories co-exist and compete (Bugge et al., 2016; D'Amato et al., 2017). The prominence of circular–sustainability framings among branded actors suggests that companies closer to consumers may be more inclined to translate bioeconomy discourse into narratives of responsible consumption, waste prevention and regenerative territorial development, even if their concrete practices remain constrained by cost structures and market volatility.

The smaller, but analytically important, subset of respondents who interpret the bioeconomy as a contested socio-political project reflects long-standing critiques of conceptual ambiguity and the risk of appropriating the concept by incumbent interests (Vivien et al., 2019; Ramcilovic-Suominen and Pülzl, 2018). In this context, the concerns relating to linguistic confusion (e.g. conflation with the term organic), bundled goals of innovation, independence and ecology, and the need for place-based small local loops echo calls to ground the bioeconomy in territorial realities, democratic deliberation and distributional questions rather than in abstract, technocratic strategies.

More generally, the findings support treating the bioeconomy not as a single, coherent transition pathway but as a heterogeneous and contested field of strategies and imaginaries. For policy, this implies that the generic promotion of the bioeconomy concept is unlikely to resolve underlying tensions. Interventions that prioritise biomass expansion and technological upgrading are likely to reinforce substitution-oriented visions, whereas those that strengthen local circular loops, ecological regeneration and social equity are more consistent with the circular–sustainability and socio-political interpretations articulated by a minority of companies in the study.

5.3 Bioeconomy and Sustainable Development

The findings indicate that agri-food companies tended to perceive a close relationship between the bioeconomy and sustainable development, but in different ways. First, the dominant framing of the bioeconomy as a necessary driver of sustainable development was conceptualised, especially amongst upstream and bio-innovation actors. This paralleled policy narratives in which bio-based resources and biotechnological innovation are presented as structural preconditions for developing the green economy and SDG delivery (Bugge et al., 2016; D'Amato et al., 2017; Priefer et al., 2017). Here, biological cycles and renewable feedstocks are cast as the material base of future economies, and sustainable development is largely equated with a successful transition from fossil to bio-based production, often situated within circular and

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planetary-boundary frames such as Doughnut Economics (Raworth, 2017). This is consistent with what Pfau et al. (2014) describe as substitution and efficiency-oriented visions of the bioeconomy, in which sustainability is assumed to follow from technological upgrading and the reorganisation of resource flows.

The second, more critical, theme problematises this automatic coupling by emphasising the conditionality of the bioeconomy–sustainable development relationship. Interviewees' concerns about monocultures, displacement of food production, long-distance shipping and burden-shifting reflect critiques that bio-based transitions can reproduce core features of the fossil economy, including land-use conflict, externalised ecological costs and uneven development. Such issues arise if governance, value chains and demand remain organised around growth and cost minimisation (Pfau et al., 2014; Ramcilovic-Suominen and Pülzl, 2018; Vivien et al., 2019). This interpretation aligns with ongoing debates suggesting that without robust safeguards on land use, biodiversity, social equity and consumption levels, the bioeconomy risks becoming a greenwashed extension of existing agri-food systems rather than a substantive contribution to sustainable development (Vivien et al., 2019). From this perspective, bio-based substitution is a necessary, but not sufficient, condition for sustainability; whereby outcomes depend on how ecological, social and economic boundaries are institutionally managed.

Finally, the socio-ecological and territorial framing articulated by a smaller subset of companies resonates with strong sustainability and justice-oriented perspectives that emphasise place-based loops, fair value capture and everyday practice (D'Amato et al., 2017; Ramcilovic-Suominen and Pülzl, 2018). By linking the bioeconomy to local composting, surplus redistribution, behavioural change and regional green transition dynamics, these actors move beyond a purely supply-side view and situate sustainable development in the co-evolution of ecosystems, communities and consumption practices. This aligns with calls for a territorially-grounded bioeconomy that strengthens regional resilience and socio-ecological feedbacks rather than prioritising export-oriented biomass valorisation (Bugge et al., 2016; Vivien et al., 2019).

These interpretations suggest that the bioeconomy is not inherently synonymous with sustainable development. It can function as an enabling pathway, a source of new risks, or a vehicle for socio-ecological transformation, depending on how it is governed, where it is anchored, and which understandings of sustainability are privileged in practice. While many actors naturalise bio-based substitution as a structural precondition for developing the green economy, others highlighted the risks of reproducing fossil-era dynamics and the need for robust

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socio-ecological safeguards. The territorially grounded, justice-oriented framing advanced by a minority of actors therefore appears crucial. It repositions the bioeconomy as one potential vehicle for strong sustainability, conditional on governance that prioritises ecological limits, local value loops and fair distribution over narrow efficiency gains.

5.4 Developing the Bioeconomy

The findings suggest that practitioners do not treat bioeconomy development as a purely technological or market-driven process but as a multi-level task distributed across governance systems, innovation ecosystems and everyday life. First, upstream and some branded actors focused on governed development, calling for a significant policy shifts, ecosystem accounting and cross-sectoral regulation that makes environmentally preferable options the most financially attractive default. This resonates with work on policy mixes and mission-oriented governance, which emphasises that bio-based transitions require coherent, long-term rules, aligned price signals and the internalisation of environmental costs rather than technological development alone (Priefer et al., 2017; Ramcilovic-Suominen and Pülzl, 2018; Mazzucato, 2018). The insistence on regulatory alignment across climate, energy, food and waste policy also reflects debates on avoiding siloed interventions that frustrate the cascading use of biomaterials (??).

Second, bio-innovation processors articulated an innovation and viability-oriented view, in which developing the bioeconomy meant investing in foundational research, regulatory sandboxes, pilots and market deployment while removing bureaucratic and financial barriers. This aligned with sustainability transition scholarship on the need to protect and nurture niches through targeted R&D support, experimentation spaces and risk-sharing instruments (Geels, 2002; Kivimaa and Kern, 2016). At the same time, practitioner focus on achieving economic viability and avoiding subsidy regimes that privilege incumbents, articulates an acute awareness that bio-based solutions will not scale without credible business models and fair competitive conditions, a concern often underplayed in more normative policy narratives (Pfau et al., 2014). The emphasis on market access, demand creation and predictable regulatory environments points towards an innovation policy agenda that treats economic viability as a necessary condition for socio-ecological transition rather than a competing objective.

Finally, branded actors called for dietary change, reduced car dependence, support for small producers and decentralised infrastructures, situated bioeconomy development in societal and territorial transformation. Here, bioeconomy development was contingent, not only through upstream investments, but through public procurement (e.g. removing beef from menus),

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mobility policies, local composting, on-farm energy and cooperative logistics that keep value circulating regionally. This perspective aligns with sustainability and social-practice approaches that focus on sufficiency, everyday routines and place-based loops as critical for maintaining planetary boundaries (Shove et al., 2012; D'Amato et al., 2017; Lorek and Fuchs, 2013). It also echoes literature on grassroots and territorial innovations, which argues that local actors, cooperatives and municipalities can co-produce bioeconomy pathways that are more socially inclusive and resilient than export-oriented, centralised models (Seyfang and Smith, 2007; Vivien et al., 2019).

