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Embracing Circularity:
A Framework for Implementing Circular Practices in the Food Industry

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Abstract

Food security and environmental sustainability are increasingly threatened by the current degradative practices of the agri-food industry. To mitigate the adverse environmental impacts of the agri-food supply chain, the circular food economy has been proposed as a strategy to enhance biodiversity, improve access to nutritious foods and reduce the industry's greenhouse gas emissions. However, progress in implementing circular initiatives within the food industry is limited. Hence, this research aims to contribute to identifying strategies for food businesses to overcome the challenges associated with adopting circular business models. Using a qualitative abductive approach, this study initially employed a deductive method to construct a preliminary framework for implementing circularity in the food industry. Through semi-structured interviews and Gioia's methodology (2021), the framework was then inductively challenged, and then deductively refined into a practically relevant developed framework. This research offers recommendations encompassing four key dimensions: integrating circularity into the corporate strategy, establishing regenerative agricultural practices, promoting circular product development, and advocating for government support. The recommendations put forward by the developed framework aim to offer food businesses practical guidance in their transition towards circularity, contributing to a more sustainable future.

Keywords: *circular food economy, regenerative agriculture, food waste, circular product innovation, circularity metrics, corporate circularity strategy, circular economy policy*

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Sincerely,

Rachel Lew & Lotte Van de Perre

List of Abbreviations

AFSC	Agri-food supply chain
AMC	Advance market commitment
CAP	Common agricultural policy
CE	Circular economy
CFE	Circular food economy
CSR	Corporate social responsibility
EU	European Union
ESG	Environmental, social, and governance
EIP-AGRI	European Innovation Partnership for Agricultural Productivity and Sustainability
ESM	Ecosystem service markets
FAO	Food and agriculture organisation
FSWL	Food surplus, waste, and loss
GHG	Greenhouse gas
KPI	Key performance indicator
MLE	Medium to large enterprises
mMCI	Modified material circularity indicator
NUE	Nitrogen use efficiency
SME	Small to medium enterprises
SOC	Soil organic carbon
RA	Regenerative agriculture
R&D	Research and development

List of Tables

List of Figures

Table of Content

1 Introduction

1.1 Reversing the overshoot: Transitioning towards a Circular Economy in the Food Industry

The pace at which our current economy is breaching the planet's limits is alarming. In 2023, six of the nine key 'planetary boundaries', which identify the key processes that determine Earth's resilience and stability, have been significantly exceeded (Richardson et al. 2023). The food industry is a major driver of climate change and has detrimental impacts on the environment, accounting for 26% of global greenhouse gas (GHG) emissions (Ritchie et al. 2022). Current traditional agricultural practices and food production systems deplete natural resources. Biodiversity is declining at an unprecedented rate, nearly half of the Earth's soil is suffering from severe degradation, and around 85% of fish stocks are at risk of collapse (Benton et al. 2021; WWF, 2022). As the global population continues to grow, with projections estimating 9.7 billion people by the year 2050 (Tilman & Clark, 2015; UN, n.d.), the food industry will face increased pressure to meet the rising demand for food. Global agricultural production is predicted to double by 2050 due to both population growth and dietary shift associated with increased incomes (Tilman & Clark, 2015). Increased food production will come with heightened environmental impacts; if the industry continues to operate with its current practices, catastrophic consequences can be expected (Tilman & Clark, 2015). Current degradative practices coupled with future pressures to meet increased food demands indicate a need for change in how the food industry operates.

The concept of a circular economy (CE) has been proposed as a strategy to combat environmental detriment (de Jesus & Mendonça, 2018). According to Circle Economy (2023), transitioning towards a CE could not only reduce our material usage by 70%, but also help restore the breached planetary boundaries to safe levels. Considering that current food production systems are responsible for over one-quarter of global GHG emissions and half of biodiversity loss, it is the primary driver in exceeding these boundaries (Benton et al. 2021; Circle Economy, 2023; Crippa et al. 2021). Therefore, achieving circularity within the agri-food supply chain (AFSC) is critical.

Although many definitions of circularity exist, within this study, the Ellen MacArthur Foundation's principles of the CE will take a central focus in how circular business practices and initiatives are defined. The Ellen MacArthur Foundation is a non-profit organisation, focused on developing and advocating for the transition towards a CE (Ellen MacArthur Foundation, n.d.b). The foundation defines circularity by the elimination of waste and pollution, circulation of products and materials (at their highest value) and by the regeneration of nature (Ellen MacArthur Foundation, 2013). Integrating these principles to food systems could be transformative, leading to improved biodiversity, better

access to nutritious foods and a reduction of up to 49% of the industry's GHG emissions by 2050 (Robertson-Fall, 2021).

As the European Green Deal aims to make Europe the first ever climate-neutral continent by the year 2050, transitioning towards the CE has been identified as a key way in achieving this (European Commission, 2020b). Moreover, a core element of the Green Deal is the Farm to Fork strategy, which emphasises circularity as a solution for creating a sustainable food system (European Commission, 2020b). With legislative support for the transition toward a circular food economy (CFE), it is essential for AFSC businesses to cooperate and begin developing circular practices.

1.2 Problematisation

Food security and a sustainable environment are crucial to humanity, yet these objectives are increasingly in conflict due to environmental threats posed by conventional agri-food industry practices (Tilman & Clark, 2015). Despite evidence demonstrating the role a CE could play in mitigating climate change and alleviating strain on natural resources (European Parliament, 2023), limited progress has been made in the transition towards a CE (Kirchherr et al. 2018). As mentioned, the EU Farm to Fork strategy highlights intentions for the food industry to become circular. It is therefore essential for businesses from across the AFSC to embrace circularity and make efforts to adopt more circular practices. However, to motivate and enable businesses' participation, circular initiatives must provide clearer and more certain opportunities for profitability (de Jesus & Mendonca, 2018).

Furthermore, the food industry can be characterised by its traditional linear supply chain (Lugo et al. 2022) and perishability. Therefore the industry is heavily regulated to maintain food safety and quality standards (Lugo et al. 2022), making the shift toward circularity a challenge. Taking a variety of factors and challenges into consideration, it is difficult for food companies to embrace circularity in a way that is both environmentally and economically feasible.

Within existing studies, proposed circular initiatives are often idyllic, without addressing the need for a landscape that enables businesses to adopt such initiatives in an economically sustainable way. Velenturf and Purnell (2021) highlight that the CE lacks evidence-based theoretical frameworks to guide the implementation of circularity initiatives, thus indicating a knowledge gap.

1.3 Research question

This thesis will focus on bridging the observed gap between the recommended circular practices outlined in research and the feasibility of implementing circularity within food business practices. The aim of this study is to deduce a framework offering AFSC businesses practical guidance in becoming circular, to facilitate the progression of a successful CFE for a more sustainable future.

Hence, this thesis focuses on following research question:

How can AFSC businesses implement practically relevant circular initiatives that are both environmentally and economically sustainable?

1.4 Purpose of research

As previously emphasised, embracing circularity is key to reducing the adverse environmental impacts of the food industry. However the feasibility of achieving such circular practices is hindered by a range of barriers (de Jesus & Mendonça, 2018; Kirchherr et al. 2018). Therefore, this thesis aims to contribute to researching how identified challenges can be overcome, to promote the adoption of circular initiatives within the food industry.

The research process will first involve studying the current linear AFSC model and its impacts, before introducing the Ellen MacArthur Foundation (2021) principles for achieving a CFE. Finally, a review of the challenges and barriers that deter the AFSC from adopting circular initiatives will be conducted. The review of relevant literature will be used to construct a preliminary framework for the implementation of circular initiatives, which will be revised once empirical data is obtained. Gaining an overview of the most prominent challenges businesses face in implementing circular initiatives, prior to data collection, serves to assist us in asking more insightful and relevant questions, leading to obtaining higher quality and insightful data for the development of our finalised framework.

The empirical data for this study will be collected from case studies of both ‘circular’ micro, small and medium enterprises (SMEs) and ‘non-circular’ medium-large enterprises (MLEs) operating within the food industry. Circular SMEs are defined as organisations with between 1 and 49 employees (OECD, 2024), and who fulfil at least one criterion of the selected CFE definition for participation. The purpose of studying circular SMEs is to understand how circular business models currently operate in the food industry and what opportunities and challenges these businesses associate with being circular. The non-circular MLEs case studies can be defined as businesses with more than 50 employees (OECD, 2024), with interest or intentions to embrace circularity, but currently operate through a more linear supply chain model. By collecting data from both circular SME and non-circular MLE case studies, we aim to gauge opportunities and challenges influencing businesses decisions to embrace or resist the CFE. Additionally, understanding these opportunities and challenges will provide insights for developing a practically relevant framework that capitalises on a company's strengths and interests. Finally, studying contrasting categories of food businesses aims to facilitate the creation of a more generalisable framework, applicable to a broad range of companies operating across the AFSC.

2 Methodology

2.1 Methodological assumptions

This research is based on various assumptions, which can be mainly categorised as ontological or epistemological in nature. Ontological assumptions question the essence of concepts; the *nominalist* branch emanates from the idea that 'reality' is perceived by the individual and is thus subjective in nature, whereas the *realist* branch is based on the idea of 'reality' as an objective concept that is imposed on the individual (Burrell & Morgan, 1979). This nominalist point of view is comparable to social constructivism as described by Priya (2021), which assumes that reality is a social construct based on human perceptions. As discussed in the literature review, the implementation of circularity in a business depends on the challenges that come with such a circular business model, the available resources and capabilities, and the business' ambitions. Since adapting a business model towards circularity could be disruptive, it is often difficult to predict relevant challenges and required resources. Therefore, we believe that the decisions made in this shift towards circularity often depend on an individual's perception of the complexity of the situation, rather than the challenge of 'becoming circular'. Consequently, this research takes on a nominalist perspective (Burrell & Morgan, 1979).

From an epistemological perspective, assumptions are made on the tangibility of knowledge. More specifically, from a *positivist* view, there is a hard distinction between what is regarded as 'true' and 'false', whereas from an *anti-positivist* view, this distinction is considered to be dependent on individual interpretation and thus subjective in nature (Burrell & Morgan, 1979). In this research, what is considered as the truth is highly context dependent, as what might be a logical decision for one organisation could be irrelevant or difficult for another. Specifically, different challenges arise from the various stages of the AFSC, the specific products being produced, and the differing roles of circular SMEs and non-circular MLEs. Therefore, an anti-positivist perspective will be adopted in this research.

The *sociology of regulation*, as introduced by Burrell and Morgan (1979), refers to the branch of sociology that is primarily concerned with the unity and cohesiveness of a society, and emphasises the need for regulation. Contrarily, the *sociology of radical change* views structural contradiction and conflict as the basis of society and aims to find explanations for radical change (Burrell & Morgan, 1979). In this research, we argue for the adoption of the sociology of regulation, as the aim is to recognize the unique context each corporation finds themselves in, and to design the circularity framework as such that it unites the organisation's circularity ambitions and its context-dependent challenges and opportunities.

The combination of the ontological assumption of social construction, the epistemological assumption of subjectivity, and the assumptions of sociology of regulation, imply an adoption of the *Interpretive Paradigm* for this research (Burrell & Morgan, 1979; Priya, 2021). Within the context of this

interpretive paradigm, an ideographic methodology is carried out through a qualitative case study method that makes use of interviews (Alharahsheh & Pius, 2020; Burrell & Morgan, 1979). Such first-hand investigation of individuals within the organisations enables a full understanding of the organisation's context, for instance their aspirations towards sustainability and circularity, the challenges they face, and how this affects the extent to which circularity has been implemented (Burrell & Morgan, 1979). In the context of such qualitative case studies, our role as researchers hinges on the assumption that the individuals shaping their organisational contexts are *knowledgeable agents*, who understand their purpose and objectives, and are able to articulate their thoughts, intentions, and actions (Gioia, 2021). Hence, our task is to act as reporters, aiming to capture the perspectives of interviewees without imposing preconceived theories upon them (Gioia, 2021).

2.2 Research design

To guide corporations in the adoption of circular initiatives in their business model, this research aims to develop a practically relevant framework that allows for modification depending on the organisation's context. Employing an abductive approach, the study initially derived a preliminary framework through deductive reasoning (Conaty, 2021; Sekaran & Bougie, 2013). Subsequently, this framework was challenged using inductive reasoning based on data generated from multiple case studies (Gioia et al. 2012). Finally, the research again took a deductive stance, refining the preliminary framework into a developed one by comparing the findings of both the case studies and literature review. Consequently, this abductive process aligns with the research question by facilitating the development of a practically relevant framework for implementation of circularity initiatives in the AFSC that are both economically and environmentally sustainable.

The broader relevance of findings derived from case studies relies on transferability (or external validity) rather than generalisability (Gioia, 2021). Specifically, instead of gathering extensive evidence for an observed phenomenon to apply universally, a thorough examination of a principle and its contextual understanding enables its transfer to other contexts, hence forming a so-called *portable principle* (Gioia, 2021). Building on this premise, we argue that by studying several businesses positioned at various stages within the AFSC and considering the difference in context in each of these businesses - such as their size (SMEs compared to MLEs) and their position within the AFSC (ranging from production to manufacturing to retailing) - we are able to develop a practically relevant understanding of the challenges and opportunities associated with the implementation of circularity within the AFSC. More specifically, the aim of this research is to learn from initiatives within circular SMEs along the AFSC, and transfer these learnings to allow for their transposition to MLEs that aim to become circular.

In reconciling the seemingly contrasting purposes of a robust case study design and the recognition of the inherent subjectivity within each individual's context, the systematic approach to new concept development and grounded theory, as outlined by Gioia et al. (2012), is adopted. Building on the assumptions of social constructivism and the interviewees as knowledgeable agents, this approach consists of a 1st-order analysis, presenting terms and codes from the interviewees' perspectives, and a 2nd-order analysis, employing researcher-centric concepts, themes, and dimensions (Gioia et al. 2012). By transparently reporting the voices of both the interviewees and researchers, a clear connection between the generated data and the emergence of new insights and concepts is demonstrated, thereby not only showcasing the qualitative rigour but also the high quality of the study (Gioia, 2021).

2.3 Case selection

A total of nine cases were meticulously chosen using an information-oriented selection method for maximal variation between cases, as outlined by Flyvbjerg (2006). This method allows for the maximisation of relevant information gathered from a limited number of cases by considering the potential contribution of each case in the selection process. To allow for a valuable comparison between the circular SME and non-circular MLE case studies, both categories had different expected contributions and thus required different selection procedures.

Aligned with the research goal of learning from circularity initiatives and transferring this knowledge to larger corporations, the selection criteria for SMEs centred on their adherence to one of the four circularity principles (section *3.3*). Conversely, for non-circular MLEs, the emphasis was primarily on the potential for integrating circularity initiatives, coupled with the interviewees' involvement in sustainability or responsible innovation (Stilgoe et al. 2013). Additionally, to allow a deeper understanding of the motivations and mechanisms behind MLEs' adoption of circularity in their business models, corporations with varying degrees of interest in circularity were chosen.

Consistent with the research question, it was crucial to ensure a comprehensive representation of the entire AFSC. Therefore, for both the circular SMEs and non-circular MLEs, the selection of case studies was structured to encompass each stage of the AFSC - agricultural production and activities, processing and manufacturing, and retail. These sampling criteria led to the selection of nine cases, outlined in ***Table 1*** for the SMEs and ***Table 2*** for the MLE businesses.

Following the principle of triangulation elucidated by Gibbert et al. (2008), this research enhances its reliability by examining the same phenomenon from diverse perspectives. Specifically, this involves comparing circular SMEs with MLEs wishing to become circular on one hand, and delving into the varied viewpoints of stakeholders in the AFSC on the other hand.

***Table 1**: Case studies of circular SMEs*

Interviewee code	Name & Function of interviewee	Name of business	AFSC stage	Circularity initiative
SME1	Samual Amant *Co-founder*	Koastal *(Sweden)*	Agricultural production & activities	Outsourced seaweed production: *Diversification of ingredients & regenerative farming*
SME2	Hendrik Hedlund *Founder*	Alovivum *(Sweden)*	Agricultural production & activities	Vertical farming equipment that facilitates reuse of water, nutrients, & heat for households, restaurants & retailers: *Regenerative farming*
SME3	Peter Andersson *CEO*	Yelte *(Sweden)*	Processing & manufacturing	Production of hemp-based milk alternative *Diversification of & lower-impact ingredients*
SME4	Matthias Lehner *Co-founder*	Roots of Malmö *(Sweden)*	Processing & manufacturing	Production of organically-certified of kombucha: *Lower-impact ingredients*
SME5	Dag Thoren *Head of Marketing*	Mylla.se *(Sweden)*	Wholesale & retail	Digital platform for distribution of locally produced products *Regenerative farming, lower-impact ingredients*

***Table 2**: Case studies of MLEs becoming circular. For data protection purposes, the participating MLEs have been kept anonymous in this study.*

Interviewee code	Function of interviewee	Aspect of AFSC	Main activity
MLE1	*Farmer*	Agricultural production & activities	Member of Belgian dairy cooperation (cooperation: ~1800 employees, and 2000 dairy farmers)
MLE2	*Sustainability & Innovation manager*	Processing & manufacturing	Swedish bakery company, production of a variety of traditional flatbreads and other baked goods (~270 employees)
MLE3	*Sustainability Program Manager*	Processing & manufacturing	Global dairy ingredients company, production of value-added whey proteins, milk-based ingredients, and custom solutions for the food industry (~20 000 employees)
MLE4	*Sustainability Staff*	Wholesale & retail	Belgian retailer, offers a wide range of food and non-food products at competitive prices (~30 000 employees)

2.4 Data generation

The generation of qualitative data was done using interviews with the selected cases, which took place either face-to-face or through online meetings (Sekaran & Bougie, 2013). These interviews followed a semi-structured approach, utilising a preconstructed interview guide containing a list of topics to address, that are relevant to the research question, along with suggested questions (***Appendix I***) (Kvale, 2007; Ryan et al. 2009). Before starting the interview, the study was introduced, the interviewers' objectives were presented, and consent for recording was obtained from the interviewee. Subsequently, the first phase of the interview focused on gathering basic factual information concerning the business background and the role of the interviewee. This pre-interview phase was crucial in establishing trust with the interviewee, thereby enhancing the quality of the responses (Kvale, 2007; Ryan et al. 2009).

Since the quality of the original interview greatly influences subsequent analysis, verification, and reporting, we evaluated Kvale's (2007) four key quality criteria: the depth of the interviewees' responses, the length of relevant answers, the clarification of interviewees' statements, and the interpretation and verification of responses. To ensure the lengthiness and richness of the interviewees' responses, it was important to pose short and open questions (Kvale, 2007). Therefore we stuck to the topics outlined by the interview guide, and posed our questions with a degree of flexibility toward the situation of each interviewee. This is in line with Gioia et al. (2012) who argue against standardisation of the interview protocol, emphasising the importance of flexibility to facilitate the emergence of new concepts. These open-ended questions were combined with probing questions, like "Can you elaborate on that?" This approach aimed to delve deeper into the underlying meanings and attain greater clarity regarding the topic under discussion. Hence, this semi-structured approach allows us to focus on interview questions relevant to the research questions, while still following the direction set by the interviewee (Gioia et al. 2012).

With the fourth quality criteria - the interpretation and verification of interviewees' statements, Kvale (2007) advocates embracing the interpretive nature of interviews, as verifying the interviewers' interpretation of the answers during the interview itself can significantly improve the reliability of the study. For this purpose, leading questions such as "Did I understand you correctly when I say that …", were deliberately used to verify whether the interviewer has rightfully interpreted the interviewees' statements.

Additionally, as outlined by Ryan et al. (2009), while the interview might resemble a dialogue between two individuals, the dynamics should not be symmetrical. More specifically, it is the interviewers' task to maintain the relationship of trust via a relaxed, confident, and attentive approach. Therefore, throughout the interviews, we adopted an active listening approach and refrained from commenting nor judging on answers (Ryan et al. 2009).

Lastly, to enhance the subjectivity inherent in each individual's perception of their context, we recorded every interview to facilitate accurate transcription. This approach allowed us to preserve the interviewees' exact wording as closely as possible during data analysis, thereby remaining faithful to their perspective (Gioia et al. 2012). This approach is vital for ensuring the internal validity of the research (Sekaran & Bougie, 2013)

2.5 Data analysis

As qualitative research methods generate a large amount of data, the data analysis must consist of a data reduction step in which the data is coded and categorised, thereby enabling a logical visualisation that on its turn allows for the deduction of valuable conclusions (Ryan et al. 2009; Sekaran & Bougie, 2013). To ensure the validity of our study, this section provides a detailed description of each of these consecutive steps (Sekaran & Bougie, 2013).

All recordings were transcribed using the Fireflies.AI tool, and both researchers reviewed the transcripts to ensure accuracy and gain a comprehensive understanding of the topics discussed in each interview. Then, the transcripts were imported into NVivo 14 (2023) to streamline the coding process. Each statement relevant to the research question was assigned a code, with both researchers independently conducting this process, so-called *consensus coding* (Richards & Hemphill, 2018), to increase the reliability of our approach (Sekaran & Bougie, 2013). The resulting coding lists were then compared and superimposed onto each other. Subsequently, these codes were utilised for the 1st-order analysis, in line with the approach outlined by Gioia et al. (2012), wherein they were organised into categories (***Appendix II***). As emphasised earlier, retaining the interviewees' language is crucial for preserving truthfulness to their perspective. Therefore, these categories were labelled and described primarily using the exact wording employed by the interviewees, resulting in the so-called *1st order concepts* (Gioia et al. 2012).

In the 2nd-order analysis, the researcher perspective was integrated by organising the 1st order concepts into *2nd order themes* (Gioia et al. 2012). A decision was made to use Microsoft Excel to visualise the connections among the categories. This process of organising the concepts was iterative in nature; to obtain mutually exclusive themes that are logically built and relevant to the research question, the structure was multiple times revised, thereby enhancing the validity of the data analysis. This stage of data analysis assumes that researchers themselves are knowledgeable agents capable of simultaneously considering multiple levels of analysis, ranging from the level of the interviewee terms and codes to the theoretical level encompassing themes, dimensions, and the overarching narrative (Gioia et al. 2012). This phase is considered as a *gestalt analysis*, wherein the construction of the larger narrative based on the individual categories facilitates the emergence of new theoretical themes that aid in describing the observed phenomena (Gioia, 2021). Lastly, these 2nd-order themes were further distilled into *aggregate dimensions*.

The complete set of 1st-order and 2nd-order themes along with aggregate dimensions serve as the foundation for building a *data structure* (***Figure 4-7***; ***Appendix III***). This structure not only visualises the data but also graphically represents the progression of data analysis from raw data to terms and themes, which serves as evidence of rigour in qualitative research (Gioia, et al. 2012).

The data structure served as the basis for the grounded theory - in this case challenging the preliminary framework for implementation of circularity in the AFSC - designed to capture the interviewees' experiences, its formulation in theoretical terms, and the dynamic relationship among the emergent themes and dimensions, thus establishing all relevant data-to-theory connections (Gioia, 2021). This grounded theory was the result of the inductive phase of the research wherein the preliminary theoretical framework was challenged. This comparison initiated the third and final stage of the research, the deductive generation of a developed framework for the implementation of circularity in the AFSC, aimed at offering practically relevant recommendations to businesses operating within the food industry.

The strength of the derived grounded theory stems from its grounding in the interviewees' direct experiences within their business contexts, which is crucial for the practical relevance of the developed framework for implementation of circularity in the AFSC (Flyvbjerg, 2006; Gioia, 2021). Therefore, to ensure that interpretations of these experiences remain unbiased by prior theoretical influences, the interviewees' perspectives are predominantly represented through direct quotations.

2.6 Limitations

2.6.1 Case Study Selection

A significant limitation of this research lies within the case study selection. As conveyed by the literature review, adopting a successful CFE model is contingent on the cooperation and coordination of the entire AFSC. Thus, by considering the perspectives and challenges faced by various AFSC parties, a more holistic implementation framework can be realised through this study. However, due to a constrained network reach and time-bound restrictions, the selection of case studies was limited, potentially resulting in suboptimal choices for cases and interviews.

Additionally, interviewing SME and MLE companies based in the EU may limit the transferability of our findings for use by food businesses operating outside of this region. The mindset and attitudes towards sustainability affairs within the EU are regarded as more important and of higher priority than in other parts of the world (European Commission, 2020a). Companies based in the selected region may face different push and pull factors. This again highlights the contextuality of our findings, as the complete business environment plays a significant role in the transferability of the developed framework (Gioia, 2021). Therefore, researchers should carefully interpret factors specific to case studies and identify assumptions and limitations of the research (Priya, 2021).

Lastly, the limited number of interviews conducted per MLE could potentially affect the transferability of the developed framework. This may have hindered the depth of contextual understanding regarding the practical implementation of circularity within each business. Therefore, future research endeavours should prioritise conducting interviews with multiple individuals within the same non-circular MLE, as suggested by Gioia (2021).

2.6.2 Interviewing

The interviews were conducted following the literature review to better understand the challenges companies face in their CFE transitions. However, this approach may have introduced a confirmation bias, as we had preexisting beliefs about the topics discussed (Nickerson, 1998). This emphasises the importance of using an interview guide that prompts us to pose short, open, and unbiased questions, in combination with the use of leading questions that allow us to verify our interpretations with the interviewees (Gioia, 2012; Kvale, 2007).

2.6.3 Data analysis

While maintaining proximity to the interviewees' perspective offers significant benefits, there are inherent drawbacks, such as the risk of adopting their perspective and consequently losing the broader, higher-level viewpoint necessary for informed theorising (Gioia, 2021). To mitigate this risk, it was beneficial for one team member to adopt the role of devil's advocate and critically evaluate interpretations (Gioia, 2021). Additionally, maintaining reflexivity regarding the adopted approaches and underlying biases throughout each stage of the process was crucial (Priya, 2021).

Furthermore, it is difficult to interpret if the data from the selected case studies accurately represents the broader food industry. Discerning whether challenges and opportunities identified through these case studies are specific to individual businesses or applicable to the entire food industry complicates the data analysis.

2.7 Ethical considerations

The protection of human subjects through informed consent is a fundamental consideration in management research code of ethics, as outlined by Bell and Bryman (2007). In this context, informed consent affects the companies participating as case studies for our research. It is imperative that companies are informed on the nature of this study and how the information they share will be used. Data confidentiality will be discussed with each company prior to conducting interviews, which is critical to ensure unfiltered and honest responses (Bell & Bryman, 2007). Companies were given the opportunity to remain anonymous in our study to avoid exposure or reveal of sensitive or potentially controversial information. All four MLE participants selected to remain anonymous to ensure the protection of any potentially sensitive information. This consideration aimed to protect participants from exploitation or causing potential harm to their image or brand, which could result from participation in our thesis (Priya, 2021). Given the increase in consumer awareness of sustainability

and increased consciousness of support for companies based on their values, publishing information that names or implies specific companies are greenwashing could be detrimental to a company's image (Bell & Bryman, 2007; Priya, 2021).

Publishing an accurate report of data is critical given current interests and sensitivity regarding sustainability affairs. With consideration to the research community, findings of this study were presented with transparency to avoid misinterpretation.

3 Literature Review and Framing

3.1 The Agri-Food Supply Chain: from linearity to circularity

3.1.1 Environmental impacts of the AFSC

The exceedingly negative impact the linearly organised AFSC has on the environment is a consequence of many different and interconnected factors: GHG emissions throughout the supply chain, loss of biodiversity, and food waste, each of which will be highlighted in the following paragraphs.

GHGs are emitted in large volumes throughout the AFSC, which, for the purpose of this thesis, encompasses agricultural production and activities, processing and manufacturing, and wholesale and retail. First, a significant amount of GHG emissions stems from land use, such as the release of carbon by deforestation and the degradation of organic soils due to agricultural practices like tilling (Crippa et al. 2021; Benton et al. 2021). The largest portion of GHG emissions results from energy consumption across each stage of food production, including the energy required for inorganic fertiliser production (Crippa et al. 2021). Lastly, methane production from livestock, and to a lesser extent, from waste treatment, makes a substantial contribution to GHG emissions (Crippa et al. 2021). Consequently, if agriculture continues under a business-as-usual scenario, it will exacerbate climate change, ocean acidification, and indirectly contribute to biodiversity loss (Benton et al. 2021).

Despite being long overlooked, biodiversity plays a crucial role in shaping both the environment and society. Ecosystems annually remove up to 60% of carbon emissions from the atmosphere, while also maintaining the quality of air, water, and soils. This not only helps mitigate the impacts of extreme weather events but also builds resilience against climate change (Benton et al. 2021; IPBES, 2019). However, the expansion of agricultural land and the intensification of farming diminish both the quality and quantity of available habitats, both on land and in the water. The latter, in turn, contributes to the run-off of pesticides and fertilisers from agricultural areas, leading to eutrophication (Benton et al. 2021).

The Food and Agriculture Organisation (FAO) has estimated that one-third of the world's food produced for human consumption is wasted and within the EU, approximately 20% of all food is wasted (IPES, 2019). The wasted resources and environmental impacts incurred as a result of the EU's high level of food waste, costs EU nations €143 billion per annum (IPES, 2019). According to the IPCC (2019), food waste products account for approximately 8% of global GHG emissions every year.

3.1.2 Rise in food demand

With the global population projected to reach 10 billion by 2050, the corresponding food demand is estimated to surge by up to 56% (Gerten & Kummu, 2021; Ranganathan et al. 2018; Van Dijk et al. 2021), thereby amplifying above-mentioned trends. Additionally, this population growth is anticipated

to coincide with an increase in global incomes, further driving food production and consumption (Circle Economy, 2023). Specifically, as income rises, there tends to be a shift towards more resource-intensive food choices, such as animal products (Stoll-Kleemann & O'Riordan, 2015). Given that livestock has by far the most impactful environmental costs, it is evident that our current food production and consumption system is unsustainable (Bowles et al. 2019; Pelletier & Tyedmers, 2010).

3.1.3 The cheaper food paradigm

As outlined by Benton et al. (2021), the *cheaper food paradigm* highlights a reciprocal relationship between supply and demand in the food system. On one hand, rising incomes enable greater consumption of resource-intensive foods like animal products, vegetable oils, and processed goods while the consumption of staple grains diminishes. This shift in dietary preferences results in a transition in nutritional patterns. On the other hand, supply influences demand: according to the principle of economies of scale, increased production leads to decreased food prices, thereby driving consumption and the nutritional transition even further (Benton et al. 2021).

This paradigm has significant consequences for the environmental footprint of our food system, reinforcing the aforementioned trends. Firstly, the surge in global food demand, coupled with the shift towards more resource-intensive products, drives the intensification of farming practices, resulting in further emission of GHGs and biodiversity loss (Foley et al. 2011). This sets off a self-reinforcing cycle: intensified farming practices drive down food prices even more, subsequently fueling increased consumption (***Figure 1***) (Benton et al. 2021).

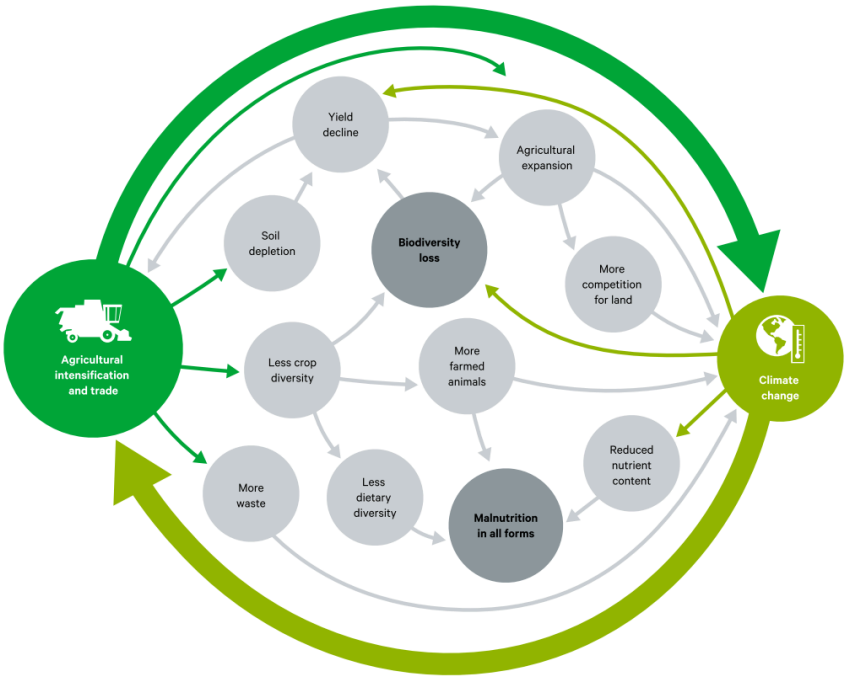

Figure 1*: The cheaper food paradigm (Benton et al. 2021).*

A direct outcome of this agricultural intensification is the increased abundance of inexpensive, calorie-rich staple crops, whereas more nutritious crops are costlier and less accessible (Benton et al. 2021). Consequently, the cheapest foods are often those that are calorie-dense but nutritionally poor, thereby rendering low-income households more susceptible to suboptimal diets, increasingly leading to concurrent obesity and micronutrient deficiencies (Benton, 2016; Drewnowski, 2018; Global Panel on Agriculture and Food Systems for Nutrition, 2020; Popkin, 2017). Lastly, Benton et al. (2021) also highlight how cheaper food prices rationalise the waste of food, further driving environmental impacts.

3.1.4 Consequences of a linear food supply chain

The current linear economy can be characterised by its take-make-waste economic model, generally moving in a singular direction: from input of raw materials to generation of waste products (Ellen MacArthur Foundation, 2013). The traditional linear food supply chain significantly contributes toward high volumes of waste generation (Lugo et al. 2022), which has resulted in detrimental environmental and societal impacts. The AFSC can be characterised by its lack of coordination in its activities and lack of collaboration among stakeholders. This contributes to supply chain inefficiencies such as overproduction, mismatched supply and demand, and unnecessary transportation and packaging. Aligning activities by following circularity techniques and initiatives could alleviate the harmful impacts caused by the food industry and lessen the volume of waste produced by the industry.

The cheaper food paradigm perpetuates that linearity is a driving factor of the environmental impact of the food supply chain. Under this system, marketers have understood human eating behaviour to drive increased production and consumption of food (Tansey, 2013). Consequently, the food products in this paradigm are typically characterised by their low nutrient density and low production costs (Tansey, 2013). As a result, the economic advantages associated with cheap food production methods often means less consideration is given to minimising waste, following regenerative practices and diversifying ingredients, further reinforcing the linear nature of this food production model. The negative impacts associated with this linear model, along with an increasing need to meet the food demands of a growing population, make it essential to shift away from a linear food supply chain toward a more circular system that offers both economical and environmental benefits (Ellen MacArthur Foundation, 2021).

3.2 The Circular Food Economy (CFE)

The concept of Circular Economy (CE) is defined in several ways by literature, and it looks differently across various industries. Within the food industry, circularity can involve redefining conditions for waste management of food, by using food waste to produce biomaterials (Mirabella et al. 2014), bioenergy or high-value products (Teigisrova et al. 2019). Velunturf and Purnell (2021) denote the diversity of perspectives on CE by outlining the three classifications of the concept that exist in policy and literature. One classification views circularity as ‘closing-loops’ in production processes, while

another perspective understands CE as maximising resource recovery and recycling of materials. The third model recognises that the latter definitions of CE have low sustainability and highlights a need to revolutionise production, consumption, waste management, collaboration, and coordination to adopt a truly CE (Velunturf & Purnell, 2021).

For the purpose of consistency and clarity in our thesis, we have selected to follow the circularity concepts proposed by the Ellen MacArthur Foundation (2013). The decision to place a central emphasis on the Ellen MacArthur Foundation in this study can be motivated by the organisation's robust knowledge of the CE and its collaborative research with businesses, policymakers and academics (Ellen MacArthur Foundation, n.d.a). Specifically, the Ellen MacArthur Foundation's (2021) Big Food Redesign study has transformed this expertise into a general framework that encourages the transition towards a circular economy. Furthermore, through the process of this literature review it became evident that the Foundation's research is widely cited by CE researchers.

The Ellen MacArthur Foundation outlines a general definition of the CE and its principles, as well as a definition specific to the CFE. In general, it defines circularity by the *elimination of waste and pollution*, *circulation of products and materials (at their highest value*) and by the *regeneration of nature* (Ellen MacArthur Foundation, 2013). Referring to circularity within the food industry, the Foundation's CFE framework proposes four principles to be adopted in a study titled The Big Food Redesign (Ellen MacArthur Foundation, 2021). These four principles are categorised as: *valorisation of food waste, lower impact ingredients, diversification of food ingredients* and *regenerative agriculture (RA)*. The Ellen MacArthur Foundation (2021) approaches the CFE from a more holistic perspective in contrast to the previously outlined definitions of CE. Rather than solely focusing on waste upcycling, a more significant level of value can be realised in the transition towards a CFE, by focusing on the broader impact and environmental costs of food production.