Overall, practitioner perspectives portrayed bioeconomy development as a negotiated project rather than a technocratic rollout, requiring the co-production of policy reform, investable innovation and shifts in everyday practice. Upstream and bio-innovation actors looked to mission-oriented governance and de-risked innovation ecosystems to structure viable markets for bio-based options (Geels, 2002; Priefer et al., 2017; Mazzucato, 2018). Branded processors emphasised demand, diets and territorial infrastructures, aligning with sufficiency- and justice-oriented approaches to sustainability (Lorek and Fuchs, 2013; D'Amato et al., 2017). Taken together, these views imply that future bioeconomy strategies must mobilise governance, innovation and societal change in tandem if they are to deliver truly resilient, regionally embedded and environmentally robust development.

5.5 Company Circular Practice

The findings show that agri-food companies operationalise circular practice through; 1) process-level resource looping; 2) regenerative supply-chain design; and 3) outward-facing relational strategies. The first, most prominent, modal centres on side-stream valorisation, cascading uses and waste valorisation logics, particularly among bio-innovation processors. This strongly reflects mainstream circular economy prescriptions around closing material and energy loops, prioritising high value uses and designing business models around by-product utilisation (Ghisellini et al., 2016; Geissdoerfer et al., 2017). The emphasis on whole-biomass use, food-first hierarchies and competition with low-value energy recovery also resonates with debates on cascade utilisation and food-waste hierarchies in agri-food systems, which argue that upcycling into human food should be privileged over feed or energy wherever feasible (Papargyropoulou et al., 2014; Teigiserova et al., 2020). In this sense, companies' internal looping practices can be read as attempts to move beyond downstream efficiency gains towards reconfigured production logics, even if they remain largely confined to the factory gate.

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The second modal extends circular practice upstream and downstream, embedding it in regenerative farming and long-term supply relationships. Here, crop rotations, soil organic matter, nutrient cycling and farm–factory feed-backs are considered central, with processors working through contracts, premiums and technical support to co-produce closed-loop systems with growers. This aligns with bio-ecology oriented visions of the circular bioeconomy, which stress ecosystem processes, soil health and territorial regeneration rather than mere resource efficiency (D'Amato et al., 2017; Kirchherr et al., 2017). It also echoes emerging research on regenerative agriculture and circular food systems, whereby mixed farming, diversified rotations and organic amendments are seen as key to restoring ecological functions while sustaining production (Tittonell, 2014; Rockström et al., 2020). The interviews suggest that where such supply-chain circularity is pursued, circular practice becomes a whole-system, farm-centred endeavour, in which processors act as coordinators of nutrient, energy and value loops rather than isolated optimisers of plant-level flows.

The third, more relational, modal focuses on trade, redistribution and collaborative innovation as enabling infrastructures for circularity beyond company boundaries. Practices such as surplus collection and redistribution, socially embedded second-use pathways for products, sustainable freight choices and cross-functional innovation teams position circular practice as a networked, socially embedded project. This approach reflects the importance of inter-organisational collaboration, logistics coordination and social enterprises in addressing food waste and building circular food networks (Masi et al., 2017; Genovese et al., 2017; Hebrok and Heidenstrøm, 2019). By framing circularity as a deliberate choice in procurement, partnerships and redistribution, these actors move closer to relational and justice-oriented understandings of the circular economy, in which questions of who benefits, who participates, and how surplus is shared are emphasised alongside technical efficiency (Gregson et al., 2015; Hobson, 2016).

These approaches suggest that company circular practice in agri-food is multi-scalar and layered. Internal process redesign provides a necessary, but not sufficient, foundation; regenerative farm–factory relations extend circularity into landscapes and soils; while relational, trade-based strategies mobilise wider networks and the public. These differing approaches reinforce the argument that circular transitions in food systems depend not only on technological innovations in processing, but also on reconfigured producer–processor relations and socially organised surplus flows. Future research should therefore investigate how companies navigate tensions and synergies between these approaches, e.g. between food-first valorisation and energy recovery, or between local regenerative loops and global trade. This should be done in

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order to understand the conditions under which circular practice can contribute to a genuinely sustainable and equitable agri-food transformation.

5.6 Pathways for Enhancing Circular Practice

The findings indicate that practitioners conceived pathways for enhancing circular practice along two trajectories: 1) deepening resource and nutrient loops inside the company; and 2) modifying the systemic conditions under which those loops operate. The first trajectory aligns with somewhat narrow circular economy framings prioritising incremental improvements in resource efficiency, side-stream valorisation and closed-loop sourcing at production level (Ghisellini et al., 2016; Kirchherr et al., 2017). The emphasis here relates to tightening water and energy use, expanding food-grade by-product upcycling, scaling side-stream technologies and strengthening nutrient cycles between factories and farms and closely reflects calls for cascade use and food-waste hierarchies that privilege re-use and food valorisation over lower-value energy recovery (Papargyropoulou et al., 2014; Teigiserova et al., 2020). That even "high-performing" processors see further scope for improvement underscores the path-dependent, iterative nature of operational circularity, where optimisation is understood as an ongoing process rather than a discrete shift.

The second trajectory highlights that many perceived bottlenecks are organisational, informational and economic rather than purely technological. Practitioners' accounts of packaging constraints, lack of life-cycle-robust reuse options, fragmented logistics, limited data on material flows and price-sensitive demand echo broader evidence that system-level enablers such as digital traceability, collaborative infrastructures and supportive market incentives, are critical for moving beyond company-level resource efficiency (Genovese et al., 2017; Masi et al., 2017; Bocken and Short, 2021). The repeated emphasis on willingness to pay, waste fee structures that reward donation, and subsidy regimes that currently privilege incumbents, reinforces critiques that circular practices often remain economically marginal when externalities are not internalised, and when regulatory frameworks do not adequately recognise by-products as valuable inputs (Korhonen et al., 2018; Ranta et al., 2018). Similarly, calls for "free consulting", better data sharing, and support for small actors, highlight capacity and knowledge gaps that can prevent companies, especially SMEs and start-ups, from identifying and acting on circular opportunities (Lopes de Sousa Jabbour et al., 2019).

These findings suggest that enhancing company circular practice in agri-food is understood as a dual challenge of pushing existing loops "deeper" through technological and sourcing advances,

while simultaneously reshaping the informational, infrastructural and economic context that determines whether such advances are feasible and scalable. This supports the argument that circular transitions require integrated strategies that couple process innovations with reforms to pricing, regulation, data infrastructures and inter-organisational coordination, rather than relying on technology or business-level initiatives in isolation (Geissdoerfer et al., 2017; Korhonen et al., 2018).