Implementing circular initiatives throughout the AFSC has several advantages: allowing the supply chain to maximise value from food, reduce waste and landfill disposal (Kumar et al. 2023), while also improving productivity and efficiency. The CFE can significantly contribute towards progress in reaching a significant number of the targets outlined in the UN Sustainable Development Goals (Velenturf & Purnell, 2021). Schroeder et al. (2019) discusses how the implementation of circular initiatives is closely related to SDG 12 (responsible consumption and production). Adopting circular practices across the AFSC would significantly contribute to the progress of several other economic, social and environmental SDGs including: SDG 2 (zero hunger), SDG 3 (good health and wellbeing), SDG 13 (climate action), SDG 14 (life below water) and SDG 15 (life on land) (Schroeder et al. 2019). Furthermore, evidence suggests that by implementing circular initiatives, synergies can exist in achieving SDGs. For instance, recycling of food waste as animal feed contributes to SDG 12 by reducing food waste, while simultaneously reducing the need for soybean farming for animal feed in

South America, thus contributing to target 15.2 and 15.5: *to halt deforestation* and *halt the loss of biodiversity* (Schroeder et al. 2019). Embracing the CFE business model presents a multifaceted strategy to make significant advancements towards achieving a sustainable future.

3.3 Principles of a Circular Food Economy

Drawing from the Ellen MacArthur Foundation's (2021) definition of a circular food economy mentioned above, this thesis discusses the principles of a CFE among four pillars; *Diversification of ingredients*, *Shift towards lower-impact food ingredients*, *Regenerative agriculture (RA)*, and *Food surplus, waste, and loss (FSWL) management*. The following sections highlight what these pillars entail. Together, these pillars form a nature-positive solution with a positive societal and economic impact (Ellen MacArthur Foundation, 2021).

3.3.1 Shift towards lower-impact food ingredients

Shifting towards ingredients with lower environmental impact is among the first actions a company can take to embrace a more nature-positive and circular approach. According to the Ellen MacArthur Foundation (2021), lower-impact food ingredients have a reduced environmental impact and potentially higher nutrient density, but are still conventionally produced.

An obvious but impactful shift is steering away from animal-based proteins and towards plant-based proteins (Bowles et al. 2019; Pelletier & Tyedmers, 2010). Given that the plant-based food and beverage market in the EU and UK has expanded by 49% between 2018 and 2020 and is expected to continue to grow, this transition presents numerous market opportunities for companies (Smart Protein, 2021). For instance, the substitution of conventional dairy with plant-based dairy alternatives like oat and soy milk is becoming increasingly popular (Plamada et al. 2023). Not only do these substitutes decrease CO2 emissions by 10 to 100 times, they are also characterised by increased productivity (Ellen MacArthur Foundation, 2021).

Furthermore, transitioning from staple crops to lower-impact alternatives could yield significant environmental benefits (Ellen MacArthur Foundation, 2021). For instance, adopting more resilient varieties like perennial wheat that root deeply largely eliminates tillage requirements, thereby building soil health which enables a sequestering of around one tonne of CO2 per hectare annually (Ellen MacArthur Foundation, 2021). Similarly, using more resilient potato varieties results in a 20% reduction in GHG emissions and 35% reduction in biodiversity loss, all attributed to a 60% increase in yield, resulting in a significantly lower land use and reduced use of fertilisers and pesticides (Ellen MacArthur Foundation, 2021).

In addition to intra-variety shifts, corporations can also opt to transition to entirely different, lower-impact crops for the production of the same food items (Ellen MacArthur Foundation, 2021). For example, substituting peas for wheat in wheat-based products like pasta reduces GHG emissions

by 40%, biodiversity loss by 5%, and yields are increased by 5% (Ellen MacArthur Foundation, 2021). Therefore, transitioning towards lower-impact ingredients serves as a crucial step in a company's journey to continually improve its product range, aiming for ingredients that will eventually be sourced in a regenerative manner (see section *3.3.3*).

3.3.2 Diversification of ingredients

Today, merely four crops - wheat, rice, corn, and potatoes - account for nearly 60% of global calorie consumption (Crop Trust, 2019). As emphasised by the cheaper food paradigm, this reliance on agriculturally intensive monocultures has yielded high efficiencies and productivity (Benton et al. 2021). However, these monocultures are highly vulnerable to diseases and extreme weather events, a vulnerability further compounded by climate change. Consequently, the reliance on pesticides, irrigation, and fertilisers increases, thereby exerting additional pressure on planetary boundaries (Benton et al. 2021).

Diversifying the agricultural landscape by transitioning away from monocultures and cultivating a wider array of plant and animal species, as well as varieties within those species, could profoundly enhance the resilience of our food system, thereby safeguarding food security (Ellen MacArthur Foundation, 2021). Furthermore, integrating intercropping, cover cropping, and rotational cropping practices enables incorporation of diverse food types as integral components of regenerative farming systems (Ellen MacArthur Foundation, 2021).

3.3.3 Regenerative agriculture (RA)

Moving away from the cheaper food paradigm toward a nature-positive food system that ensures the security of our food supply necessitates the adoption of regenerative farming practices (Ellen MacArthur Foundation, 2021). According to Giller et al. (2021), RA focuses on restoration of soil health and countering biodiversity loss. Its primary aim is to enhance environmental, social and economic aspects of sustainable food production, as a healthier soil has increased carbon-capture capacity, while simultaneously facilitating increased yields and reducing reliance on pesticides and fertilisers (Giller et al. 2021). Therefore, RA exemplifies the shift away from linear practices by prioritising yield enhancements to establish sustainable food provision. These practices encompass a spectrum of approaches, such as reduced tillage, conservation agriculture, agroforestry, silvopasture, green manure, cover crops, and crop rotations (Giller et al. 2021).

As outlined earlier, the combination of rising food demand and a shift towards more resource-intensive food consumption is expected to surpass current production capacities, emphasising the need of changing the system as a whole (Circle Economy, 2023). Therefore, businesses' ambitions should not only focus on the transition towards more diverse and lower-impact ingredients, but also pursue the regenerative cultivation of those ingredients (Ellen MacArthur Foundation, 2021).

3.3.4 Food Surplus, Waste and Loss (FSWL) Management

Food surplus, waste, and loss (FSWL) represents the fourth and final pillar of the CFE model. FSWL is generated throughout the entire AFSC, thereby constituting a considerable environmental challenge. Annually, FSWL accounts for 25% of all water used by agriculture (Searchinger et al. 2019), occupies 23% of all cropland (Kummu et al. 2012), and contributes approximately 8% of annual global GHG emissions (IPCC, 2019; Teigiserova et al. 2020). To effectively address FSWL and develop policies for its management, it is essential for all stakeholders to adopt consistent definitions of food surplus, waste, and loss (Teigiserova et al. 2020). Given the interchangeability of these terms in various research and policies, it is chosen to adopt the definitions outlined by Teigiserova et al. (2020), as they connect FSWL management to the waste hierarchy, and are cited in other circular economy research.

Surplus food refers to edible items produced, manufactured, retailed, or served that remain unconsumed by humans, including food exceeding nutritional needs (Teigiserova et al. 2020). Although food surplus occurs along the entire AFSC, it primarily arises at the agricultural production stage in the form of overproduction and at the retail and consumer stage due to socio-economic factors (Lugo et al. 2022). Food waste accounts for all food that is unfit for human consumption, whether due to a natural inedibility, or caused by poor food management practices, such as food that has perished (Teigiserova et al. 2020). Lastly, food loss comprises all food streams that are genuinely lost due to inexplicable reasons and that are consequently unaccounted for (Teigiserova et al. 2020).

Furthermore, Teigiserova et al. (2020) have introduced the waste hierarchy (***Figure 2***) to emphasise that FSWL management practices should be prioritised in a particular order. With a priority on FSWL prevention, *Prevention* is placed on top of the waste hierarchy (Lugo et al. 2022; Teigiserova et al. 2020). This is then followed by *Reuse*, *Material recycling*, *Recovery*, and *Disposal*. Ideally, efforts at each level of the hierarchy aim to obviate the need for disposal, as this is the most environmentally harmful end-of-life treatment (Teigiserova et al. 2020). Subsequent sections explore various possibilities at each hierarchical level.

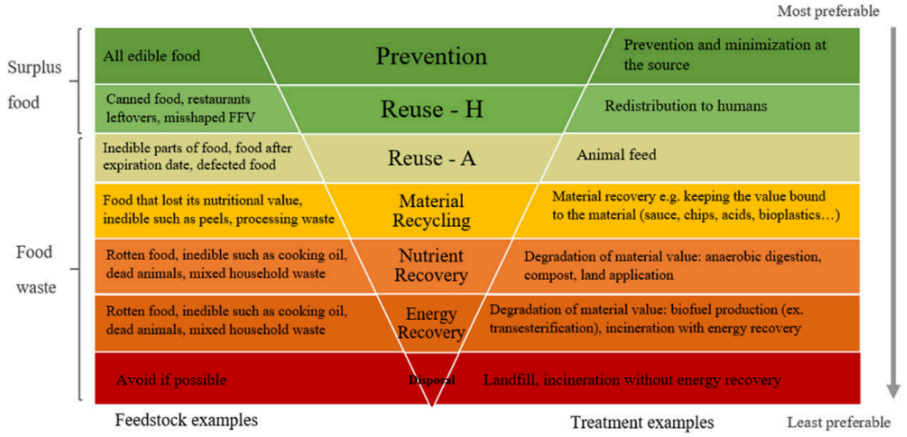

***Figure 2**: The waste hierarchy, as introduced by Teigiserova et al. (2020). FSWL management practices at the top of the hierarchy should receive the highest priority, whereas practices at the bottom of the hierarchy are ideally avoided.*

3.3.4.1 Prevention

For effective FSWL prevention, it is crucial to maximise alignment and cooperation among all AFSC stakeholders, thereby facilitating streamlined logistics and management tools (Lugo et al. 2022; Teigiserova et al. 2020). In this regard, the integration of digitalisation into the supply chain and leveraging big data can play a pivotal role (Onyeaka et al. 2023). It is important to note that significant efforts should be invested in the prevention of surplus, waste, or loss of the most resource-intensive and polluting food items like red meat and dairy products (Garrone et al. 2014; Hedenus et al. 2014; Stoll-Kleemann & O'Riordan, 2015; Teigiserova et al. 2020).

Despite divergent economic incentives of individual AFSC stakeholders, the collaboration necessitated by these digitalisation initiatives could yield an optimally streamlined and circular supply chain, which would not only drive up incomes at initial stages in the supply chain but also reduce costs associated with FSWL management at later stages (Lugo et al. 2022). Thereby, shorter and more localised supply chains possess greater agility in responding to food demand fluctuations, resulting in less overproduction and decreased food loss due to spoilage during transportation (Teigiserova et al. 2020). For instance, initiatives like Mylla (2024), which brings together Swedish farmers to directly offer their products to customers through a digital platform for online grocery shopping and home delivery, exemplify the potential benefits of regional collaborations.

Lastly, the consumer level, representing the final stage of the AFSC, constitutes a crucial factor in the management of food surplus and waste (Teigiserova et al. 2020). This stage targets consumers' education, behaviour, and consumption habits, yet is challenging to control due to a myriad of economic, social, cultural, and individual motives (Teigiserova et al. 2020). Consequently, food companies should prioritise informing their customers through targeted marketing campaigns or package design. For instance, avoiding misleading 'sell by' dates on retail store packages can already yield significant reductions in food waste (Lipinski et al. 2013; Searchinger et al. 2019). Moreover, recent studies suggest that consumers are increasingly interested in supply chain traceability

(Anastasiadis et al. 2022) and the origins of their food, indicating a growing demand for upcycled products (Lugo et al. 2022).

3.3.4.2 Reuse

Following prevention, the second most preferred FSWL management practice is the reuse of food products, either for human or animal consumption (Teigiserova et al. 2020). The stringent quality standards in place for human consumption emphasise the value of proactiveness along the food supply chain, for instance, by using AI image recognition to identify visually unappealing yet high-quality food items, allowing for their repurposing before spoilage occurs (Onyeaka et al. 2023; Sundaram & Zeid, 2023). Moreover, surplus food and leftovers from catering establishments and restaurants can be redistributed through food banks or sharing platforms (Teigiserova et al. 2020). However, when repurposing food for animal consumption, it is essential to consider and adhere to different regulatory standards (Teigiserova et al. 2020).

3.3.4.3 Material Recycling

In contrast to reuse, material recycling redirects food for purposes unrelated to human or animal consumption (Teigiserova et al. 2020). Instead, these products are reintegrated into the economy as high-value commodities, such as bio-based chemicals or other products, excluding fertilisers and compost. According to Mirabella et al. (2014) and Galanakis (2012), the increased industrial use of food waste as a secondary resource input for biorefineries holds significant potential for material recycling of the non-edible food fraction. To classify the repurposing of food as ‘upcycling’, a prerequisite is the end-value of the product, which typically ranges from 1 to 50 000 US dollars per kilogram (Teigiserova et al. 2019).

3.3.4.4 Recovery (Nutrient, Energy)

Unlike material recycling, recovery involves the complete degradation of food, typically achieved through anaerobic digestion. During this process, biomass is converted into fertiliser, facilitating nutrient recycling, and energy, in the form of methane or storable hydrocarbon (Teigiserova et al. 2020). It should be noted that most often, anaerobic digestion for the sole purpose of energy recovery is suboptimal due to the loss of nutrients.

3.4 Challenges of the Circular Food Economy

Shifting from the traditional linear economy toward a circular economy presents a variety of challenges. According to a 2013 report by Accenture and Compact, one third of global CEOs reported having an active interest in the CE concept (Accenture & Compact, 2013; Velenturf & Purnell, 2021). The study reported their interests are driven by factors such as personal beliefs, business interests and concerns regarding sustainability (Accenture & Compact, 2013; Velenturf & Purnell, 2021). However, despite the reported high interest levels in embracing circularity, its implementation has made limited progress in businesses and is progressing at a slow pace within governments. The slow and limited

progress in achieving circularity can be attributed to a variety of industry and stakeholder specific factors. The literature associated with barriers to implementing circularity, suggests that many factors that hinder CE development are interconnected (Kirchherr et al. 2018). Identified challenges can be categorised by four broad categories: regulatory, technical, cultural, and market barriers (Kirchherr et al. 2018). The interactions that exist between each of these barriers means progress made in each area hinges on the progress made in lessening the effects of other challenges. Thus, a successful transition toward CE is reliant on AFSC stakeholders coordinating and collaborating to embrace its implementation (Kirchherr et al. 2018; Witjes & Lozano, 2016)

2.4.1 Regulatory barriers

Regulatory and institutional factors have the potential to both enable or hinder progression of the CFE. By establishing funding schemes, incentives, and offering an environment for innovation and entrepreneurship, governments and policymakers can facilitate AFSC stakeholders implementation of circular initiatives (Alberich, 2022). However, literature suggests that at present, law and regulation obstructs CE transition, as circularity is not integrated effectively enough in innovation policies (Kirchherr et al, 2018; van Eijk, 2015) and that governmental incentives support linear economic models (van Eijk, 2015). The validity of this argument is dependent on the region in focus, for instance, the European Union has made efforts in developing the EU Green Deal Circular Economy Action Plan 2050, with the Farm to Fork Strategy being at the heart of this policy (Alberich, 2022). Moreover, twelve EU member states including the Netherlands, Sweden, Denmark, Finland, France and Ireland have already adopted CE strategies whereas others have progressed in implementing legislation and funding schemes to support CE (Alberich, 2022). AFSC stakeholders operating in nations that support and promote CE will likely face lesser challenges in overcoming regulatory barriers to adopt circularity initiatives. A connection can be drawn between regulatory barriers and market barriers, as the extent to which circularity is embraced in regulation and policy influences the significance of market barriers (Kirchherr et al. 2018). However, even within regions that have adopted circularity strategies, progress in the CFE transition remains slow. Ranta et al. (2018) report that despite the adoption of CE legislation at the EU or individual member state level, low-level implementation of circularity remains inefficient. The Ellen MacArthur Foundation (2021) advocates for governments to implement policies such as incentivisation of regenerative farming and fund research on CFE at both farm and business levels. This indicates incentives and subsidies will be crucial prerequisites to aid a successful transition toward a CFE.

As the food industry is regarded as a highly regulated industry it faces unique and additional challenges in adopting circular initiatives. The limited shelf-life of food is a major contributor of food waste and loss at retail and consumer levels (Lugo et al. 2022). The highly perishable and degradable nature of food means reuse of surplus food and food waste is subject to safety regulations (Teigiserova et al. 2020), thus limiting the possibilities for development of closed-loop systems and initiatives to

implement circularity. Although food safety legislation is essential for human health and wellbeing, this area of regulation challenges and limits opportunities for reuse or recycling of food ingredients, which may be possible in industries dealing with non-perishable, non-edible products. Therefore, placing an emphasis on reducing volumes of surplus food to prevent loss and waste is a more effective area to mitigate in the CFE, than attempting to upcycle waste products.

From review of relevant literature, it appears that within the EU, specific food safety, hygiene and quality regulations are the greatest barriers to implementing circularity in the food industry, rather than general CE policy, due to development of the EU Green Deal and progression of state-specific strategies.

2.4.2 Technical and Quality Barriers

Technical barriers must be taken into consideration in a company's implementation of circular initiatives. A review of circularity literature carried out by Kirchherr et al. (2018) reported that possession of relevant technology is a fundamental prerequisite for transitioning to a circular structure. One study outlined that technical bottlenecks are perceived as the most significant challenge to circularity (de Jesus & Mendonça, 2018) while other literature has reported finding that businesses have the relevant technologies in place (Kirchherr et al. 2018). Variation in findings regarding technical barriers indicates that the significance of technical challenges is dependent on specific industry and business' level of progress in the CE transition. Challenges such as lack of data, large-scale demonstrations, and ability to deliver high quality products, are among the most pressing technical barriers highlighted by businesses, governments, and researchers in the CE transition (Kirchherr et al. 2018).

Focusing on the food industry, perishability, and the level of demand for high quality food are significant factors in adopting circular initiatives (Lugo et al. 2022). These challenges can be related to regulatory barriers, such as strict quality and safety legislation, and can hinder many forms of circular practices from being effectively integrated to the food supply chain. Furthermore, manufacturing and supply chain efficiency are key technical requirements (Lugo et al. 2022). Innovation and redesign of current systems will be essential to the development of effective and economically viable circular business models.

Onyeaka et al. (2023) outlines the potential applications of AI technologies that the AFSC can adopt to transition toward the CFE. Digitalisation techniques such as smart monitoring and analytics, predictive analytics and smart inventory management (Onyeaka et al. 2023), can ease technical barriers associated with designing circular food systems. However, opportunities presented by new technologies come with challenges, for instance, high costs and complexities in system setup have been identified as major barriers to embracing new technologies at farm management level (Fiocco et

al. 2023). Funding schemes and supporting structures will be required to ensure an effective and widespread integration of emerging technologies.

2.4.3 Cultural barriers

Cultural behaviours and consumer interest in the concept of CE are indicating factors of whether circularity initiatives will succeed (Kirchherr et al. 2018), making cultural barriers a critical and primary area to address in CE implementation. In the study by Kirchher et al. (2018), "lacking consumer awareness and interest" was the most frequently mentioned challenge reported by interviewees. Without significant interest or demand from consumers for businesses to become more circular, there is less pressure for companies to implement circularity initiatives.

Interaction effects can be observed among various categories of CE barriers (de Jesus & Mendonça, 2018). A lack of popular interest and awareness on circularity can influence the extent to which regulatory or market barriers exist. Although economic incentives play a significant role in driving behavioural change, merely offering upcycled products at a lowered price may not suffice. Psychological incentives such as conservatism, misinformation, and bureaucratic resistance still account for up to 40% of challenges associated with waste prevention (Henningson et al. 2004; Thyberg & Tonjes, 2016). Limited discussion surrounding the concept reflects low priority of the CE transition for businesses and consumers alike. Although de Jesus and Mendonça (2018) reported that cultural barriers appear to be less significant influences on CE transition, it is possible that the more pressing regulatory and market barriers identified are manifestations of cultural hesitancies and lack of knowledge on CE.

Recent years have seen a significant shift toward more plant-based alternative products in the food industry (Smart Protein, 2021) and the Institute of Food Technologists reports that both sustainability and health are ranked highly among consumer food trends and choices (Brewster, 2022). Evidently, sustainable food choices are valued by consumers, suggesting that low consumer awareness of the CFE is a greater cultural barrier than an inherent disinterest or negative perceptions of the concept. Informing and educating consumers on the benefits offered by the CFE model is key to increasing the demand for circular initiatives within the food industry (Rathore, 2017). Therefore, the current lack of consumer awareness related to CE presents a challenge to overcome.

Despite findings that business leaders display interest in embracing the CE, hesitant company culture and organisational resistance have been identified as main CE barriers (Kirchherr et al. 2018; Pheifer, 2017). A study by Pheifer et al. (2017) found that the concept of circularity was not yet integrated into organisational strategies, missions, visions, goals and key performance indicators (KPIs). Reports of resistance to CE within businesses could indicate that discussions on becoming circular are limited to environmental or corporate social responsibility (CSR) departments (Kirchherr et al. 2018). Larger and more influential departments of organisations such as operations and finance are essential to

discussions on circularity for a unified and successful transition to a CE (Kirchherr et al. 2018). Furthermore, it appears that the extent of a company's abilities to embrace circularity is contingent on the cooperation and willingness of their supply chain to also embrace circularity (Witjes & Lozano, 2016).

2.4.4 Market barriers

For an effective adaptation to the CE, economic viability of circular initiatives is key. The limited development of circular procurement systems poses a CE market barrier for businesses (Kirchherr et al. 2018). According to Kirchherr et al. (2018), businesses and policymakers experience market barriers such as low prices of virgin materials - referring to unused raw materials - and costs associated with implementing circularity hinder the transition towards the CE. It has been suggested that because virgin product materials can be offered at such low price points, there is no space for circular products to compete with these linear counterparts (Mont et al. 2017). The success of the CFE will be impeded if the costs associated with recovering food waste or manufacturing by-products cannot match the prices offered by linear procurement. Moreover, Ranta et al. (2018) suggested CE initiatives could be so expensive that they would require financial subsiding to ensure economic viability. An argument can be made that in the longer-term, circular initiatives offer more economical sustainability and are cost effective (Ellen MacArthur Foundation, 2021). However, the high initial investment costs associated with implementing such initiatives could result in financial losses (Mont et al. 2017) before the value of CFE is recognised.

With regards to the regenerative farming principle outlined by the Ellen MacArthur Foundation (2021) CFE model, Benton et al. (2021) argues that such farming practices are inevitably associated with reduced yields. On the other hand, Ellen MacArthur Foundation (2021) and Bugas et al. (2023) argue that after an initial transition period, regenerative production can result in higher food output and increased farmer profitability. Although there is evidence to support the long term profitability of the CFE and creation of additional revenue streams through CFE initiatives, overcoming the short to medium term barriers associated with the transition is a challenge.

Regulatory and policy limitations are connected to market barriers, as the prevalence of these challenges influences the ability of AFSC stakeholders to enter the CFE market. Farmers will require support from governments and corporations to overcome the transition periods and address potential reduction in yields associated with adopting RA (Ellen MacArthur Foundation, 2021). Therefore, corporations are encouraged to take proactive steps in their procurement activities, such as providing financial assistance to farmers transitioning towards sustainable farming methods. Additionally, exploring cooperation opportunities among AFSC stakeholders to create economies of scale could offer another avenue to enhance profitability from RA (Ellen MacArthur Foundation, 2021).

The lack of large-scale demonstrations of CFE contributes to the scepticism of how businesses can effectively embrace circularity without suffering financially. As explained by an interviewee as part of a survey by Kirchherr et al. (2018), the initial actors and companies that invest in transitioning to circularity will likely lose money, while the 'second mover' will reap the financial benefits by learning from earlier adapters. A study specifically addressing circularity in the agri-food sector discusses AFSC stakeholders resisting circular initiatives due to a lack of data related to costs and incomes (Lugo et al. 2022). This supports the narrative that businesses are interested in implementing circularity but are waiting for stronger supporting structures and schemes to emerge to help facilitate and incentivise their transition.

2.4.5 Relationships between key challenges

Among the four outlined categories of CE barriers, there is a high degree of interconnection and thus interaction between the categories. Therefore, it is imperative to address each of these categories in implementation of circularity initiatives to avoid a 'chain reaction' causing CFE transitions to fail (Kirchherr et al. 2018). The level of interconnection between various food industry stakeholders indicates that overcoming the barriers and challenges to successfully implement a CFE will require a united effort from the AFSC, governments, and policymakers.

3.5 Preliminary framework for implementation of CFE initiatives

The successful implementation of circular initiatives is influenced by various factors, as indicated by the findings of the literature study. These factors are delineated in a preliminary framework, which identifies four key elements: *Regenerative agricultural production*, *Collaborations across the AFSC*, *Product portfolio innovation*, and *Policies and regulations* (***Figure 3***). The subsequent paragraphs provide further explanations of each of these factors.

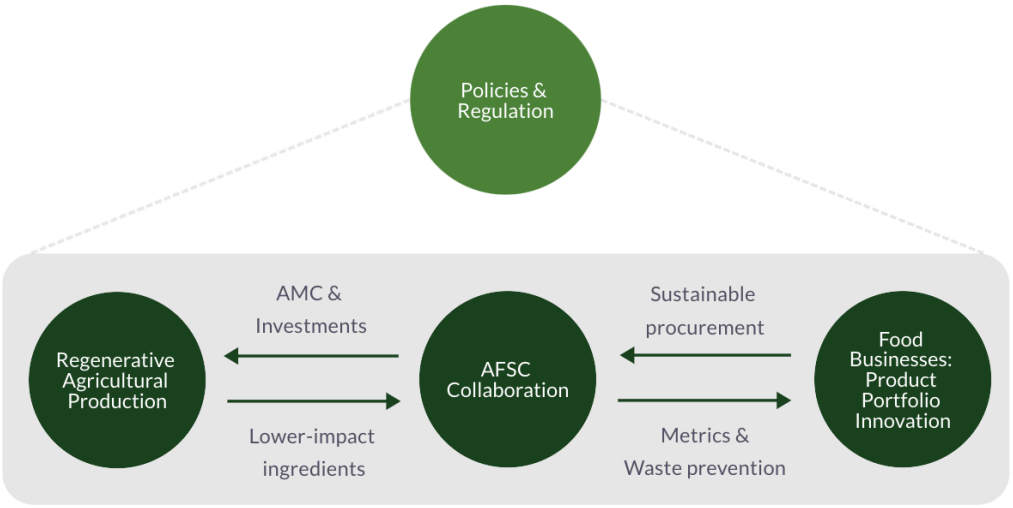

***Figure 3**: Preliminary framework for implementation of CFE initiatives.*

3.5.1 Agricultural production: transition to RA

The initial and crucial stage in determining the success of circular initiatives lies in regenerative agricultural production. For farmers to transition effectively to RA, they must overcome the financial hurdles associated with initial investments and potential yield reductions during the transition period before achieving profitable production (Bugas et al. 2023). Collaboration and resource pooling across the AFSC are essential for empowering farmers to contribute effectively to a CE. Specifically, initiatives such as an Advance Market Commitment (AMC), which involves a cooperation among multiple stakeholders to guarantee future demand for RA products, coupled with additional investments, play a pivotal role in enabling farmers to produce lower-impact ingredients in a nature-positive way (Bugas et al. 2023; Gazibara, 2023).

3.5.2 AFSC collaborations

Besides facilitating the transition toward regenerative farming, collaborations across the AFSC can play a crucial role in driving product portfolio innovation by establishing industry-wide food circularity metrics. For instance, leveraging blockchain technology can enhance traceability of products throughout the AFSC (Suta & Tóth, 2023), enabling a comprehensive evaluation of all direct and indirect GHG emissions (Abbate et al. 2023). Such an LCA standard is essential for comparing environmental impacts of different products, thereby allowing businesses to shift towards lower-impact alternatives. Moreover, it has the potential to raise awareness about the environmental footprint of products, incentivising food businesses to invest in sustainable procurement and engage in AFSC collaborations that support circular initiatives.

Furthermore, the integration of big data and transparency along the AFSC represents another crucial factor, by enabling more accurate prediction of demand, thereby preventing the generation of waste throughout the AFSC (Onyeaka et al. 2023).

3.5.3 Food businesses: product portfolio innovation

Reshaping the product portfolio to align with social, environmental, and economical goals is crucial for a successful transition toward a CE. On one hand, food businesses must prioritise the adaptation of more diverse and lower-impact ingredients. On the other hand, they face inevitable challenges related to consumer demand and profitability. In addressing these challenges, marketing and communication strategies play a significant role in the success of circular products, as consumer interest and trends drive demand (Kirchherr et al. 2018). The success of product portfolio innovation in this regard is demonstrated by companies like Unilever, where their Sustainable Living Brands are experiencing a 69% faster growth rate compared to the rest of the business (Unilever, 2019). Additionally, businesses can explore opportunities to repurpose waste streams, either by developing new products from them or by selling the entire stream to other businesses, thereby creating a profitable case out of waste..

3.5.4 Policy and regulation

A clear and stable policy framework outlining ‘rules’ and predictive timelines for the implementation of circular initiatives would result in less complexity regarding legal and regulatory compliance (Wasserbaur et al. 2022). Clearer and more specific recommendations are required to clarify how AFSC stakeholders can play an active role in policy development, thereby empowering them to influence regulatory decisions. Forming alliances, unions and collaborations acting in the interests of the CFE transition could be effective measures to emphasise CE discussions and highlight a level of demand and need for change in the food industry.

Although subsidies will be essential - particularly to farmers for helping to tackle short-term barriers to the CFE transition (Ellen MacArthur Foundation, 2021), they create an artificial business landscape and are not a viable long-term solution for maintaining circular practices (Wasserbaur et al. 2022). As the CFE’s success hinges on cooperation and collaborations across the AFSC (Velenturf & Purnell, 2021), food companies should support farmers by refraining from driving down prices in their procurement operations and instead negotiate deals that enable farmers to adopt circular and regenerative farming practices.

4 Findings and Analysis

The coding process resulted in the development of a data structure (***Appendix III***), consisting of four aggregate dimensions (***Figure 4-7***); *Collaboration to establish regenerative agriculture*, *Corporate circularity strategy*, *Challenges of product development*, and *Creating a level playing field*. This section aims to analyse each of these aggregate dimensions by transparently reporting the voices of both interviewees and researchers, thereby establishing a clear connection between the generated data and the emergence of new insights (Gioia et al. 2012).

4.1 Collaboration to establish RA

Many food businesses recognise RA as a major impact lever in the transition towards circularity (Ellen MacArthur Foundation, 2021). As emphasised by MLE3, *"Regenerative farming is where the majority of our impact levers lie … It's mainly the farm emissions that make up our footprint."* Moreover, referring back to the four pillars of circularity in the food industry - RA, lower-impact ingredients, diversification of ingredients, and valorisation of waste - both lower-impact ingredients and the diversification of ingredients are only valuable when they are regeneratively produced (Ellen MacArthur Foundation, 2021). Hence, it can be stated that RA lies at the basis of circular product development.

Nevertheless, as discussed earlier, farmers are confronted with serious challenges. In the business environment, they face pressure from food businesses to reduce prices, exacerbating their already narrow profit margins. Simultaneously, governments expect them to invest in sustainability measures to meet regulatory requirements. Therefore, to enable a sustainable transition towards RA, it is key that farmers are not the only stakeholders held accountable (SMI Agribusiness Task Force, 2022).

These concerns are addressed in the first aggregate dimension, *Collaboration enabling RA* (***Figure 4***). This section highlights the key challenges in transitioning to RA identified by interviewees: a considerable knowledge gap and a lack of circular farming incentives, and advocates for collaboration throughout the AFSC to overcome these challenges.

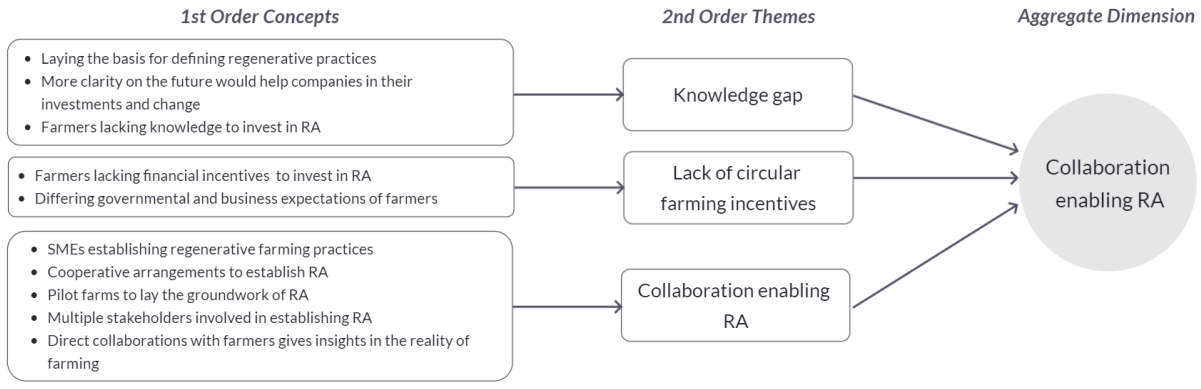

Figure 4*: The 1st aggregate dimension: 'Collaboration enabling RA'.*

4.1.1 Knowledge gap

The definition of RA causes ambiguity for many companies, as it remains unclear which specific farming practices effectively enhance soil health and biodiversity to a degree that warrants the label 'regenerative'. This is exemplified by MLE2's statement: *"To take a step towards circularity, we want to buy all of our ingredients from farms that work regeneratively, but the challenge is what that means. There is no one definition of regenerative practices, but we can all agree that you promote soil health and biodiversity in the region of the farm, and that you don't degrade the land so that it's at least in as good a condition, if not better."*

Therefore, in order to persuade suppliers and farmers to embrace RA, companies such as MLE2 and MLE3 are proactively establishing criteria to delineate practices that qualify as regenerative and those that do not. *"There is the challenge of knowledge development. We strive to work with our suppliers, who work with farmers, to figure out ways to encourage these kinds of practices."* In doing so, MLE3 emphasises the importance of obtaining a shared understanding of this definition throughout the supply chain: *"I think there is a lot of need to align. What do we actually mean? What is science based and how to drive action? We are right now working in our group, and there's also been cross industry work on defining what regenerative practices are. We are very much part of driving this sectoral alignment"* (MLE3).

4.1.2 Lack of circular farming incentives

As outlined by the SMI Agribusiness Task Force (2022), farmers lack the financial incentive to engage in RA. This is elucidated by MLE1: "*We are open to circularity initiatives, but at the moment it is just pure survival ... Currently, nobody has to knock at our door with suggestions to think about this or that, at the moment we don't have to think about much."* The reason farmers lack financial means to invest in regenerative farming lies partly in their position as price takers (Kohn & Anderson, 2022; Malak-Rawlikowska et al. 2019), as they *"have no certainty about the price. In almost all agricultural products, the farmer is the price taker and the buyer determines the price on the world market"* (MLE1). The resulting uncertainty further complicates investing in circularity: *"We don't actually know until next month what the price for the previous month will have been … There are a lot of farmers who are thinking about it [circularity, RA], reading about it and so on, but not knowing where that's going, so that doesn't start much new [investments in circularity]"* (MLE1).

The challenge for farmers in the price-taker position stems from the fact that *"farmers are the furthest back in the value chain, which means that everybody adds on to their cost, and everybody is trying to push down costs lower in the value chain"* (MLE2). With the rise in food prices, manufacturers and retailers in the AFSC were forced to intensify pressure on farmers to ensure competitiveness (Kolesnichenko, 2024; Wunsch, 2024). Consequently, farmers are sometimes forced to sell below cost, *"a store is legally [in Belgium] not allowed to sell below cost, but for farmers this does not apply.*

That just does not feel right" (MLE1). To address this issue, MLE1 suggests that "*fair prepayments"* are essential to offer a viable alternative and foster investments in circularity initiatives.

Additionally, both the industry and governments impose additional requirements on farmers to sell their produce, often necessitating investments without immediate returns. For instance, *"supermarkets often say they only want to buy our milk or cheese if it is CO2-neutral … We have the idea that the investments always come back to us, and that the rest [of the AFSC] can benefit from them. We want to invest; we did so for our green power, but we have to make sure the economics are right"* (MLE1). This aligns with Bounds et al. (2023), who argue that increasing environmental regulations, such as those outlined in the EU Green Deal, compel farmers to make sustainable investments, yet retailers are unwilling to pay premium prices for resulting products. Consequently, farmers find themselves caught between government regulations and retail demands, further diminishing already thin profit margins (Bounds et al. 2023). Moreover, the adverse financial circumstances farmers encounter, coupled with the arguable profitability of investments in RA, often impede farmers' ability to secure loans (Fi-compass, 2020), hence limiting their capacity to invest in RA.