5.7 Wider Application of Circularity

The findings suggest that practitioners envisage the wider application of circular practice in agri-food through pathways: 1) the systemic reorganisation of material flows; and 2) the redesign of enabling frameworks. First, the emphasis on food-waste prevention, by-product valorisation, regenerative agriculture, composting and life-cycle-aware packaging reflects a material-flow perspective consistent with circular food system and food-waste hierarchy literature, which argues for prioritising prevention and high-value re-use (especially for human food) over lower-value uses such as energy recovery (Papargyropoulou et al., 2014; Teigiserova et al., 2020). The call for "widespread take-up of regenerative agriculture" and better management of manure, compost and nutrient flows echoes research on regenerative and agroecological approaches that frame soils, nutrient cycles and biodiversity as critical infrastructures for circularity, not just backdrops to industrial optimisation (Tittonell, 2014; Rockström et al., 2020). Life-cycle-based packaging decisions (e.g. PET vs glass) similarly reflect debates on the need to move beyond intuitive eco-choices towards robust LCA-informed trade-offs in circular economy strategies (Korhonen et al., 2018).

A slightly larger group of interviewees emphasised governance, infrastructure, regulation, incentives and mindsets, as preconditions for scaling circular practice. The focus here rests on regional coordination platforms, cross-company hubs for by-product exchange and local governance that optimises energy use, waste separation and logistics. This reflects arguments that circular economy implementation hinges on meso-level industrial symbiosis and regional innovation systems, rather than isolated company-level action (Genovese et al., 2017; Masi et al., 2017). Calls to make the "green option… the most profitable and least risky", to prioritise prevention and reuse in regulation, and to reform waste-fee structures so that donation is rewarded rather than penalised, directly echo critiques that current institutional arrangements continue to favour linear, low-cost disposal, thereby constraining circular business models (Korhonen et al., 2018; Ranta et al., 2018). Likewise, concerns around legal barriers to donation,

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re-labelling and cross-sector flows illustrate how classification and liability regimes can impede the redefinition of "waste" as resource, a problem widely noted in the resource recovery literature (Gregson et al., 2015).

Importantly, practitioners also emphasised the cultural and cognitive dimensions of scaling circular practice. References to circularity becoming "more normal, not just something for organic or niche companies", and to the need for common packaging standards, peer-learning networks and better communication, resonates with studies that frame the circular economy as a socio-cultural transition requiring changes in norms, expectations and professional routines as much as technology (Hobson, 2016; Kirchherr et al., 2017). The insistence that circularity is "not a single-company topic" but a value-chain endeavour, further supports relational accounts of circular transitions, where distributed agency and trust between growers, processors, logistics providers, and retailers are essential (Genovese et al., 2017).

Taken together, these practitioner perspectives reflect the view that extending circular practice across agri-food is not simply a matter of diffusing best-practice technologies, but of synchronising sector-wide resource strategies with regionally grounded governance, regulation and market reforms. Material-flow interventions, such as regenerative agronomy, food-waste redistribution and by-product valorisation, are seen as necessary but insufficient unless embedded in enabling frameworks that reconfigure incentives, infrastructures and mindsets, so that circular choices become the default rather than the exception.

5.8 Institutional and Policy Environment

The interviews portray an institutional environment that is neither uniformly enabling nor wholly obstructive, but characterised by patchy support architectures, regulatory misalignment and uneven scaling pathways. On one level, practitioners reported encountering an increasingly dense "support architecture" of grants, incubators, clusters and green public procurement, which they recognised as crucial for de-risking experimentation, accessing knowledge and opening early markets. Yet these same instruments were said to be experienced as fragmented, short-lived and unevenly accessible, with design choices around eligibility, reporting and co-funding loading administrative risk onto SMEs and social enterprises, while large companies with specialist staff capture a disproportionate share of resources (Vivien et al., 2019). Rather than a level playing field, practitioners described a tiered regime in which public funds and networking infrastructures tend to stabilise incumbent positions, while smaller actors rely on a patchwork of precarious, project-based support.

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Regulation appeared as an equally ambivalent force. Processors rarely questioned the need for stringent food-safety and environmental protection per se; instead, they emphasised how existing rules encode a linear ontology of "product versus waste" and are fragmented across ministries and agencies. Once materials fall under "waste status", companies were said to face protracted permitting, liability and traceability obligations that make even technically safe reuse unviable, while labelling and donation regulation could lead to the destruction of edible products purely for formal non-compliance (Gregson et al., 2015; Kirchherr et al., 2018). In practice, this means that regulatory systems designed to prevent harm also inhibit the reclassification of residues as inputs, raising the transaction costs of cross-sector loops and favouring disposal or low-value energy recovery over higher-order circular options. Governance silos between agriculture, environment, waste and food authorities were said to amplify this effect, as companies must navigate multiple, partially inconsistent regimes for the same material (Korhonen et al., 2018).

The most acute concerns related to what interviewees describe as a "scaling gap". While early-stage grants, municipal pilots and visionary demonstration projects were described as existing, practitioners found limited institutional support when moving from prototype to durable infrastructure and business model. Upstream processors and bio-innovation companies alike described a "valley of death" scenario whereby regenerative farming schemes, decentralised biorefineries, or side-stream valorisation platforms require long-lived, capital-intensive investments and multi-actor coordination, but actually encounter finance and policy tools calibrated to fast-return, low-asset digital innovation (Kivimaa and Kern, 2016; Mazzucato, 2018). In this context, expectations that private capital will take over once technical feasibility is shown are perceived as unrealistic, given uncertain revenue streams, policy risks and the need to renegotiate value distribution along supply chains. SMEs, in particular, were said to be left to absorb disproportionate risk when attempting to mainstream circular practices that deliver public environmental benefits.

Taken together, these dynamics suggest that the institutional turn towards a circular bioeconomy remains partial and internally contradictory. Emerging funding instruments, clusters and procurement programmes signal political interest and create islands of experimentation, but core legal and financial architectures still reflect linear, volume-based models and a preference for large-scale, high-tech investments (Bugge et al., 2016; Ramcilovic-Suominen and Pülzl, 2018). For the practitioners in this study, advancing circular practice is therefore less a question of inventing new technologies than of reconfiguring the state's role across there dimensions: 1) redistributing support so that SMEs and territorially embedded initiatives can access stable,

implementation-oriented finance; 2) re-writing regulatory categories and responsibilities so that resource-valorising loops are administratively normal rather than exceptional; and 3) aligning industrial and agricultural policy to reward regenerative, decentralised infrastructures alongside flagship bio-based industries. Without such changes, the institutional environment risks perpetuating a two-track transition in which everyday food-system circularity is both rhetorically endorsed and experimentally piloted, but most importantly structurally under-developed.

5.9 Relationships with Primary Producers

Interviews indicated that relationships with primary producers function as a critical "relational infrastructure" through which circular practice is either enabled or effectively bounded. Where ties are long-term, contract-based and value-oriented, circularity is co-produced with farmers rather than retrofitted onto existing supply bases. Cooperative models and stable contracts above conventional prices redistribute some of the risks and rewards of transition, allowing farmers to invest in crop rotation, soil health and nutrient cycling. In these cases, circular practices such as water and nutrient loops, surplus absorption and on-farm waste reduction are not simply technical options but negotiated outcomes of trust-based partnerships, underpinned by premiums, tailored advisory support and joint planning of rotations and varieties. This resembles forms of "relational governance" in agri-food chains in which quality, sustainability and innovation are coordinated through repeated interaction rather than arm's-length transactions (Gereffi et al., 2005; Ponte and Sturgeon, 2014).