In conclusion, despite farmers' best intentions to invest in RA, the fact that the burden of all costs and risks associated with the transition falls on them provides little incentive for them to make the switch.

4.1.3 Collaborations enabling RA

The approach to addressing this issue varies between circular SMEs and non-circular MLEs becoming circular. Circular SMEs typically concentrate on specific principles of regenerative farming, which they then scale up. For instance, companies like SME1 and SME2 have each developed methods for RA, which they offer to farmers as complementary practice to diversify their income. In contrast, MLEs becoming circular, such as MLE2, MLE3, and MLE4, addressed their uncertainty surrounding RA and the financial constraints faced by farmers by establishing cooperative arrangements like pilot farms or foundations - non-profit corporations that usually provide funding (Minefee et al. 2015).

These cooperative arrangements aim to establish regenerative production standards that ensure profitability for food businesses without compromising the nature-positive aspect of RA: *"We established a big network of pilot farms … to see how we can implement regenerative practices. … You need to make sure you have the right safeguards in place to be actually credible and valid in your approach. Therefore, we are doing a lot of groundwork to define the right practices*" (MLE3). More specifically, given the absence of a formal definition of regenerative practices and their variability depending on the crop of interest (Jameson et al. 2024; Page & Witt, 2022), MLEs must devise strategies for large-scale regenerative production of products with an existing market demand. This is essential not only to avoid greenwashing but also because unlike monocultures, RA provides a variety of crops at the same time. Hence, food businesses must adapt their procurement models accordingly, shifting towards purchasing a variety of ingredients from one farm, and find viable uses for each of

these crops (Ellen MacArthur Foundation, 2021). Despite the complexities involved in product innovation and development, businesses may reap benefits by pioneering regenerative product development, leading to a competitive advantage and improved brand image (Przychodzen et al. 2019; Zhang & Song, 2020).

However, to enable a sustainable transition towards circularity, these cooperative arrangements must provide financial support to farmers embracing RA. As "*the current agricultural policy doesn't necessarily give farmers incentives to do these things"* (MLE2), foundations and pilot farms are crucial to provide farmers with the required new equipment, inputs, and training (Ellen MacArthur Foundation, 2021). MLE2 further emphasises: *"With regard to our raw materials, the biggest challenge is figuring out cooperative arrangements so that we can work strategically in order to have the farming practices that we want. We want to figure out how we can promote these regenerative practices and how much it will cost."* Hence, there may be opportunities to collaborate with other AFSC stakeholders and set up cost-sharing initiatives that facilitate farmers' CFE transition (Ellen MacArthur Foundation, 2021; SMI Agribusiness Task Force, 2023). The importance of such cost-sharing initiatives are emphasised by MLE4: *"With the foundation, we can start supporting projects that give training and support to farmers that want to start the transition to regenerative agriculture."*

Moreover, MLE2 explains that "*the fact that we are quite far removed from the farmer, as we don't directly buy from them, poses a challenge in implementing regenerative farming practices. Many people are involved, thereby making it complicated."* This emphasises that such collaborations throughout the AFSC are crucial to provide stable support to farmers for regenerative practices, thereby facilitating the transition towards circularity (Ellen MacArthur Foundation, 2021; SMI Agribusiness Task Force, 2022).

Additionally, as transitioning to RA often entails a temporary dip in yields, businesses could play a crucial role in ensuring farmers have a stable income until they reach a mature and profitable stage of regenerative farming (Ellen MacArthur Foundation, 2021). MLE4 elaborates on this approach, describing how they engage in contracting farmers to provide them with financial incentives: *"We have 300 to 400 of our own agricultural lands, which we contract out to normal farmers that are willing to start working regenerative … So that's some kind of space for farmers that are interested in the transition but don't have the land to take the investment and to take the risk."* Therefore, a stable income during the transition period is a crucial prerequisite for such contracted agricultural practices to be viable for farmers (Ellen MacArthur Foundation, 2021).

In conclusion, effective implementation of aforementioned initiatives relies on close collaboration throughout the entire AFSC to cultivate stronger relationships with farmers and support their transition to RA.

4.2 Corporate circularity strategy

The second aggregate dimension (***Figure 5***) encompasses two main themes: challenges and opportunities associated with consumer buying patterns, and the barriers and requirements associated with integrating circularity into corporate strategy. Both themes are discussed in the following section.

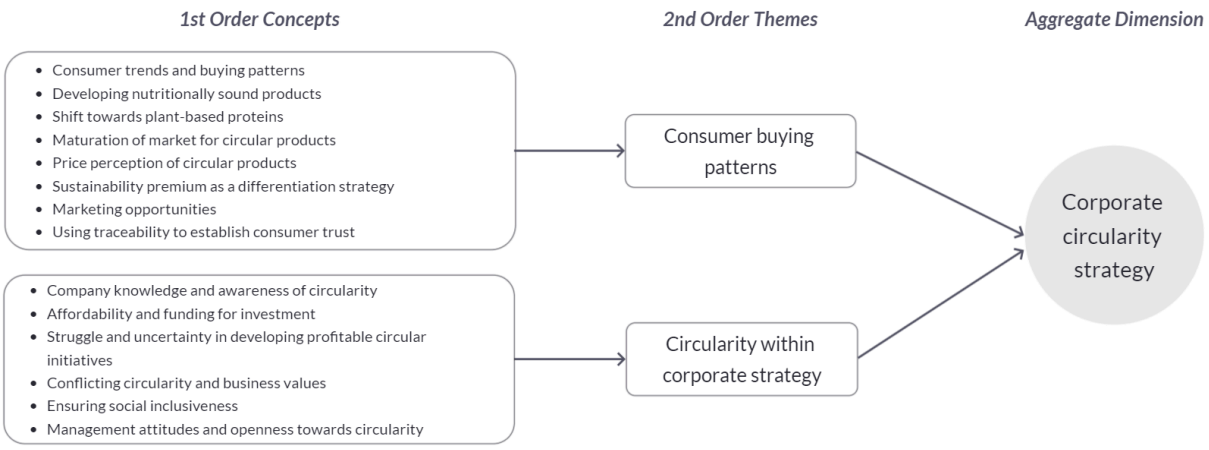

***Figure 5**: The 2nd aggregate dimension: 'Corporate circularity strategy'.*

4.2.1 Consumer buying patterns and market trends

Out of the nine interviewed subjects, seven reported consumer demand and buying patterns as influential factors in their decision-making process to adopt circular initiatives. SME1 reported they are *"helped by the fact that there is a search for more sustainable food alternatives"* (SME1). Shifts observed in consumer food trends including plant-based protein alternatives and more *"nutritionally sound"* (SME3) products were highlighted in interviews with both circular SME and non-circular MLE companies. MLE3 reported interest in changing their product portfolio toward lower impact ingredients, stating *"we are working on protein shift, which is also considered in the circular food economy*." They also acknowledged the *"protein supplementation market is growing a lot,"* (MLE3) further motivating companies to align with consumer food trends. In reference to opportunities for partnerships, SME3 stated developing products that *"having a vegan, non-allergenic, extremely nutritionally dense, sustainable ingredient to work with is the dream for a lot of companies."* This demonstrates how companies embracing CFE principles, such as regenerative farming and a shift to lower-impact ingredients, can capitalise on environmental and health-conscious trends in the food industry.

SME3 highlighted that consumers are too often *"forced to make purchase decisions where either you purchase something that is environmentally sound or you purchase something that is nutritionally*

sound" which highlights a gap in the food industry where *"there is an opportunity to choose a sustainable product that actually cares about nutrition as well"* (SME3). This highlights how consumer demands for nutritious and sustainable foods are relevant to the CFE (Ellen MacArthur Foundation, 2021). By recognising that employing regenerative practices, diversifying food ingredients and using lower impact ingredients inherently results in production of more nutrient dense foods (Ellen MacArthur Foundation, 2021), consumer trends and the CFE can go hand in hand.

SME2 reported market demand as a driving factor for the CFE transition, explaining *"there is a trend of more and more people wanting to eat more healthy or sustainable food… I would say it is driving the demand [for RA], then you see that these different parts of the supply chain need to follow."* However, resistance to such trends is also present in the supply chain, as MLE1, a farmer participant, believes a greater level of consumer demand is required to motivate their transition; evident from the statement *"I think society's support for such things is overestimated."* Farmers' attitudes and perceptions towards the CFE are crucial to adopting circular innovations and practices (Herrera et al. 2023). Therefore, it is evident that efforts must be made to actively involve farmers as stakeholders in the CFE transition and improve their perceptions of circularity. This approach aims to drive regenerative farming initiatives and achieve circularity across the AFSC.

MLE3 summarised *"it is customer demand that determines where the industry is going and that is where we naturally follow as our business grows."* Both MLE3 and MLE4 explained that although consumers are interested in plant-based alternatives, encouraging them to purchase such products is challenging. MLE3 stated *"alternatives for animal proteins are considered expensive, so we are searching for ways to change the buying patterns of consumers."* This implies the expense of plant-based food products drives down consumer interest in circular initiatives. Although Beacom et al. (2021) recognises that cost considerations can hinder the maturation of plant-based alternative markets, price is reportedly less influential on consumer purchasing decisions compared to factors like sensory attributes. MLE4 spoke in line with MLE3's opinion, stating *"it's not that alternatives are not available, it's more about how we can make people buy them."* As companies evidently struggle with encouraging consumers to buy more circular alternative products, there is an opportunity to improve the sensory appeal of these products and to improve marketing around such products. By doing so, they can better engage consumers with lower-impact and circular product options.

SME1 who offer a circular novel food product, reported their market is growing however it is *"not growing fast enough"* thus limiting the attractiveness of lower impact and novel food business ventures. This issue stems from a lack of public interest and awareness regarding circular products and initiatives (Kirrcherr et al. 2018). The interviewee described a need for maturation and increased market demand for circular food products, explaining that their company's current product offering *"will take a lot of time to develop and mature"* (SME1). Similarly, MLE3 spoke of company efforts to

shift towards a circular product portfolio, explaining "*it's a lot harder to mature these markets."* It is evident that maturation of circular product markets could act as a barrier and will slow the progress of the CFE transition. Raising consumer interests and awareness of emerging circular products could improve support for businesses implementing circular initiatives and alleviate the impact of slow market growth.

4.2.1.1 Consumer price perception toward circular food products

Many companies emphasised that costs associated with adopting circular initiatives lead to increased consumer prices. SME1 provided insight to their difficulties *"competing with the prices on the market, aiming to come to at least a price parity,"* as a born circular company, trying to compete *"with the big guys"* in the food industry. MLE2 spoke about *"the impact food inflation has had on consumer behaviour"* in recent years, implying consumers have become increasingly sensitive to food pricing.

Conflicting statements have been gathered with regards to consumer price perception towards circular products. MLE2 explained *"it's difficult to get a price premium for sustainability [circular] initiatives, even if it costs more, so that is a challenge. You can have a product that is good in terms of circularity, but you can't necessarily take more money for it because consumers are not necessarily willing to pay more for it."* While SME5 said "*price is not that sensitive, but habits are harder to change,"* meaning changing the buying patterns and shopping methods of consumers are considered a greater barrier in the case of this circular business model. An insight can be drawn here, that circular SMEs often attract a more niche consumer base, who are more engaged with environmental sustainability, while non-circular MLE food companies struggle to attract consumers through the adoption of circular initiatives, as these companies typically cater to a broader consumer base. Similarly, Ingenbleek (2015) discusses that producers of sustainable food products rely on consumer groups who are more concerned with sustainability, to maintain a permanent position in the industry. SME1 touched upon this issue by explaining *"we don't have enough of a market with just niche products"* to expand and compete with mainstream food businesses.

MLE1 drew a relationship between the shifting food trends and price sensitivity: *"everybody wants to be environmentally conscious, but in the supermarket, they buy the cheapest thing."* Supporting this statement, Ingenbleek (2015) reported findings that consumers state they are willing to pay price premiums for sustainability, however in practice it appears they still opt for cheaper alternatives. Consumer interest in circularity appears to be a major influencing factor for MLE interested in becoming circular. MLE2 confirmed *"if the consumer doesn't want to pay for the investments we would make or the idea that we work out, then investment actually stops."* MLE2 further stated *"consumers, perhaps rightfully so, actually think they shouldn't have to pay more for something that doesn't destroy the environment - that should be a condition of doing business."* From these statements, a trade-off between adopting circular initiatives and their feasibility is made apparent. The

lack of certainty among AFSC businesses on consumers' willingness to bear costs associated with circular initiatives limits their progress in becoming circular.

4.2.1.2 Opportunities for differentiation through circularity

From interviews with circular SMEs it was evident that these companies all employ a differentiation strategy; SME4 said *"you can either win by being the cheapest or by diversifying and being unique, and we definitely chose to specialise and develop a unique selling proposition rather than being the cheapest."* SME5 also highlighted their strategy is to use digitalisation to *"create something unique that you don't find in the supermarkets,"* which is how they *"want to compete and find a niche in the market."* SME1 discussed the opportunities that come with having a circular business model, explaining that *"there is a kind of sustainability premium where brands are more open to collaborate"* with companies that value sustainability.

Both SME and MLE companies mentioned the marketing opportunities associated with offering circular food products. In reference to the shift towards plant-based milk alternatives MLE1 - a dairy farmer, agreed *"the marketing around it is very strong and that's a point that we're not as strong in."* From the perspective of circular SME3 said *"I see a lot of marketing opportunities - you can talk to those that are super health conscious, you can talk to those who are very sustainability aware, or you can use creative marketing to appeal to a whole different kind of consumer."* Furthermore, SME3 explained how novelty or scepticism of new food ingredients can be an opportunity: *"because more people will have an opinion, more people will talk about it and that gives us a chance to showcase all the great product benefits."* Rathore (2017) discusses green marketing strategies as a means of aligning business profitability with environmental responsibility. Educating consumers on benefits such as the health and environmental impacts of circular food products encourages sustainable behaviours and buying patterns (Rathore, 2017), thus increasing market demand for circular products and business practices. As highlighted by our SME case studies, embracing the CFE offers a competitive advantage and strategic marketing opportunities, enabling companies to amplify consumer interest and awareness in circular products. In this context, marketing can serve as a key facilitator in driving the CFE transition.

Anastasiadis et al. (2022) emphasises that consumers' perception of AFSC traceability acts as a driving force for the implementation of CFE initiatives. When asked about opportunities to use digitalisation for transitioning towards a more circular supply chain, SME3 said *"I absolutely see cases where perhaps you could use something like blockchain to trace your sourcing back to its root, and then we can actually show the consumer [the short length of the supply chain]."* As articulated by Anastasiadis et al. (2022), consumer interest in traceable food systems and supply chain visibility has increased over recent years. SME3 pointed out a *"trend with consumers wanting more information on the raw material,'* and said *'digitalisation is a huge enabler in that"* (SME3). Furthermore, SME3

believes as traceability becomes more important to consumers *"there are opportunities to increase trust, and brands that can establish a high trust relationship with their consumers, I think, will be the winners."* Anastasiadis et al. (2022) indicated that more reliable and high quality traceability systems improve consumers' perceived value and purchase intention of circular food products. This suggests an opportunity to enhance legitimacy of circular products and increase consumer demand for circular practices through traceability systems.

4.2.2 Circularity within corporate strategy

A lack of knowledge and awareness among AFSC businesses was realised from interviews with the studied companies. SME1 expressed confusion on the definition of circularity and was not familiar with the principles of the Ellen MacArthur Foundation (2021) CFE model, despite the company's adoption of many circular initiatives. SME1 explained "*We don't always classify it as a circular economy, we use that name for other stuff.*" Many interviewees appeared to lack clarity in the differences between the term 'sustainability' and 'circularity', as made evident by SME1: "*I'm connecting systems, sustainability and circularity. So like, which are in my understanding, two different things, although in the same ballpark.*" MLE3 was more familiar with the principles of the relevant CFE framework, however described the term *"regenerative agricultural practices"* as being *"a little bit of a buzzword."* MLE2 expanded on this challenge saying "*we want to buy all of our ingredients from farms that practice regenerative processes and practices. And so then you have the challenge of what that mean*s." Business' lack of awareness or clarity regarding the CFE limits their abilities to capitalise on opportunities to implement circular initiatives.

Related to consumer buying patterns, companies highlighted their struggles to make circularity initiatives profitable. Lugo et al. (2022) attributes the resistance of businesses operating across the AFSC to cost requirements, which is reflected by SME3, who identified *"finding funding"* as a challenge, with another company stating *"if you can't afford it, you don't start it"* (MLE4). MLE4 also related this paradigm to their company's economic situation, mentioning that finding *"the financial space to invest in extra efforts and experiments [for sustainability initiatives] has been harder for some years."* Additionally, SME3 described *"the cost of the raw material is much higher"* when using diverse ingredients for circular food products. MLE1 mentioned that *"sometimes you do get an incentive,"* however *"often it's not enough to bear the costs that come with it"* in relation to meeting sustainability criteria in their production. This statement aligns with literature that emphasises the importance of incentivisation and subsidy schemes to support and motivate food producers in adopting circular initiatives (Alberich, 2022), particularly at farming and food producer level (Ellen MacArthur Foundation, 2021).

Not only do companies experience challenges with the costs associated with implementing circularity initiatives, but empirical findings also show they are concerned with maintaining a profitable business

model in transitioning towards the CFE. As outlined under section *2.4.4*, high initial investment costs of circular initiatives discourages companies from advancing toward the CFE (Mont et al. 2017). Referring to opportunities to implement more regenerative farming practices, MLE4 explained *"it's a real struggle because the system does not allow for easily making these changes, and it comes with investments that have a cost now, but you're not sure if and when there will be income compensation for it."* Kirchherr et al. (2018) speaks in line with our empirical findings, explaining AFSC stakeholders struggle to identify economically viable business opportunities within the CE. Companies' scepticism of CFE profitability is evident from interviews with MLE2: *"how long is it going to take us to find the thing that will be profitable; profitable for both the planet and for us and to provide a good product that consumers want?"* Similarly, MLE3 simply described the struggle with profitability stating *"if it was more attractive from a commercial lens we would do a lot more."*

4.2.2.1 Trade off between adopting circularity initiatives and existing business values

Many companies explained the trade-off situations they face in attempting to become more circular, while upholding existing business values. For instance, MLE2 recounted their company found possibilities to valorise waste streams for beer production, however the company does not want their brand *"to be associated with alcohol, so we're never going to sell beer."* Another company, committed to more circular manufacturing practices, discussed the conflict they face between providing a healthy product, and choosing a packaging solution that *"would be a lot better from an environmental perspective, but comes with a real health concern for our product"* (SME4). These quotations highlight that even where potential solutions to become more circular exist, these opportunities do not always align with company values, adding to the complexity of the CFE transition.

MLE4 explained their values and responsibility in fostering *"social inclusiveness"* by offering consumers food at a low price point. As circularity initiatives evidently come with cost and investments, the company's management have stated they *"support sustainability, but the social part is equally important as the environmental part"* (MLE4). As previously highlighted in section *3.1.2*, the cheap prices of food contribute to increased generation of food waste due to its abundant accessibility (Benton et al. 2021). Additionally, Röös et al. (2021) reported consumers typically perceive cheap food products as *"chance bargains they do not want to miss out on"* leading to unintended purchases - a phenomenon which acts against the CFE. MLE4 understands the detriment of this paradigm and said *"I think we can all see that maybe for years and years food was too cheap, because the cost of the negative impact was not reflected by the price."*

Companies following a low-price strategy and rely on low-income consumers markets evidently face challenges in navigating the implementation of circularity initiatives that come with increased costs. As MLE4 explains the conundrum: *"if people's incomes are not getting higher, then you exclude people from access to sustainable and healthy foods - so we feel a bit in between."* From the opposite

end of the AFSC, low-cost strategy food manufacturers and retailers also face difficulties in supporting producers to adopt regenerative farming practices. MLE4 described how procurement negotiations contribute to the economic complexity of becoming circular - *"we understand that producers say, hey, I'm changing my practices, but it has a cost - can you support me? Or can you give a more realistic price for what I produce? And on the consumer side they say, but if the price goes high and my income doesn't go up, then what do I do?"* Facilitating a widespread transition of farmers to RA hinges on both AFSC businesses and retailers paying fair prices for the regeneratively produced products. This ensures equitable incomes for farmers based on environmental outcomes (SMI Agribusiness Task Force, 2023). MLE4 underscores this necessity: *"Our buyers are known to be very tough negotiators, so now we are trying to educate them that there are some values and costs of regenerative agriculture that have to be taken into account. So it's not fair to negotiate hard on the price. ... And if we don't have the buying department supporting the idea, then it will be hard to scale up, because what we do on our own farming grounds, what the foundation is supporting, are like small niche experiments. But if we want to scale it up, then we need support from the buying departments."* Considering the interests of stakeholders at both ends of the AFSC, leaves manufacturers and retailers in a complicated situation where company values and circular initiatives clash. MLE4 concluded *"it's a failure of the system, but we are part of that system and you cannot change it on your own."* This highlights the necessity of regulatory intervention to make way for the implementation of CFE principles. Although many of the trade-offs reported by interviewees are case-specific and cannot be made applicable to the entire food industry, it is critical to highlight that many businesses feel constrained by their commitment to fulfil particular company values.

4.2.2.2 Circularity strategy and company management

Both MLE2 and MLE4 spoke about the importance of having support from top management to ensure successful implementation of circularity initiatives. Tawse & Tabesh (2021) indicate that suggest support and consensus among company management improves organisational commitment to new strategies. Moreover, Kirchherr et al. (2018) stresses the importance of embracing strategy throughout the entire organisation for successful implementation. This reinforces an insight that it does not suffice to simply have a sustainability team within the company - sustainability and sustainable innovation need to be embedded within company strategy.

MLE2 provided a nuanced perspective on goal setting for circularity through the explanation *"we set really ambitious goals that we're not sure we will be able to fulfil, but that we really want to strive to fulfil. The reason we set goals that we're not sure we can even reach is because our experience is that the harder the goal is to reach, the more effort you make. And so you make bigger strides, even if you don't reach the whole goal, than if you set a lower goal and meet it."* MLE4 explained that with growth of the business *"sometimes decisions can go slow,"* which can hinder change initiatives. Interestingly, Tawse & Tabesh (2021) report findings that although a more involved management team

may slow the implementation of new strategies, the ultimate outcome of such initiatives sees improved success. MLE4 also highlighted that efforts to implement circular initiatives must be integrated within corporate strategy and an environment to be *"able to make some smart, proactive decisions"* and having *"management that is open to that"* is key to progressing circular business practices. MLE4 followed up by acknowledging *"part of the business model will probably have to change"* to embrace circularity in a meaningful way.

4.3 Challenges of product development

As illustrated in the third aggregate dimension (***Figure 6***), our findings emphasise three main challenges concerning product development: waste prevention, waste valorisation, and the process of scaling up. Each of these challenges are discussed in detail in the following paragraphs.

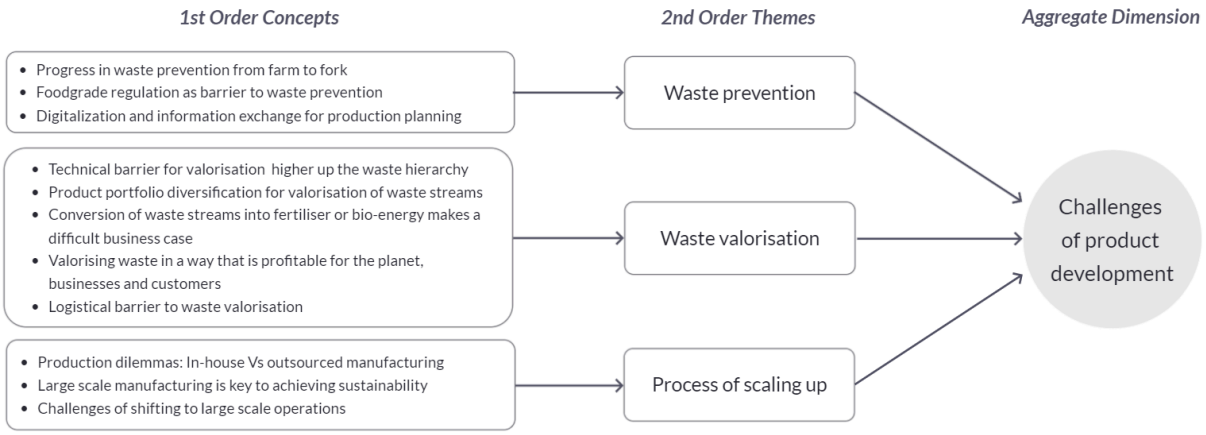

Figure 6*: The 3th aggregate dimension: 'Challenges of product development'.*

4.3.1 Struggle for waste prevention and valorisation

Considering the excessive costs associated with waste, waste prevention and valorisation rank high on the agenda of every AFSC business (Roy et al. 2023; Zainal, 2018). However, there is a considerable difference in how circular SMEs and non-circular MLEs address this issue. According to our findings, circular SMEs are highly efficient in their production process, yielding little to no waste streams, *"simply because we don't have the financial means to do otherwise"* (SME4). For instance, unlike other plant-based drinks, SME3 has made the *"conscious decision"* not to *"separate the fibre phase out from the product"* and hence avoid a large volume of end-waste product. Despite the challenges this poses for downstream processing, this approach allows SME3 to operate more sustainably and maintain the nutritional value of their product. On the retailer side, SME5 has adopted a *"model of selling on-demand rather than keeping a big storage."* Although this strategy entails some risk, they *"don't have the scale to be able to forecast,"* making on-demand sales the most cost-effective and least wasteful option for their operations. This aligns with the study by Zainal et al. (2018), that states that attributes leanness in FSWL management is a key lever for production performance.

Unlike circular SMEs, whose existence and viability depends on the optimisation of their processes, MLEs transitioning towards circularity face the challenge of transforming their full-fledged operations to become less wasteful. MLEs are aware of the opportunities that waste valorisation can bring - in terms of product portfolio diversification and additional revenue streams (Roy et al. 2023). In line with the discussion of Teigiserova et al. (2020) on the environmental and societal benefits within the waste valorisation hierarchy, MLE2 explained: *"What we're interested in is how we keep these side streams in the food system. ... The waste that we have now, so that we think of it as side streams and upcycle it, or somehow reuse it as high up in the value ladder as possible."* However, MLEs struggle to obtain a profitable business case out of these upcycling endeavours, as *"it's cheaper not to do anything"* (MLE2).

The main reason for these struggles is the increased product development cost that comes with higher levels of the waste valorisation hierarchy (Teigiserova et al. 2020). Hence, even though repurposing waste streams into biofertiliser does not require much development costs, *"there is not as big of a business case in it"* (MLE3) since the resulting product is relatively low in value (Teigiserova et al. 2020). On the contrary, *"profitable business cases are getting more out of food and feed markets"* (MLE3), but this requires long and expensive experimenting to *"find the thing that will be profitable, both profitable for the planet and profitable for us and provide a good product that consumers want"* (MLE2). In this product development endeavour, MLEs face three main challenges: consumer interest, food grade regulations, and logistical issues, each of which are discussed in following paragraphs.

First of all, unlike circular SMEs which primarily target niche markets characterised by increased awareness of environmental impacts of food production, MLEs engage with broader customer bases (Galli-Debicella, 2021). Consequently, MLEs cannot presume that their customers will readily embrace upcycled products, especially if they entail a price increase. As articulated by MLE2, prioritising consumer demand is crucial: *"the first thing is to figure out something that consumers really want to buy, and then you solve all the other problems, because if you solve all the other problems and you have something that nobody really wants, then it's just wasted anyway."* Similarly, MLE4 emphasises that *"if the customer doesn't want to buy it, then it will get wasted somewhere further in the stream [value chain]."* Thus, MLEs stand to benefit from strategic efforts to identify innovative ways to convert waste streams into marketable products that resonate with consumers (Ellen MacArthur Foundation, 2021).

Secondly, a recurring challenge for corporations revolves around food grade regulations (Rao et al. 2023), as *"once they [the food] leave the shop, they are considered waste. And once it's waste, you cannot use it to make new food"* (MLE4). For instance, MLE2 explains that "*when something occurs during packaging, we have perfectly good bread that is still food grade but that doesn't have anywhere to go. If we could figure out a way to quickly put it in containers to ensure that it's completely*

uncontaminated, the question is whether the regulation says it is still food grade when moved from one facility to another." This reflects the findings of the Ellen MacArthur Foundation (2015b), indicating that waste regulations predominantly address waste as an environmental risk, focusing on its safe disposal rather than recognising its potential as a resource of valuable ingredients and products.

Lastly, logistical issues form a considerable challenge to both waste prevention and valorisation initiatives (Rao et al. 2023). In terms of waste prevention, retailers recognise the *"impact on the amount of food waste at the farming stage because of the specifications we put on"* (MLE4). However, efforts to broaden specifications to accommodate more farm products for sale in stores have encountered *"logistical problems,"* because *"irregular things [irregularly shaped fresh produce] don't fit the cases,"* hence resulting in packaging issues (MLE4). Additionally, waste valorisation efforts face hurdles at the distribution stage, because once the food is distributed *"it's small quantities at a lot of places. This makes it really expensive to get them as an ingredient to one central place. So our experiment [of collecting unsold bananas for the production of banana bread] had to stop after the study phase"* (MLE4).

Consequently, addressing the challenges of waste valorisation initiatives proves to be a complex exercise, and MLEs struggle to develop profitable products. Therefore, both SMEs and MLEs can benefit from prioritising waste prevention initiatives (Roy et al. 2023). Our research indicates that leveraging digitalisation efforts across the AFSC presents a promising opportunity to enhance production planning, thereby reducing food surpluses and mitigating waste. More specifically, SME4 highlights how "*digitalisation and information exchange is very important for our planning … Via the supplier portal we can basically see in real time how much they have left of our produce, and their predictions for how much they're going to need every week, which is something we check every day. It helps us very much in avoiding waste due to miss-calculations or bad planning*". Thereby, MLE4 explains how "*the lack of transparent flows of data and information from producers to consumers forms a real challenge*," which, according to them, is the consequence of "*either protection or the burden of the extra administrational work such data sharing requires to undigitized companies*." This aligns with the study by Roy et al. (2023), that emphasises the prioritisation of digital prevention initiatives, like demand forecasting and smart stock management and marketing, for food waste minimisation.

4.3.2 The process of scaling up

A common theme identified among SME case studies was the challenge associated with establishing and scaling up their businesses in an economically sustainable manner. Similarly to MLEs and their projects for waste valorisation, it appears the interviewed SMEs struggle with the scale-up of their circular business models, first on a technological ground, but later within the AFSC.

In relation to choosing in-house or outsourcing manufacturing operations, challenges exist on both sides. SME3 said *"there is always a challenge with not owning your own manufacturing equipment because then you're dependent on someone else,"* while SME4 explained that as a start-up business, running production in-house *"slowed us down a lot - Many of our competitors are taking the more, I would say, more typical, modern way to grow a business and build a brand, which is to basically sit in an office and assemble different parts out of an office."* SME4 elaborated on the *"painful process of building up our own production line and production capacity"* and in earlier years of the business' existence they *"were supply limited, not demand limited."* The challenges faced by SMEs in deciding how to operate highlights an insight: manufacturing of circular products can be hindered by technical barriers, thus impeding the scale-up of circular food companies.

When SME1 was asked *"what are the key success factors in achieving profitability with the company?"* the reply was *"scale."* Growing the scale of production was also identified as a key success factor by SME4; *"production only starts to make sense at a certain size... I think now the price is still very high due to the low scale of the industry; it's all a question of scale and volume."* SME3 shared insight to their operating model, explaining *"it's kind of a go big or go home type of business model because it's so large scale"* and elaborated with *"the way this is produced is, by nature, very, very large scale. So, although it would be desirable to produce small quantities, sell that, produce a little bit bigger quantity, sell that, and grow [the business] organically, that is not possible with this type of product."* This creates a challenge in achieving profitability as an SME operating in a developing market. When asked "*by producing on a larger scale, is it difficult to maintain the circularity aspect [of the business model]?*" SME3 responded *"producing on a large scale is a key to achieving sustainability. A lot of people, I think, are mistaken in thinking that small-scale production is the most sustainable. I think in many cases, large-scale production is more sustainable - if you calculate on a per unit level. Of course it looks scary with a big factory, but if that factory can feed a million people, then it's not so scary anymore."* This perspective provides insight that the growth of born circular companies is key to progressing the CFE, as such companies can serve as successful examples, encouraging other businesses to adopt circular practices. Moreover, Närvänen et al. (2021) contends that circular start-up businesses have a great impact in disrupting established and normative practices of the food industry and are therefore key to the development of a more circular AFSC.

Speaking on volume and scale-up challenges, SME1 reported "*in the food industry, from the moment you enter a big contract with one of the major manufacturers, you really need to contribute [larger] volumes and then the market comes easier."* Similarly, SME5 spoke in relation to food producers that *"have entered the bigger [retail] players"* there is *"an issue of volume before they can call this profitable"* In addition, SME5 outlined how scale can be a challenge in operating through an 'on demand' supply chain model. As stated *"we don't have the scale to be able to forecast; let's say we need 100 kilos of carrots, but the week after we only need 70 kilos. That would be a big risk and also a*

big waste if we just order based on last week's demand." These scale limitations circular SMEs experience indicates a need for support and collaboration from more established MLEs to grow the scale of the circular business models effectively.

4.4 Creating a level playing field

The last aggregate dimension focuses on government support (***Figure 7***), highlighting their role in including environmental damage cost into pricing structures, and creating a level playing field to promote the CFE transition.

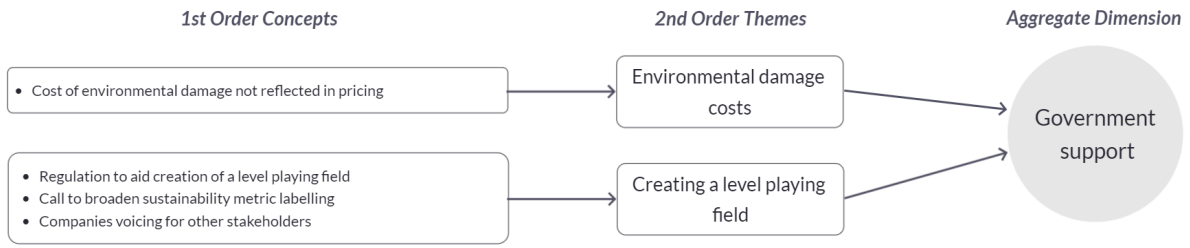

***Figure 7**: The 4th aggregate dimension: 'Government support'.*

4.4.1 Environmental damage costs

Historically, advancements in agricultural productivity have resulted in economic prosperity, as increased access to food significantly reduced world hunger (Squires & Gaur, 2020). However, the costs of the environmental damage caused by these productivity improvements have never been accounted for in the cost of food, leading to ongoing environmental degradation without clear accountability (Benton et al. 2021). Today, the consequences of soil depletion and climate change pose significant threats to the resilience of our food system (Ellen MacArthur Foundation, 2021). Nevertheless, subsidies are mainly allocated towards practices that improve yields, perpetuating the degradation of agricultural lands (Benton et al. 2021)

In line with Benton et al. (2021), all interviewed MLEs emphasise that the absence of environmental damage costs in food pricing constitutes a systemic failure, hindering the transition towards a circular food industry. For instance, MLE4 highlights, *"For years and years food was too cheap because the cost of the negative impact was not in the price."* Similarly, it is stated by MLE2 that *"it should be a condition of doing business that products that don't destroy the environment should be cheaper,"* and by SME2 that *"those that are dealing with high-volume monocultures don't pay the price for damaging the environment."* These statements reflect the prevailing perception that regenerative production carries a higher cost compared to conventional food production, thereby undermining the competitiveness of circular products. This resonates with the findings of the Ellen MacArthur Foundation (2015b), which identified unpriced externalities as a key barrier for the implementation of circularity in the food industry.

4.4.2 Focus of the regulatory framework to creating a level playing field

As articulated in MLE4's statement, companies remain hesitant about the additional costs associated with circular production, uncertain about how to ensure profitability in such operations: *"It always helps in a commercial environment to have some kind of level playing field, as such that the conditions to get access to the market are the same for everyone and you don't feel negative commercial impact if you try to do better than the others [concerning environmental impact]."* This desire for commercial protection through governmental regulations reflects the pivotal role of a regulatory framework in driving the transition towards a CFE.