Importantly, these partnership-based arrangements also perform a legitimacy function. By tying circular initiatives to farmer ownership (cooperatives), fairer prices and surplus valorisation that "adds value at the farm level", companies construct circular practice as socially grounded rather than merely efficiency driven. This addresses a recurring critique of circular economy discourse as inattentive to distributional issues by embedding circular gains within farm livelihoods and rural development (Sonnino and Marsden, 2006; Calisto Friant et al., 2020). The capacity to adjust product development to farm surpluses, or to create dedicated channels for surplus transformation, further illustrates how close producer–processor relationships can generate "mutual adjustment" loops in which production decisions, product design and circular strategies evolve together.

By contrast, where relationships with primary producers are indirect or project-mediated, circular practice tends to be displaced downstream and framed around industrial residues and certification schemes. Reliance on intermediaries, cooperatives and standards such as Fairtrade

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or Rainforest Alliance allows companies to signal concern for farm-level conditions but inhibits their direct leverage over agronomic practices and limits the visibility of how circular benefits are distributed. In such configurations, residues from other processors and side-streams become the primary locus of circularity, while farms are positioned as contextual mechanisms rather than active partners. This reflects concerns in the sustainable value-chain literature that third-party certification can spatially and institutionally distance companies from production realities, transforming social and environmental issues into audit variables rather than domains of joint problem-solving (Ponte, 2019; Tallontire et al., 2011).

The interviews also revealed an intermediate position in which bio-innovation processors begin to involve primary producers through cooperatives and project consortia, but where commercial ties remain thin. These emerging linkages are perceived as making projects "more robust" and keeping companies "close to raw-material realities", yet they do not yet afford the stability or bargaining space needed to systematically reshape cropping systems or nutrient cycles. In practice, this reinforces a dualism between upstream and branded actors with long-standing producer partnerships that can more readily extend circular practice into soils, rotations and farm-level waste, and actors who are embedded primarily in industrial or R&D networks and who remain confined to valorising what arrives at the factory gate.

Results indicated that the depth and form of producer relations decisively shaped the ambition of circular practice. Where farmers were shareholders, long-term partners or co-innovators, circularity could be pursued as a shared project of reorganising biomass flows, risk and value along the chain. Where relations were mediated or distant, circular efforts gravitated towards post-farm residues and symbolic assurances, with limited capacity to influence land-use decisions or address structural drivers of waste. For policy and governance, this underscores that fostering circular agri-food systems requires not only technical and financial support, but also institutional arrangements that stabilise and democratise producer–processor partnerships through cooperative structures, fair contracting and joint investment mechanisms, so that circularity is anchored in the everyday political economy of farming rather than in downstream optimisation alone.

5.10 Wider Collaboration

Collaboration emerged, not as option, but as a constitutive dimension of how circular practice is organised and governed. Participants described consortia, clusters, trade associations and research partnerships as extending their own capabilities by providing technical expertise,

access to side-stream users, regulatory intelligence and routes into funding competitions that could not be assembled in-house. In this context, collaboration networks were described to function as "distributed infrastructures" for circularity, creating shared spaces in which problems such as residue logistics, carbon accounting or packaging redesign could be collectively framed and experimented with, rather than left to individual companies acting in isolation (Klerkx et al., 2010; Coenen et al., 2012). The fact that upstream and bio-innovation actors were particularly embedded in such arrangements suggests that circular transitions in agri-food are already being mediated by specialised multi-actor intermediaries such councils on food resilience, bioeconomy clusters, or EU consortia, that shape which solutions are rendered visible, fundable and legitimate (Geels, 2002; Hargreaves et al., 2013).

At the same time, accounts pointed to collaboration as an uneven and resource-intensive field that could entrench, rather than dissolve, asymmetry. Participation in numerous networks and projects was said to demand time, language (English) skills and administrative capacity that smaller processors, farmers and social initiatives often lack. In practice, this was said to produce a familiar core–periphery pattern whereby well-resourced upstream and innovation actors occupy central positions in multiple EU consortia and national councils, accumulating agenda-setting power and access to cascade funding, while smaller companies and primary producers appear mainly as occasional partners or absent altogether (Avelino and Wittmayer, 2016; Ponte, 2019). Interviewees' concerns that partners "assume services are free" and that collaboration requires dedicated but unfunded labour, highlights how relational work is systematically undervalued, even though it is indispensable to making circular pilots function. Without explicit recognition and remuneration of coordination, facilitation and boundary-spanning tasks, collaborations risk reproducing a pattern in which the costs of participation fall disproportionately on those least able to bear them.

The temporal organisation of collaboration was also considered important. Many of the networks described such as EU projects, regional initiatives, and innovation contests, are anchored in short funding cycles. Practitioners described periods of intense, well-resourced interaction followed by sharp drop-offs once projects end, with knowledge, relationships and experimental infrastructures often left without a clear institutional home. This project-based scenario was said to fragment learning and make it difficult to sustain the cumulative, long-term coordination required to reconfigure logistics, shared infrastructure or cross-sector by-product exchanges (Jensen et al., 2018). The recurrent call for more permanent "circularity hubs", including digital platforms, regional centres and government-facilitated fora, reflects a practitioner intuition that

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the current patchwork of projects is ill-suited to stewarding multi-decadal transitions in agri-food systems.

Finally, collaboration remained strongly structured along sectoral and territorial lines. Actors reported that "dairy stays with dairy, cereals with cereals", and that linguistic and national boundaries limit access to some events or associations. Combined with intellectual property concerns and heavy contracting costs, this was thought to constrain more radical forms of circularity that would cut across value chains and redistribute material flows between sectors and regions (Kirchherr et al., 2018; Genovese et al., 2017). Where more experimental, cross-sector collaborations was said to occur, such as industrial ecology platforms or regional "Blue Economy" networks, they are often heavily dependent on public funding and were said to struggle to evolve into self-sustaining, market-embedded arrangements.

These findings suggest that wider collaboration was simultaneously an enabling condition and a site of fragility for circular agri-food transitions. Networks amplified a companies' ability to innovate, align with policy and access resources, but their current design favours well-resourced actors, short-term projects and sectoral silos. From an analytical perspective, this implies that the politics of "who collaborates with whom, on what terms, and for how long" will be as important in shaping the trajectory of circular practice as technological options or price signals. Strengthening circular transitions will therefore require not only more collaboration, but collaboration architectures that are more inclusive, durable and explicitly oriented towards cross-sectoral, territorially embedded forms of circularity (Coenen et al., 2012; Avelino and Wittmayer, 2016).

5.11 Market Conditions

Findings depicted market conditions as a central limiting factor in implementing circular practice throughout the agri-food value chain. First, actors described operating in markets where the attributes they invest in, whether it be water recycling, residue valorisation, alternative proteins, are largely invisible at the point of purchase. Business-to-business suppliers and ingredient processors are reported to be collapsed into generic categories ("sugar", "grain"), while even branded actors reported that consumers recognise taste or "clean label" but not packaging recyclability, CO_2 reductions or food-waste prevention. This mirrors evidence that many sustainability attributes function as "credence qualities" that are difficult to observe or verify, even when communicated via labels, and are therefore weakly translated into routine purchasing criteria (Thøgersen, 2000; Grunert et al., 2014). Bio-innovation processors' reliance on specialist

networks to test public attitudes to yeast, algae or insect proteins emphasised that knowledge about circular practices is concentrated in niche populations rather than mainstream food cultures (Calisto Friant et al., 2020).

Second, the results highlight a pronounced tension between stated concern for "better" products and the dominance of price at point of sale. Processors repeatedly described consumers and buyers who express interest in health, provenance and sustainability, but default to the cheapest option under budgetary pressure, with inflation further eroding demand for organics and other premium segments. This closely parallels the "attitude–behaviour gap" documented in sustainable consumption research, where pro-environmental intentions are routinely overridden by constraints of income, habit, convenience and trust in information (Vermeir and Verbeke, 2006; Carrington et al., 2014). Interviewees' references to Germany's "ultra-low food prices", retailer pressure and the need to "stay affordable but still stick to our principles" emphasise that this gap is not merely psychological, but embedded in a wider "cheap food" regime in which margins are thin, downstream buyers hold significant bargaining power, and sustainability costs are difficult to pass on (Lang and Barling, 2013; Clapp, 2016).

Commodity price volatility added a further layer of instability. The example of cocoa prices pushing truffles into "luxury" status shows how global climate and supply shocks can abruptly shift products into higher price brackets, making circular or ethical positioning harder to sustain. For upstream and branded actors, this volatility interacts with the need to secure long-term contracts with farmers and invest in regenerative practices, increasing perceived risk and shortening planning horizons. Such dynamics reflect broader concerns that bio-based and circular models are being developed within markets still organised around volume growth, cost minimisation and short-term contracting, rather than long-term stewardship of soils, biomass and nutrition (D'Amato et al., 2017; Korhonen et al., 2018).

Against this backdrop, interviews portrayed the state, not as an absent actor, but as a weak shaper of demand. Companies pointed to sporadic awareness campaigns and fragmented subsidies as insufficient to alter financial parameters of cheap food and tight margins. Where actors saw potential was in instruments that structurally change relative prices and normalise circular products, e.g. public procurement of plant-based or circular food in schools; waste-fee structures that reward donation rather than disposal; and funding instruments accessible to SMEs rather than only to "big corporates with full-time grant writers". This resonates with work on sustainable public procurement and "the public plate", which highlights state catering as a powerful lever for reconfiguring demand and legitimating alternative production models (Morgan

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and Sonnino, 2010), as well as with calls for fiscal and regulatory measures that internalise environmental costs instead of relying on consumer choice alone (Lorek and Fuchs, 2013; Kirchherr et al., 2018).

Overall, the findings suggested that market conditions generate a structurally "thin" demand for circular attributes. Awareness is segmented, much of the circular work is invisible to end-buyers, and purchasing decisions remain dominated by price in highly competitive, low-margin environments. In such settings, expectations that circular agri-food models will diffuse primarily through informed consumer choice or voluntary business-to-business premiums appear optimistic. The interviews instead pointed towards a political economy in which meaningful scaling of circular practice depends on reconfiguring the rules of the game in respect to price signals, procurement norms, risk-sharing and information infrastructures, so that circular products are not exceptional fragile niches, but viable options within the everyday constraints faced by households, retailers and processors.

5.12 Logistics

Logistics emerged from the interviews as a key set of conditions that delimit what kinds of circular and bio-based practices can work in agri-food value chains. Processors described campaign-based operations, short harvesting windows and sharp seasonal peaks as structuring plant capacity, energy demand and sourcing radii. This temporal precarity is well documented in agri-food supply chain literature, where harvest-related surges and off-season troughs constrain storage, processing and transport decisions (Ahumada and Villalobos, 2009). In this context, circular options such as pulp-to-steam boilers or residue valorisation cannot simply be "plugged in"; they must be compatible with highly uneven material flows and factory utilisation rates. Likewise, branded actors working with fresh vegetables and dairy emphasised that very short processing windows and tight use-by dates turn minor delays into waste, directly undermining circular ambitions. This confirms that perishability and time–temperature dependence, long recognised as central challenges in food logistics (Akkerman et al., 2010), also act as hard boundary conditions on the design of circular loops.

Bio-innovation processors added a further layer by focusing on feedstock instability and time-critical intermediates. Biological inputs and fermentation broths were described as variable in composition and sometimes stable for less than 24 hours, making co-location or tightly synchronised hand-offs essential. This stands in tension with buyer expectations shaped by petroleum-based inputs and mirrors wider findings that bio-based supply chains face higher

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uncertainty in quality, volume and timing than their fossil-based counterparts (Genovese et al., 2017; Cambero and Sowlati, 2014). The findings therefore suggest that circular bio-based models must grapple not only with closing loops, but with designing logistics that can absorb biological variability without triggering either food-safety risks or costly safety margins that erode competitiveness.

The second theme concerns how logistics systems are actively configured, be it through storage formats, cold-chain design, routing or use of existing distribution networks, to reconcile circularity with cost and carbon constraints. Frozen-food processors, for example, described their systems as “quite energy-intensive”, prompting investment in route optimisation, load planning and more efficient cold stores. This reflects a broader recognition that frozen food chains are major energy and emissions hotspots in food systems, and that marginal efficiency gains in refrigeration, vehicle utilisation and facility design can yield disproportionate environmental benefits (James and James, 2010). Other actors described managing perishability by using promotions and giveaways to avoid write-offs, or by piggy-backing on partners’ existing distribution networks to “avoid redundant trips”, illustrating how circularity can arise from reconfiguring flows within existing logistical architectures rather than from wholly new infrastructures (van der Vorst et al., 2009).

Product format emerged as a strategic variable. Dried exports and ambient-stable legumes were portrayed as “ideal” from a circular-logistics perspective, because they were said to reduce refrigeration needs, extend planning horizons and lower the risk of waste. Fresh or frozen food stuff, by contrast, was said to require new cold storage and distribution investments if they are to compete with incumbent products on convenience and shelf life. This trade-off echoes life-cycle studies showing that moving from ambient to chilled or frozen formats often shifts environmental burdens from waste to energy use, raising complex optimisation questions for circular design (Akkerman et al., 2010; Gustavsson et al., 2011). Finally, repeated references to the need to be “close to brewers” or to coordinate manure, compost and by-products across farms, highlighted that spatial proximity and hub-like nodes are considered critical for economically viable loop-closing, a point long emphasised in work on industrial symbiosis and circular supply-chain configuration (Genovese et al., 2017).

These findings demonstrate that logistics is not a neutral conduit through which circular practices simply flow, but a dense web of temporal, spatial and technological constraints and opportunities that co-determine what forms of circular practice are feasible. Seasonality, perishability and material variability impose hard limits on how far loops can stretch in time and

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space, while cold-chain design, routing strategies, choice of product format and the leveraging of existing networks become pivotal levers for reducing the energy and cost penalties of circular models. Therefore, circular agri-food transitions will depend as much on logistics innovation in storage, scheduling, spatial configuration and collaboration for example, as on new biotechnologies or business models, and that research on circular bioeconomy should bring logistics from the periphery to the analytical centre of transition debates.