More specifically, our findings have highlighted three requirements for the establishment of a level playing field: the establishment of standardised circularity metrics, the involvement of the industry in the establishment of this framework, and the provision of a clear future perspective. These requirements are elaborated upon in the subsequent sections.

4.4.2.1 Standardised circularity metrics

As highlighted by MLE3, an important prerequisite of circularity-focused procurement across the AFSC is the ability to measure regenerative production: *"How do we measure it [circularity]? How do we implement it at scale? ... Many AFSC stakeholders practise sustainable procurement, which translates into our customers primarily asking us about our emission factor and when we will reduce, and I'm doing the same with our suppliers. So it's like a collective zooming in on a certain important aspect because we can measure it."* In this regard, SME2 advocates for an expansion of the current labelling system to more accurately convey the benefits of regenerative products to customers and consumers: *"ecological labelling is well established but can be counterproductive since quite a lot of ecological farming is not the best in class when it comes to GHGs. So we have been thinking about broadening labelling to address all kinds of sustainability metrics."*

Currently, RA relies heavily on practice-based assessment. However, since this approach lacks context specificity and does not allow for quantifying the outcomes of regenerative practices, establishing industry-standardised circularity metrics is crucial (Schreefel et al. 2020; SMI Agribusiness Task Force, 2023). Such metrics facilitate outcome-based assessment, enabling farmers to tailor regenerative practices to their specific context (Schreefel et al. 2020; SMI Agribusiness Task Force, 2023), facilitate the formation of coalitions, incentivising funding (SMI Agribusiness Task Force, 2023), and empower governments to allocate subsidies and financial incentives effectively to promote RA (Ellen MacArthur Foundation, 2021).

The benefits of adopting such standardised metrics are reflected by MLE3: *"I think there is a lot coming our way concerning measuring environmental impact and implementation of circularity, and I actually think it forms less of a barrier but more of an opportunity if used in the right way. Because*

even though reporting requirements and regulations in general produce a lot of more work for all companies, it helps to create a level playing field that can gear your strategic direction."

4.4.2.2 Industry alignment

To obtain practically relevant delineations that allow for adaptability to the specific circumstances and context of AFSC stakeholders, it is imperative for policymakers to engage in collaborative efforts with industry stakeholders. The resultant guidelines should enable companies to gain insights into the prospective direction of future markets towards circularity, thereby facilitating the establishment of ambitious targets and objectives (Ellen MacArthur Foundation, 2015b).

Moreover, a crucial aspect of developing a regulatory framework that is practically applicable is striking the right balance between specificity to provide guidance and generality to ensure relevance for all stakeholders across the AFSC. As emphasised by MLE3, *"It's not that we have one silver bullet and one approach. I think that's also why we are so interested in creating a general frame that can work for a lot of types of firms, depending on the conditions."* Hence, *"the government needs to get the industry on board to join forces"* (MLE3). By opening the discussions and actively involving representatives from across the AFSC, policymakers can ensure alignment of the regulatory framework with industry requirements (Ellen MacArthur Foundation, 2021).

4.4.2.3 Need for clearer future outlook

Lastly, a future outlook is crucial for food businesses to make informed decisions. For instance, farmers in Belgium face uncertainty concerning future licences due to government struggles to reach consensus on nitrogen regulations (Vrt nws, n.d.). This uncertainty regarding the requirements farms must meet to sustain their operations inhibits their ability to invest in circular initiatives. As articulated by MLE1, *"The Belgian nitrogen issue is something that blocks everything. Even though we want to make investments towards something circular, we don't know what's coming. … The dairy industry as a whole is standing still, and that is never a good thing, both economically as well as environmentally."* This is supported by the Ellen MacArthur Foundation (2015b) who highlight the prevalence of poorly defined targets and objectives as a key barrier to the effective implementation of circularity within the food industry. This emphasises the need for a regulatory framework with a clear future outlook, as such that food businesses can align their strategic choices with governmental decisions (Ellen MacArthur Foundation, 2021).

In conclusion, standardised circularity metrics, collaboration between the government and the AFSC, and a clear future outlook are crucial for the establishment of a level playing field, and will help incentivise food businesses to invest in circularity.

5 Discussion

In this research phase, the insights gathered from interviewee experiences, along with the themes and dimensions that emerged from the analysis, are used to challenge the preliminary framework (section *3.5*), and formulate a grounded theory (Gioia et al. 2012). Subsequently, the resulting developed framework is elaborated upon, forming the basis for making practical recommendations.

5.1 Introduction of the developed framework for implementation of CFE initiatives

The preliminary framework (***Figure 3***) identifies four key factors essential to the implementation of circularity in the food industry: *Regenerative agricultural production*, *Collaborations across the AFSC*, *Product portfolio innovation*, and *Policies and regulations*. In accordance with our findings, the relevance of each of these elements is further elaborated in subsequent sections.

Aligned with the preliminary framework, the data analysis underscores that RA serves as a significant lever for circular product development. However, the framework fails to address the ambiguity surrounding the definition and measurement of RA, which presents a practical barrier to implementing regenerative practices. Furthermore, while the preliminary framework briefly acknowledges the lack of financial incentives for farmers to transition, the data analysis reveals the underlying causes of this issue. Consequently, these insights enable the formulation of recommendations aimed at assisting farmers in overcoming these challenges, such as fostering collaborations that facilitate cost, risk, and benefit sharing across the AFSC, and promoting knowledge-sharing among farmers.

Moreover, the preliminary framework and literature review highlighted the impact of cultural, technical, regulatory, and market barriers on product portfolio innovation. This is in line with the data analysis, which reveals how food businesses encounter challenges in developing products that adhere to the CFE principle, comply with food regulations and operate profitably. Nevertheless, the preliminary framework lacked practical recommendations to guide food businesses in sustainably integrating circularity into their corporate strategy or attracting consumer interest through pricing or marketing strategies.

Additionally, consistent with the findings of the data analysis, collaboration across the AFSC is recognised as crucial for circularity-focused procurement and digitalisation efforts aimed at waste prevention. However, the data analysis also highlights the necessity of quantifiable results to improve collaboration across the AFSC, and attract funding and initiatives for risk-sharing beyond the AFSC. Moreover, it is essential to emphasise how such collaborations contribute to building bargaining power towards the government and advocating for policies that promote the CFE transition.

Lastly, although the preliminary framework highlights the crucial role of government support in catalysing the CFE transition, the data analysis, contrary to the literature review (section *3.4.1*), reveals a lack of guidance concerning circularity measures. Specifically, companies need a level playing field

with clear definitions of 'circularity', especially for RA, and financial support to navigate the premature market for circular food products. The data analysis was essential in identifying specific pain points, thereby facilitating the formulation of targeted policies to help businesses become circular.

In conclusion, as the literature review provided a comprehensive view of the challenges that businesses in the AFSC face when implementing CFE initiatives, the corresponding preliminary framework consisted of general key factors addressing these challenges, albeit lacking practical relevance. Conversely, the data analysis revealed the specific challenges encountered by these businesses, resulting in a deeper understanding of each challenge and serving as the foundation for practical recommendations. Based hereon, a developed framework (***Figure 8***) is introduced, which was obtained by identifying relationships between the aggregate dimensions. This process revealed two main actors driving the CFE transition; *government support* working top-down, and *corporate circularity strategy* working bottom-up. How these actors are recommended to drive change is portrayed in the grey boxes, and the corresponding expected outcomes are outlined by the central green arrows. Specifically, *RA* forms a basis for *circular product development*, and together they constitute a circular food economy. Each box is elaborated upon in following sections.

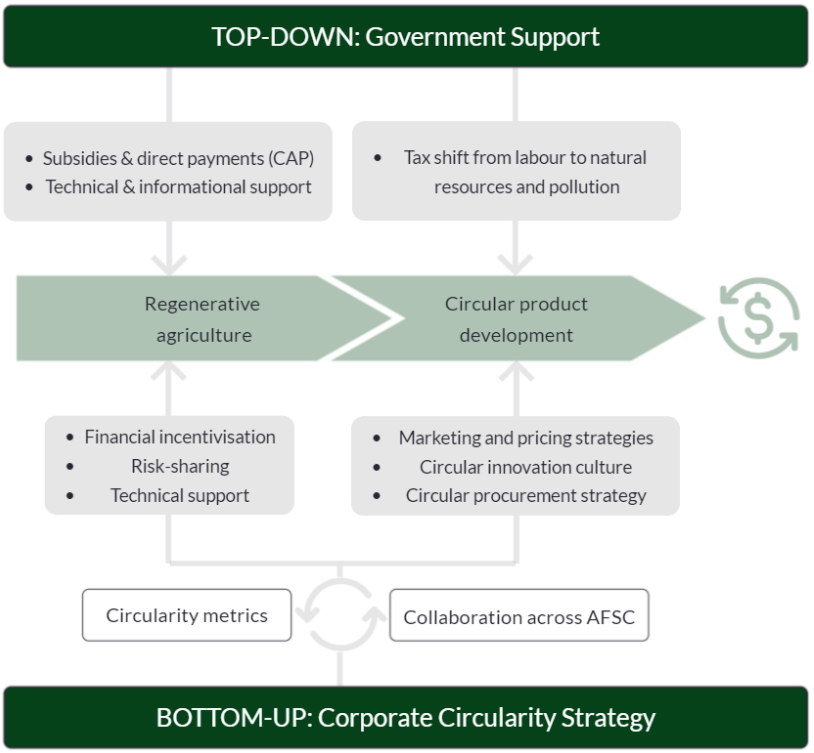

Figure 8*: Developed framework for the implementation of circularity in the food industry. Vertically, government support and corporate circularity strategy are identified as two main actors, driving RA and circular product development. Practical recommendations are portrayed in the grey boxes.*

5.2 Introduction of food circularity metrics

In line with Moraga et al. (2019) our findings emphasise the critical need for industry-standardised metrics to evaluate the outcomes of circular food initiatives. This study specifically identifies two primary areas where metrics play a crucial role: evaluating regenerative farming practices, and assessing the circularity of specific products across the four principles of the CFE (***Figure 8***).

Firstly, metrics offer a potential solution to the existing ambiguity surrounding RA. Particularly, the quantification of RA outcomes is poised to transition assessment from a practice-based to an outcome-based approach, empowering farmers to customise regenerative practices to their specific circumstances (Schreefel et al. 2020). Additionally, given that the lack of available data to assess the risks and benefits associated with RA forms a major barrier to attract investments from financial institutions (SMI Agribusiness Task Force, 2023), tangible outcomes derived from quantifiable metrics could potentially increase funding opportunities.

Furthermore, these metrics empower food businesses to make informed procurement decisions and track progress toward their goals (Ellen MacArthur Foundation, 2021; Schreefel et al. 2020), thereby encouraging coalition formation and expansion (SMI Agribusiness Task Force, 2023). Moreover, such metrics hold significance from a marketing perspective, potentially serving as the foundation for a labelling system that educates consumers about the circularity of individual products (Röös et al. 2021).

When selecting circular food metrics for the aforementioned purposes, it should be acknowledged that no single metric adequately quantifies all CFE initiatives (Moraga et al. 2019). To effectively address the multifaceted nature of the CFE transition, it is essential to utilise a combination of metrics to evaluate each of four CFE principles. In line with the SMI Agricultural Task Force (2023), SAI Platform (2023), and the Ellen MacArthur Foundation (2015a), the following metrics were selected: *GHG Emission Factor, Soil Organic Carbon* (SOC), *% natural / restored habitat in agricultural land*, *Blue Water Withdrawal*, *Nitrogen Use Efficiency* (NUE), and *modified Material Circularity Indicator* (mMCI) (***Table 3***).

***Table 3**: Proposed metrics for quantification of the CFE. As each metric enables the assessment of one or more of the CFE principles, the inclusion of all six metrics should provide a more comprehensive quantification of the degree of circularity of a particular product.*

Food Circularity Metric	Impacted CFE pillars	Explanation
GHG Emission Factor [MTCO2eq / unit of production]	RA, Lower impact ingredients, FSWL management	The rate at which a given activity releases GHG into the atmosphere (SAI Platform, 2023) *Outcome*: Maximise carbon sequestration
Soil Organic Carbon (SOC) [SOC / area]	RA, Lower impact ingredients, Diversification of ingredients	Measure for the amount of carbon retained in the soil, which determines the soil health (Saha et al. 2023). *Outcome*: maximise the SOC-value
% natural / restored habitat in agricultural land [% / area]	RA, Diversification of ingredients	Measure for biodiversity, taking the value of complete ecosystems into consideration (SAI Platform, 2023) *Outcome*: Protect on-farm habitat
Blue Water Withdrawal [m^3 / unit of production]	RA, Lower impact ingredients	The use of fresh surface and groundwater for agricultural purposes (Hoekstra et al. 2011) *Outcome*: Optimisation of water use
Nitrogen Use Efficiency (NUE)	RA, Lower impact ingredients	Ratio between amount of fertiliser N applied and amount of N removed with harvest (Cassman et al. 2002) *Outcome*: Optimise fertiliser N use
Modified Material Circularity Indicator (mMCI)	FSWL management	Accounts for the linear and recovered flow flow cycles, together with the repurposing of by-streams (Rocchi et al. 2021) *Outcome*: Maximise material recovery

The first five metrics (***Table 3***) were selected for their practical relevance, because of their ease of monetisation, current usage, and wide geographic applicability (SMI Agribusiness Task Force, 2023). For instance, with the recent enactment of the EU Nature Restoration Law, the significance of *% natural / restored habitat* for financial purposes is expected to increase. Additionally, these metrics overall exhibit favourable attributes such as ease of measurement, affordability, accessibility, and applicability (SMI Agribusiness Task Force, 2023). Nevertheless, even though the metrics *GHG Emission Factor* and *NUE* hold great financial potential, challenges persist with regard to the ease of measurement and affordability (SMI Agribusiness Task Force, 2023).

The selection of the last metric, *modified MCI*, was motivated by its significance in accounting for circularity and its focus on material retention (Ellen MacArthur Foundation, 2015a), as well as its adaptation for use in an agricultural and food systems context (Rocchi et al. 2021). Despite being one of the few circularity metrics capable of quantifying material recovery in biological systems, it does not consider the origin of feed or manure, thereby impeding the calculation of complete closed loops

(Rocchi et al. 2021). Additionally, further research is required considering the practical relevance of this metric.

It is important to acknowledge that this list of metrics is intended as a starting point and is not exhaustive. Further research is required to evaluate the practical relevance of this list and ensure they accurately represent measures to quantify the circularity of specific products or initiatives. Additionally, it is essential to emphasise that for these metrics to be effective in facilitating the CFE transition, they must be adopted across the entire AFSC (SMI Agribusiness Task Force, 2023). Nevertheless, we advocate for considering the context when applying these metrics, as their use may oversimplify the circular nature of CFE initiatives (Rocchi et al. 2021). Consequently, it should be noted that while these metrics do not provide a standalone solution to the CFE transition, they serve as a toolbox to help businesses understand the necessary steps for making food production more circular (Rocchi et al. 2021).

5.3 AFSC Collaboration for regenerative agriculture

As depicted in ***Figure 8***, the establishment of optimal practices for RA through AFSC collaboration and metrics can facilitate the CFE transition. For this purpose, it is crucial for food businesses to alleviate the growing pressures on farmers by offering financial incentivisation, initiating risk-sharing programs within and beyond the AFSC, and providing technical support and knowledge-sharing initiatives. In this discussion, the research done by the SMI Agribusiness Task Force (2022; 2023) is central due to their close cooperation with many AFSC stakeholders, the Ellen MacArthur Foundation and many other non-profit organisations.

5.3.1 Financial incentivisation

According to our findings, the high upfront costs and the initial period of lower yields associated with transitioning to RA act as disincentives for farmers (Jameson et al. 2024). To facilitate this transition, it is crucial for food businesses to adapt their financing models. This entails sharing costs across the entire AFSC while ensuring that farmers can reap the benefits of RA (Ellen MacArthur Foundation, 2021; SMI Agribusiness Task Force, 2023). As a solution, a combination of approaches is proposed, encompassing new buying models, revised contract terms, diversified revenue streams, and reduced capital investments, all of which can be customised to suit specific contexts.

First of all, as RA is characterised by the production of a variety of crops on the same field, food businesses have to adapt their buying models accordingly. Ideally, these businesses can assign a purpose for each crop within their own operations, otherwise collaboration with other companies, both within and outside the food industry, can help ensure all produce finds utility (Ellen MacArthur Foundation, 2021). Moreover, these buying models may also involve waste valorisation through partnerships with entities that can utilise by-products. However, such changes introduce complexities along the AFSC, making digitalisation crucial for streamlining operations (Ellen MacArthur

Foundation, 2021). Digital tools can provide vital data on ingredient localisation, volume, and availability, facilitating smoother collaboration (Onyeaka et al. 2023).

Secondly, revised contract terms offer a means to ensure stability in farmers' income throughout the transition to RA. Initially, short-term offtake premiums can be employed, wherein food businesses compensate for regenerative products, aiding them in covering initial costs of investment (Jameson et al. 2024; SMI Agribusiness Task Force, 2023). Additionally, food businesses can reduce capital investments by offering equipment pooling or input provision programmes (Ellen MacArthur Foundation, 2021). However, for a successful transition, long-term offtake agreements are essential, providing farmers with stable incomes over extended periods. Flexibility is key in these contracts, allowing for adjustments in practices and crops as the transition progresses, benefiting both food businesses and farmers (Ellen MacArthur Foundation, 2021).

Lastly, the emergence of Ecosystem Service Markets (ESM), driven by progress in carbon credit markets and corporate Scope 3 reduction strategies, holds significant potential for diversifying farmers' revenue streams (SMI Agribusiness Task Force, 2022). More specifically, the rotational cycles inherent to RA present opportunities to sell carbon credits generated by, for instance, rotational crops - which have no further use in the AFSC - to buyers interested in offsetting their Scope 3 emissions. Although ESM for carbon credits is currently more developed, there is potential for expansion to other areas such as water use, soil health, and biodiversity in the future (SMI Agribusiness Task Force, 2023).

5.3.2 De-risking mechanisms - involvement of the entire AFSC and beyond

Both farmers and food businesses stand to gain from risk-sharing initiatives extending beyond the AFSC. Essential to this endeavour are the previously introduced metrics, as data can serve as a catalyst for developing new financial products by demonstrating the efficacy of RA (SMI Agribusiness Task Force, 2023). For instance, given the increasing popularity of higher environmental, social, and governance (ESG) ratings among institutional investors, food businesses can, based on data, engage in negotiations with banks to secure green mortgage bonds offering lower interest rates (Jameson et al. 2024). Similarly, discussions with insurance companies could lead to more favourable insurance rates, particularly for crop insurances, leveraging the benefits of regenerative practices (SMI Agribusiness Task Force, 2023).