6. Conclusion: Applying Exemplars of Circular and Sustainable Practice to Regional Ireland

The role-model regions and company-level exemplars analysed in this report demonstrate that circular and sustainable agri-food practices are most effective when embedded in territorially specific configurations of agroecology, market structure and governance. In line with the case-study methodology, these exemplars support *analytic* rather than statistical generalisation and offer theoretically and empirically grounded propositions that can inform, but not be mechanically transplanted into, rural Irish contexts (Yin, 2014; Flyvbjerg, 2006). The challenge, therefore, is not to "copy–paste" German, French or Belgian configurations onto Irish regions, but to treat them as heuristic devices for exploring how similar principles might work under Ireland's distinctive farm structures, land-use patterns and institutional path-dependencies (Marsden, 2012; Wiskerke, 2009).

From this perspective, upstream, branded and bio-innovation exemplars can be understood as modular "building blocks" for a regionally tailored Irish strategy. Upstream and ingredient processors highlight the role of long-term farmer–processor partnerships, regenerative crop rotations and nutrient cycling between fields and processing facilities, echoing wider evidence that circular agri-food systems depend on re-designing producer–buyer relations rather than simply adding new technologies (Levidow, 2015; Lamine, 2015). In the Irish context, such lessons point towards regionally adapted cooperation around soil health, surplus management and side-stream valorisation, while recognising differences in herd structures, cooperative traditions and land tenure. Branded and consumer-facing exemplars emphasise how surplus redistribution, "second-life" products and low-waste diets can be normalised through retail, catering and social-enterprise channels, aligning with broader work on circular foodscapes and social value recirculation (Kirchherr, Reike and Hekkert, 2017; Geissdoerfer et al., 2017). Bio-innovation and upcycling processors show how low-value residues can be re-positioned as core feedstocks in regionally anchored biorefineries and ingredient chains, providing conceptual guidance for re-

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imagining Irish biomass flows (e.g. grass-based residues, dairy and meat by-products, horticultural surpluses) within a circular bioeconomy (Stegmann, Londo and Junginger, 2020).

Equally important are the institutional architectures and policy mixes that underpin these exemplars. The role-model regions point to the importance of coherent regulatory frameworks that integrate waste, food, climate, energy and agricultural policy, as well as meso-level platforms or clusters that coordinate by-product flows, shared infrastructure and collaborative innovation across processors (McCormick and Kautto, 2013; Hansen and Coenen, 2015). Translated to rural Ireland, this implies that regional bioeconomy strategies must treat circular practice not as a purely company-level choice, but as a function of enabling environments, and should include: 1) regional hubs for nutrient and biomass exchange; 2) permitting and classification rules that facilitate safe re-use; and 3) funding instruments genuinely accessible to SMEs, cooperatives and community enterprises, rather than only to large actors. At the same time, comparative evidence cautions against an over-emphasis on capital-intensive flagship projects at the expense of decentralised, small-scale infrastructures that fit dispersed settlement and production patterns (Levidow, 2015).

Importantly, the exemplars confirm that circular and bio-based transitions are socio-political processes, shaped by governance choices, social norms and everyday practices, not simply technological substitution (Geissdoerfer et al., 2017). For Ireland, this means that lessons from role-model regions should be treated as *inputs* to, rather than *templates for*, regional transformation. They constitute a foundational backbone for co-design which includes a preliminary portfolio of circular practices (e.g. regenerative sourcing, side-stream valorisation, social surplus redistribution), institutional levers (e.g. regional clusters, brokerage hubs, SME-oriented funding) and governance principles (e.g. prevention and human-food use hierarchies, territorial justice, farmer participation) that stakeholders in different Irish regions can interrogate, prioritise and recombine. In this way, exemplars from elsewhere anchor the design space, but the concrete pathways are co-produced with local actors and institutions, ensuring that circular and sustainable practices are not imported wholesale but re-worked into regionally embedded trajectories of change.

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Appendix: Gioia-Style Tables

Table 1: Thematic Structure concerning Interpretation of “Circular Practice”

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
2	Practice-orientated	Technical-process	“reuse and to valorise the maximum of the biomass… and to have less waste.”
4			“use the outputs of human activity in production… to bring value to another activity.”
5			“waste and byproducts from one processor being used and taken up by another… thinking about things in terms of cycles.”
8			“the reusage of energy, machines, products in general.”
11			“using all or most outputs of a production process to minimize waste, recycling streams back into the food system.”
12			“we trade bio-resources—anything that grows… [and] create new loops so natural products remain in circulation.”
14			“designing our operations in a way that nothing goes to waste unnecessarily… every part of the production cycle… stays in use or returns to the system.”
3		Socio-economic	“the first is the money back to the farmers… everybody gets the good value for his work in the system.”
6			“if I have products close to expiry, I don’t throw them away. I give them away… or partner with organizations to redistribute them.”
9			“giving things a second life and minimizing waste—turning items into something new, adding value so as little as possible is lost.”
1	Systematic-normative	Systematic-normative	“ERP systems weren’t designed with donation in mind… to implement a donation policy, you need to reconfigure [them] and educate people.”
7			“circularity as choices that create feedback loops — an action in one area affects another and feeds back again.”
13			“circular practice means to think in cycles, not just in straight line… to look how we can reuse things, or keep materials longer in the loop.”
15			“designing our food system so that resources are kept in use for as long as possible, and waste is minimised or eliminated altogether.”
10			“It means treating circularity as a mindset across the value chain.”

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 2: Thematic Structure concerning Interpretation of "Bioeconomy"

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Biobased techno-economic transformation	Biobased substitution & innovation	"An economic model that seeks to valorise living and renewable biological resources."
2			"An economy that is organised around biomass instead of fossil resources."
8			"An economy driven by natural or renewable products."
11			"Replacing chemical solutions with biology."
4			"Generate new raw materials for everyday products with less impact."
10			"Working with nature-based resources as the obvious default."
5		Circular & sustainable economic system	"Assigning a value to every aspect of the environment… recognising the value that ecosystem services deliver."
7			"An economy functioning in a loop… favouring the greenest option."
6			"Sustainable food, circularity, and using natural resources responsibly."
9			"Turning leftovers into new, longer-lasting products, an enabler of circular economy."
14			"Rethinking how we produce, use, and reuse biological resources; farm as a living ecosystem."
15			"Shifting from a fossil-based linear system toward a regenerative bio-based one."
3	Normative & socio-political reframing	Normative, contested & socio-political	"Bioeconomy? Is it linked to the organic?… in France 'biologic' stands for organic."
12			"A long-neglected part of the economy with huge potential, innovation, independence, ecological gains."
13			"It should also include farming, food systems, and small local loops… composting, reusable packaging, shorter supply chains."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 3: Thematic Structure concerning the perceived linked between the “bioeconomy” and “sustainable development”

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Pathway to SD	Bioeconomy as driver	“The two go hand in hand… reduces impact, supports renewable use, promotes regional development.”
2			“Very closely linked… reduce fossil use and valorise everything from biomass.”
3			“It’s connected. It’s connected.”
5			“If you have a thriving bioeconomy… development should be in a sustainable direction.”
6			“It must operate within the Doughnut… sustain people without exceeding planetary boundaries.”
10			“One of the practical toolsets… for achieving sustainability.”
11			“Absolutely indispensable… translating biological cycles into industry.”
12			“It can be the material base… bio-based flows must play a major role.”
4	Conditional/Critical relationship	Conditional & risk of burden-shifting	“It depends how you use it… biological processes can reduce emissions.”
13			“It fits together… but only if we keep the focus on soil, water, people… not just profit.”
14			“One of the key tools… but if done badly becomes just another form of industrial production.”
15			“Replacing fossil inputs but depleting soils… not sustainable development.”
7	Socio-ecological	Socio-ecological & territorial framing	“An economy in a loop… green option becomes the natural choice.”
8			“Yes… but online shopping increases vans and emissions.”
9			“Important part; less material loss, new processes from old ones.”

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 4: Thematic Structure regarding views on Developing the Bioeconomy

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
2	Systematic & Governed Development	Governance, Incentives & Territorial Focus	"We have to start from what we already have: residues and wastes."
5			"There needs to be a big policy shift… it all comes unfortunately… down to legislation just to level the playing field."
7			"If the green option becomes the natural, obvious choice, because it's financially sensible, you get a domino effect."
9			"Ensure research translates into practice; coordinate actors… more public sensitisation; and embrace 'less is more.'"
10			"Adopt a systemic approach: multiple problems, multiple answers… plan streams across food, feed, and energy; align actors."
15			"We need to focus on three things: integration, inclusivity, and practicality… the bioeconomy can't be something that sits in isolation."
1	Innovation & Viability-Driven	Innovation, Research & Deployment	"We should be valorising more sustainable fibres, not just using synthetic ones… microalgae to produce biofuels… very promising."
4			"By making it easier to sell and use the products generated by companies in this ecosystem, and by funding companies willing to work in this environment."
11			"Support foundational research, fast/iterative market testing in safe regulatory sandboxes, and bold policy. Reduce red tape."
12			"Make it pencil out costs. Expand research and take a holistic view… more data and cross-disciplinary work."
6	Societal & Everyday Transformation	Demand & Diet Change	"We need to reduce livestock farming, starting with cows… remove [beef] from menus in schools, hospitals, and public buildings."
8		Everyday Practices	"People should focus on buying only what they need… governments should… encourag[e] fewer cars per family but also making public transport affordable."
13			"It should start with everyday things: how we grow food, how we use waste, how we support local supply chains… include smaller businesses more."
14		Decentralised Model	"Supporting regional and decentralised bioeconomy models… investing in smaller-scale, community-based solutions… local composting, farm-based energy systems."
3	-	-	"No idea"

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 5: Thematic Structure regarding Company Circular Practice

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Operational & Value-chain Circular Practice	Resource Looping & Upcycling	"In our process, we use 100% of the biomass."
2			"We recover all the water contained in our sugar beets to run our processes."
4			"We were created around circularity… bringing value to what was perceived as waste."
8			"At the end of truffle production, we try to reuse some waste in a new batch."
10			"We start from nature-based resources and side streams, not from 'virgin' inputs."
11			"We use mycelium fermentation to turn agricultural side streams… into new food products."
3		Regenerative Farming & Supply-chain Circularity	"We are working with 200 French farmers… the rotation works well for them."
5			"We obviously have a big emphasis on regenerative agriculture… putting organic matter back into soils."
13			"We are very focused on organic farming… many of our partner farms use crop rotation and mixed farming."
14			"We source all of our milk from organic farms in Bavaria… operating within closed-loop systems."
15			"We work closely with our suppliers to reduce losses before the ingredients even reach us."
6	Relational & Enabling Circularity	Relational, Trade & Collaborative Approaches	"The only thing I can control is the final product… the main thing is avoiding waste in the final product."
7			"Many are… choosing certified or labelled options, and sourcing more sustainable products."
9			"We run a large food-surplus project… collect surplus food… and distribute it to social organizations."
12			"Connection first… we assemble cross-functional teams… to generate new ideas and solutions."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 6: Thematic Structure regarding Enhancing Circular Practice

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
2	Deepening resource & nutrient circularity	Deepening resource & nutrient circularity	"We can still continue… to reduce and reduce… our water consumption… *andneed*new technologies."
4			"90% of what we use to produce is upcycled… maybe the room for improvement is… to use everything generated."
5			"We expand on our sourcing of regenerative agriculture…, that's a small component of the total volume of barley."
8			"They work on it every day, trying to reduce waste… we try to recuperate as much as possible during production."
11			"Our side-stream technology is advanced but not yet scaled… matching species to side streams remains."
14			"One of the biggest opportunities is in nutrient recovery… *residues*could be cycled back into the farming system."
15			"We're very interested in improving valorisation we'd need processing technologies."
1	Systemic constraints & enabling conditions	Enabling infrastructure, incentives & capacity	"One obvious area is packaging and logistics… we are still searching for truly sustainable solutions."
3			"It could be improved if the end consumer… are ready to pay for that… they are not ready to pay for it."
6			"Because I'm small, I don't have the bandwidth or budget… if there were free consulting support."
7			"Push circularity deeper into our own sourcing criteria… sustainability is still not weighted as strongly."
9			"We would like to reduce the share of surplus that ends up as biomass… *weneed*donations happening earlier."
10			"One obvious area is scaling and stabilising the flows we work with… standardise certain streams… design more."
12			"Better data sharing… marketplaces try to match materials and needs, but data exchange is hard."
13			"I think we can still do more… work closer with suppliers to redesign the whole chain… if we use better data"

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 7: Thematic Structure relating to Wider Sectoral Uptake

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Resources & Waste	Sector-wide practices & resource management	"We need to do more composting and better valorise what's currently considered waste."
4			"Everyone understands co-products and by-products can have value, but there is still hesitation."
5			"There needs to be a widespread take up of regenerative agriculture."
6			"Governments could make it easier by funding trucks to collect food waste from stores."
8			"We changed from glass to PET bottles… glass requires more energy to recycle, is heavier… and increases.. costs."
11			"Given that 30% of food is lost or wasted, there's huge potential… short-term focus should be on…waste."
12			"Big gaps remain in nutrient sourcing (e.g., manure flows) and reducing transport volumes."
2	Enabling Frameworks	Governance, infrastructure & coordination	"We have so much waste… there are so many ways of recovering and making bridges between companies."
3			"If we… make more communication about it so that everybody understands what could be possible."
7			"We have to make the 'green option' the obvious, default choice… if the greenest choice is also the most profitable."
9			"Laws should require prevention and reuse for human consumption first… make food businesses pay for waste."
10			"Build value-chain collaboration. Circularity isn't a single-company topic; you need growers, processors, logistics."
13			"It should be more normal, not just something for organic or niche companies."
14			"We need to move away from this idea that waste is inevitable… there's a huge opportunity in the valorisation."
15			"We need better material exchange platforms… shared logistics and processing infrastructure… and regulation."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

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Table 8: Thematic Structure relating to Institutional and Policy Environment

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Enabling & Partial Support Architecture	Targeted funding, incentives & intermediary supports	"Most of the support goes to well-established companies."
4			"We have a great bio-cluster in France called Bioeconomy for Change… a network… to create a viable bioeconomy."
6			"Governments need to put their money where their mouth is… implement plant-based, circular food in schools."
9			"We received a time-limited subsidy… and ask municipalities for co-funding proportional to population."
10			"Circular Wallonia just concluded… future policy should be more systemic and less siloed."
14			"We need funding instruments that are accessible to SMEs, not just big corporates with full-time grant writers."
2	Structural constraints & political–economic context	Regulatory complexity, waste status & governance silos	"It takes two or three years of administrative papers before installing a new [methanisation] installation."
3			"One issue is when waste is contaminated… it is very difficult to reuse the material in the feed industry."
7			"Stringent food-safety rules can lead to waste… if labeling isn't compliant, there's limited recourse to relabel, resell."
8			"Europe looks green on paper, but the problem is shifted elsewhere."
12			"Waste status is a major hindrance. Once a material is classified as waste, new companies often cannot use it."
13			"There's no unified framework that says: 'Here is what we mean by circular practice…'."
5		Scaling gaps, big-player bias & burden-sharing issues	"There needs to be some kind of bridging finance… farmers need to be incentivised through subsidies."
11			"The scale-up 'valley of death' is real… late-stage bioeconomy needs more public co-financing."
15			"Funding is good for exploring ideas and testing them, but it's not well structured for implementation at scale."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

Draft

Table 9: Thematic Structure concerning Relationships with Primary Producers

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Relational Infrastructures	Partnerships supporting Circularity	"We have a very close relationship with producers… we buy legumes that would otherwise be discarded."
2			"Our relationship with farmers is really at the core of everything, because we are a cooperative."
3			"We are working closely with the farmers.. we are in connection directly with them,… there is no intermediate."
5			"A tailored plan for each farm… farmers receive practice-based payments and generate carbon certificates."
6			"They grow red beets and asked if I could develop a recipe to use them, since they often have excess."
9			"We pay a small amount—ethically important since farmers often aren't fairly remunerated."
12			"Farmers: more personal and complex; it's new for many, so trust-building and mutual understanding are crucial."
13			"We try to build long-term partnerships with them, not just short contracts… we also help to keep prices fair."
14			"Partnerships based on shared values around sustainability, animal welfare, and.. stewardship of land."
15			"We set up supply contracts that go beyond just price and volume… information exchange is quite important."
4		Indirect or Intermediary Links	"Not really, no."
7			"We're downstream from farmers… we maintain friendly association-to-association relations."
8			"We don't deal directly with farmers… we pay extra for Fair Trade and Rainforest Alliance."
10			"Cluster projects are now open to primary actors… we often work via cooperatives."
11			"Not directly."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

Draft

Table 10: Thematic Structure concerning Wider Collaboration

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Wider Collaboration Ecosystem	Collaboration as Enabling Infrastructure	"Community of professionals… building resilient, local food systems, from farm to fork."
2			"We are involved in several other forms of collaboration networks at local, national and European level."
4			"Benefits include contacts with industrial players, potential customers, and R&D people."
5			"We do work with research institutions… and other industry partners."
7			"The main benefit of those links is visibility, being cited and footnoted at global level."
8			"We're part of Choprabisco, and we work with FEVIA… Choprabisco informs us on regulations and changes."
10			"We're in a dozen EU consortia focused on circularity and nutrition. Benefits: cascade funding for SMEss."
3		Uneven Participation & Future Needs	"I don't think so… it's a lot of time-consuming energy. And for us it's not fun."
6			"We need more events in English and better cooperation between organisations."
9			"Improvement requires dedicated time and resources and clearer funding expectations."
11			"Mapping who has what, protecting IP, and heavy contracting costs are hurdles."
12			"Improvement would come from more market-driven, self-sustaining business ties."
13			"Smaller partners don't always have the time or staff to take part in these networks."
14			"These networks still operate a bit in silos… we'd love to see more government-facilitated collaboration hubs."
15			"Helpful to have more permanent platforms or frameworks… something like a regional circularity hub."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

Draft

Table 11: Thematic Structure regarding Market Conditions

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
1	Market Visibility, Demand & Competitiveness	Public Awareness	"Public awareness is still quite low… very few understand that…companies… discard the majority of the biomass."
2			"From the consumer side, awareness of how that sugar is produced… is very low."
4			"Networks like Protein France run surveys… we've seen a positive evolution [in acceptance of yeast etc.]."
9			"Awareness is growing but not universal… we also run public sensitisation on food surpluses."
12			"Public awareness is near zero, and so is public demand. State awareness efforts don't affect our competitiveness."
15			"When it comes to circularity or environmental impact… awareness is still more limited."
3		Demand, Price & Support	"There is more and more demand for the type of product that we produce … we are more on the premium level."
5			"There's definitely lots of demand… the challenge is obviously… getting customers to pay a premium for it."
6			"There is growing intent to eat products like mine, but wallets lag behind intent… visibility is still low."
7			"People care about what they can afford at the shop. Public awareness of our association's services is low."
8			"Cocoa prices have risen enormously… As a result… truffles [are] almost a luxury product."
10			"Demand rose in recent years, but recent economic pressures push consumers to lowest price at purchase."
11			"Consumer brand awareness is just beginning… ultra-low food prices and retailer pressure make margins tight."
13			"The pressure from economy and competition is strong… we have to stay affordable but still stick to our principles."
14			"Demand has become much more fragile… we can't, and don't want to, compete purely on price."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

Draft

Table 12: Thematic Structure regarding Logistics

Interview	Aggregate Dimension	Second-order Theme	First-order Emphasis (short description)
2	Temporal & Material Constraints	Seasonality, Perishability & Variability	"Logistics are absolutely central to our model… sugar factories run only from the end of September to January."
3			"There is a peak season… end of August and beginning of September… another peak season at the end of May–June."
8			"Truffles are seasonal, shipped May to December in containers and trucks. Lemon juice is year-round."
11			"Some intermediates are unstable (≤24h), so co-location or tightly synchronized handoffs are crucial."
12			"Firms used to petroleum-like inputs expect…consistency. Bio-resources vary by season, quality, and volume."
13			"We work with many fresh products, so seasonality and perishability are big challenges."
14			"Perishability is a major factor… we have very short windows to process, package, and deliver."
15	Logistics design & Infrastructure	Design, Storage & Transport Efficiency	"We've invested… in optimising routes, improving load planning, and upgrading our cold storage facilities."
1			"Legumes are actually ideal… dried and can be stored… at ambient temperature."
4			"We have to be close to brewers, making sure they have good storage, food safety, and food grade levels."
6			"Perishability is managed through promotions and giveaways."
7			"It's mostly ocean freight and road haulage; [we] try to choose greener options where possible."
9			"Daily retailer pickups, thermal boxes, cold storage, and digital registration."
5	-	-	I'm not sure. I don't know a huge amount about how it works.
10	-	-	"Limited from our side."

1 upstream (n = 4).

2 branded (n = 6).

3 bio-innovation (n = 5).

Draft

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