Additionally, as elaborated upon later, governments play a pivotal role in incentivising the transition to regenerative agriculture through financial measures such as tax incentives and subsidies. Therefore, collaborations across the AFSC will be crucial to acquiring collective bargaining power to advocate for policies that support regenerative agriculture (Ellen MacArthur Foundation, 2021; SMI Agribusiness Task Force, 2023).

5.3.3 Technical support and knowledge-sharing initiatives

In addition to financial incentives, our research highlights the knowledge-gap hindering the adoption of regenerative practices. Therefore, food businesses can play a pivotal role by offering technical support tailored to individual farmers, helping them identify regenerative practices that best suit their specific circumstances and maximise benefits for local ecosystems (Khangura et al. 2023). Moreover, initiatives promoting knowledge-sharing among farmers, whether through in-person networking or digital platforms, are essential for the wide-spread adoption of regenerative practices (Ellen MacArthur Foundation, 2021). As research suggests, these initiatives are most effective when they involve multiple stakeholders from across the AFSC and empower farmers to take a leading role in setting the agenda (Ellen MacArthur Foundation, 2021; Khangura et al. 2023).

5.3.4 Importance of collaborations

Collaboration emerges as a common thread across the aforementioned initiatives. A pivotal aspect of these collaborations is to ensure minimal burden on farmers when engaging in the aforementioned initiatives. Ideally, all available transition initiatives should be consolidated and offered by food businesses, allowing farmers to easily select and adopt them while minimising administrative tasks and research efforts on their part (SMI Agribusiness Task Force, 2023). Additionally, fostering local collaborations is essential for offering solutions tailored to farmers' contexts, as this cultivates a sense of agency and trust among the farmers (SMI Agribusiness Task Force, 2023).

5.4 Circular product development and waste valorisation

Figure 8 illustrates circular product development as a central element of the CFE. Within the development of circular products, all four principles of the CFE can be embraced. Through innovative strategies, both new and existing products can become circular by valorising waste streams and sourcing circular materials for procurement.

5.4.1 Strategy for circular product development

Innovation is key to driving circular practices such as diversification and development of product portfolios, valorising waste streams and adopting digitalisation solutions. Establishing an organisational culture of circular innovation is therefore a key prerequisite to meeting CFE goals (Ellen MacArthur Foundation, 2015b). Integrating the dimensions of responsible innovation - anticipation, reflexivity, inclusion and responsiveness - as outlined by the EU Responsible Research Innovation framework (Stilgoe et al. 2013) provides highly relevant guidelines for effective implementation of circular business practices. In particular, the anticipation and responsiveness aspects of this framework are highly relevant to businesses innovating circular food products. The anticipation dimension enables businesses to use foresight, revealing opportunities to become circular and improve resilience in the food industry transition to a CE (Stilgoe et al. 2013). Responsiveness ensures innovations address social concerns and promotes sustainability (Stilgoe et al. 2013),

ultimately leading to more responsible circular food solutions. By prioritising these dimensions, companies can better navigate the complexities of circular innovation and product development.

Investing in research and development (R&D) and embedding circularity goals within such departments of companies is essential for researching valorisation of waste streams and how to incorporate lower impact ingredients to food products. Food producers who fail to innovate on multiple attributes of their products and solely rely on sustainability to differentiate their product fail to gain high market share through this strategy (Ingenbleek, 2015). Innovating on other product attributes in combination with circularity, such as using alternative, more nutritional or novel food ingredients, or adopting a creative marketing strategy allows companies to further differentiate themselves from competitors. Our data analysis highlights the extensive opportunities for companies to innovate in line with consumer food trends. Companies should leverage trends such as plant-based proteins and nutritional awareness in product development with the aim of offering products that are both circular and appealing to consumers. By aligning product development closely with market demands, companies affirm their products are both circular and profitable.

However, research of product development and delivering circular value comes at a cost. Given that R&D can be labour intensive, associated business expenses must be highlighted as a barrier. As previously explained, the current low costs of virgin materials (Kirchherr et al. 2018), diminish financial incentive or motivation for companies to pursue circular product development. This underscores a failure of the linear supply chain model, necessitating a systemic shift to address this challenge, as further illustrated in section *5.6.2*.

5.4.2 Strategy for circular procurement

Waste valorisation can be implemented as a circular procurement strategy, offering the potential to internally reuse or repurpose resources. This approach provides dual benefits of reducing costs associated with purchasing new materials, while lowering waste management expenses (Teigiserova et al. 2020). The big food redesign (Ellen MacArthur Foundation, 2021) emphasises designing food products with consideration for environmental impact and logistics involved in obtaining ingredients. Collaboration between R&D and procurement departments can improve ingredient selection and sourcing decisions, resulting in more circular and lower-impact product designs (Ellen MacArthur Foundation, 2021).

Establishing more direct relationships with food producers and making efforts to shorten the AFSC can result in lower impact ingredients, as well as a more traceable supply chain - an important component of the CE (Ellen MacArthur Foundation, 2021). Furthermore, by reducing the length of food supply chains, fewer intermediaries are involved in adding their premiums to the price of materials. A shorter value chain can enable farmers to receive higher, fairer prices for their produce, which consequently would improve the feasibility of investing in regenerative farming practices. As a

result, food manufacturers would also benefit from such a change, as sourcing regeneratively farmed ingredients supports the development of circular food products.

Operating through an 'on-demand' production strategy offers companies a potential opportunity to adopt a circular procurement system. Through improved demand planning and forecasting production volume requirements, more effectively, companies can more accurately estimate their necessary input volumes of materials or ingredients. Stronger collaboration across the AFSC, may enable companies to negotiate greater flexibility in ingredient order volumes, ensuring businesses purchase only what is necessary to fulfil demand, therefore managing waste through prevention (Teigiserova et al. 2020).

The adoption of standardised food circularity metrics and traceability measures such as blockchain (Kumar, et al. 2023) across the AFSC, as outlined in section *5.2*, would facilitate the procurement of circular materials, by enabling businesses to assess the degree of circularity of ingredients. This in turn, would establish a more circular procurement system and ultimately the development of more circular food products.

5.5 Corporate circularity strategy

Integrating circularity within corporate strategy is imperative to facilitate a successful CFE transition. As depicted by ***Figure 8***, a bottom-up approach to adopting circularity within the food industry first involves embedding circularity strategies within organisation culture and business functions. This integration seeks to improve market demand for circular products through utilisation of various communication and marketing initiatives. Zhang & Song (2020) discuss how by launching sustainable products, first-movers often experience market advantages and exhibit imprinting effects on the development of sustainable initiatives in both new and existing companies. As opportunities for AFSC companies to become circular remain in early stages of adoption, companies should leverage the opportunity to become first-movers by incorporating circularity to business values and strategy.

5.5.1 Influencing consumer buying patterns

Affordability and increased costs associated with circular products is recognised in both the collected empirical data and in studies examining the challenges food businesses face in implementing circular initiatives (Kirchherr et al. 2018; Mont et al. 2017). While funding and financial incentives will be critical to support the industry's shift towards circularity, businesses must also take responsibility by reevaluating their pricing strategies and developing innovative ways to influence consumer buying patterns, promoting purchase of circular food products.

Röös et al. (2021) stresses that reducing prices of environmentally and health conscious foods can drive consumers towards more sustainable buying patterns. The concept of *stability pricing* offers a pricing strategy to encourage a shift in consumer buying patterns. A price stability strategy would entail that companies maintain the current pricing of their product, even after adopting circular

practices (Ingenbleek, 2015). This creates a competitive advantage for companies becoming circular through offering more sustainable products at the same price-point as their non-circular counterparts, encouraging consumers to purchase the more circular product option. Removing supply chain inefficiencies and valorising waste products to compensate for other costs incurred in the process of implementing circularity initiatives may enable companies to adopt this strategy (Ingenbleek, 2015). As the Ellen MacArthur Foundation asserts that there is potential for profitability within the CFE (Ellen MacArthur Foundation, 2021), companies must individually conduct research to identify economically feasible circularity strategies. Rather than relying on shifts in consumer buying patterns and governmental initiatives, it is critical for companies to innovate and stimulate demand for circular products.

5.5.2 Marketing and communication to improve consumer awareness and demand

As elucidated in section *4.2.1.2,* marketing can be used as a tool to educate and inform consumers on the importance of transitioning to a CE. As previously acknowledged, consumers lack awareness of the CE (Kirchherr et al. 2018), highlighting a challenge to be addressed through marketing and consumer communication strategy. Developing marketing strategies that highlight the circular attributes of food products can strengthen the perceived value of products or brands among consumers (Chamberlin & Boks, 2018). The message framing of products and way in which value is communicated to consumers affects purchase attitudes and intentions (Chamberlin & Boks, 2018). Grimmer and Woolley (2014) reported company CSR activities such as positive environmental performance can improve consumers' value perception of businesses' products. As the value of a product is dictated by value communication (Chamberlin & Boks, 2018), leveraging the 'green appeal' (Grimmer & Woolley, 2014) of circular products is suggested as a key aspect of marketing in the CFE. Chamberlin & Boks (2018) also suggests aligning environmental benefits of a product with the interests of consumers as a marketing strategy to increase sales. Furthermore, communicating the value of circularity not only improves product value offering, but simultaneously enables food companies to take a proactive approach in shaping market trends, by influencing the interests and buying patterns of consumers.

5.5.3 Circularity labelling strategy

Communicating CE attributes through product labels can be a profitable strategy that promotes sustainability (Anastasiadis, 2022; Boyer et al. 2021) and can assist in tackling several barriers associated with implementing circularity initiatives. A labelling system of recognised symbols displayed on product packaging can contribute to consumers' perceived legitimacy of the CFE movement. Furthermore, companies becoming circular who can brand themselves as such may gain a competitive advantage or prestige through this approach. Eco-labelling, which signals that a food product is more environmentally-friendly, has been demonstrated to impact consumer purchase behaviours by influencing as well as by raising their environmental awareness (Röös et al. 2021).

Röös et al. (2021) highlighted that hierarchical labelling schemes that convey the environmental impact of food products in the form of different levels have the potential to change consumer behaviours. For instance, inspiration can be drawn from the Nutri-Score labeling initiative, which the European Commission intends to adopt as part of its Farm to Fork strategy (EU Scientists & Health Professionals for Nutri-Score, 2023). This label conveys the nutritive value of food products to consumers in a simplistic manner, and evidence supports its effectiveness in encouraging healthier food choices within EU countries where it has already been implemented (EU Scientists & Health Professionals for Nutri-Score, 2023). The success of this initiative provides encouraging evidence that a similar labelling regime could be effective in promoting the CFE. The proposed circularity metrics, outlined in section *5.2*, could be further examined to calculate a so-called 'circularity score' to determine the extent of circularity embraced in the production of food products. From a regulatory standpoint, if such a circularity initiative was implemented to legal or regulatory frameworks, making the display of circularity symbols on labelling the norm, food businesses would be further encouraged to transition towards the CFE to become certified to display circularity symbols or to improve their 'circularity score.'

As consumers are also becoming increasingly interested in AFSC traceability (Anastasiadis et al. 2022) there may be opportunities for food businesses to explore methods of communicating their circular initiatives through a traceability labelling system. This could further promote consumer awareness and prioritisation of the CFE, especially with current discussions on implementing the EU Digital Product Passport initiative (PSQR, 2023). According to Anastasiadis et al. (2022), transparency and traceability facilitated by blockchain technologies can greatly improve trust among consumers and help to promote purchase of circular products. Moreover, when some companies adopt such practices while others do not, not only do more circular companies gain a competitive advantage but other competitors are also compelled to become circular, thereby progressing the entire CFE movement.

5.5.4 Organisational implementation

Through our findings and analysis it has become evident that not only consumers, but in many cases companies also lack knowledge and awareness of the CFE. In many cases, the selected companies already practice circular initiatives but do not explicitly define them as such. The limited understanding of circularity in some cases, and misalignment of circularity definitions within the AFSC, constitute a barrier to progress in embracing principles of the CFE. Without adequate understanding and awareness, initiatives cannot be implemented, thereby hindering the circularity transformation of the AFSC system. By embedding circularity as a value or integral part of company strategy, organisations can better educate and equip themselves to adopt circular initiatives.

A holistic approach to the implementation of circularity strategies is imperative to a successful CFE transition, meaning that specific circularity goals are set for each business unit, at every level within organisational structures (Kirchherr, 2018; Tawse & Tabesh, 2021). Tawse and Tabesh (2021) review measures that have been demonstrated as effective in implementing new strategies to organisations. Establishing transparent goal-setting policies is essential for creating a common understanding and criteria for decision-making (Sull, 2018; Tawse & Tabesh, 2021), contributing to improved coordination across the business. As outlined in section *5.1.1,* identifying metrics can help AFSC businesses to track their goals and progress. Moreover, specifying metrics enables companies to identify KPIs, thus facilitating the integration of circularity strategy to organisational operations. Furthermore, adopting performance control systems, such as KPIs, allows members of the organisation to understand new responsibilities of the organisation (Atkinson, 2006; Tawse & Tabesh, 2021), thereby ensuring alignment of employees and activities. As part of 'The big food redesign' the Ellen MacArthur Foundation (2021) calls on the food industry to set ambitious and 'thought-through' goals. As previously motivated by MLE2, setting ambitious goals encourages organisations to strive for higher levels of success. This approach to goal and target setting could be an effective motivation strategy to improve companies' circular practices and help dedicate focused effort to the CFE transition.

Section *4.2.2.1* highlights a challenge regarding conflicting values between the CFE agenda and existing organisational values. Although this challenge is situational and not applicable to all food business models, companies such as MLE4 face difficulties in navigating the balance between circularity and social inclusivity values. Despite this challenge, an argument can be made that resisting the shift toward a CFE poses risk to the future resilience of companies' supply chains.

Several possible scenarios highlight the potential ramifications for businesses that resist adopting circular initiatives. For instance, if consumer trends increasingly prioritise circularity or if governmental systems implement policies to reduce the costs of operating circularly; businesses that choose to stand still now will consequently risk missing opportunities to capture value from the CFE as the industry moves forward. Furthermore, as EU policymakers have already implemented legislation in favour of the CE transition (European Commission, 2020b), it will likely become increasingly challenging for food companies to maintain current business models. Therefore a proactive approach to circularity is recommended for food businesses, allowing them to transition towards the CFE on their own terms, before new industry standards render current strategies and practices outdated.

5.6 Government initiatives

While the primary focus of this research was to explore the implementation of circularity in food businesses, our analysis emphasises the need of top-down clarity on definitions of circularity and the creation of a level playing field. More specifically, the government plays an essential role in providing environmentally and economically sustainable solutions that are socially inclusive as well, as exemplified by initiatives like the EU's Farm to Fork strategy (European Commission, 2020b). Therefore, government support is considered to be crucial, both in advancing RA through subsidies, direct payments, and technological and informational support, and in promoting circular product development by implementing a tax shift from labour to natural resources and pollution (***Figure 8***). Moreover, by outlining concrete government recommendations, food businesses can gain clarity on which policies to advocate for.

5.6.1 Regenerative Agriculture: Making the economics work

While the food circularity sector ideally sustains profitability independently, government support can significantly facilitate the transition (Dey et al. 2022). Analogous to the renewable energy sector, which initially relied on subsidies to overcome low market demand and eventually flourished, targeted government assistance can similarly propel the development of the food circularity sector (Ellen MacArthur Foundation, 2021). Moreover, considering the EU's role in setting environmental standards and co-financing the majority of Member States' agricultural expenditure through the Common Agricultural Policy (CAP), they play a pivotal role in steering the progression towards a circular food economy (European Commission, 2022)

In the previous CAP cycle, during the period of 2014 to 2020, over 100 billion euros was allocated toward climate change mitigation efforts, yet minimal reductions in agricultural emissions were obtained (European Court of Auditors, 2021). This outcome was largely attributed to the fact that the mitigation measures supported by the CAP lacked sufficient potential to effectively address climate change (European Court of Auditors, 2021). This is in line with the Benton et al. (2021) and the Ellen MacArthur Foundation (2021), who state that subsidies have historically mainly supported conventional food production based on the belief that it is crucial for addressing hunger and food insecurity.

To address this shortfall, the new CAP framework for the period of 2023 to 2027 has introduced eco-schemes and rural development support (European Commission, 2022). These eco-schemes involve providing financial assistance, in the form of direct payments, to promote sustainable farming practices such as better nutrient management, agro-ecology, agroforestry, and carbon farming. As part of this initiative, the EU mandates that Member States allocate a minimum of 25% of their total budget for direct payments (which amounts to 194 billion euros annually for the entire EU) towards eco-schemes (European Commission, 2022).

Additionally, the current CAP cycle contains a rural development support framework, encompassing climate-friendly land management, animal welfare, and compensation for natural and other disadvantages. For this purpose, the EU has set aside 60.6 billion euros, with Member States obligated to allocate at least 35% of their respective rural development budgets towards these initiatives (European Commission, 2022). Both these measures offer flexibility, allowing Member States to allocate more funding to sustainability practices depending on their individual sustainability ambitions.

Consequently, since regenerative practices are eligible for both eco-schemes and rural development support, farmers who adopt such practices can qualify for direct payments and subsidies (Jameson et al. 2024). Additionally, the flexible nature of these CAP measures, coupled with the outcome-based assessment facilitated by food circularity metrics (section *5.2*), empowers food businesses to leverage robust collaborations and advocate for more ambitious governmental sustainability objectives (Ellen MacArthur Foundation, 2021). Hence, this advocacy effort can lead to increased subsidies and direct payments towards regenerative agriculture.

Additionally, given that the findings highlight the importance of non-financial support, such as knowledge-sharing initiatives, for farmers to adopt RA (Khangura et al. 2023), food businesses stand to benefit from aligning their knowledge-sharing efforts, as discussed in section 5.3.3, with government initiatives. For instance, initiatives like the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) (EU CAP Network, n.d.), which is a farmer-led innovation project that, amongst others, provides access to a website containing information, tips, and research findings on RA, could benefit from collaborations with businesses across the AFSC.

5.6.2 Circular Tax Shift: from labour to resources

Transitioning towards a circular economy carries significant economic implications. As the emphasis shifts towards resource conservation and recycling, and the development of circular products demands considerable time, effort, and innovative thinking, there is a transition in cost dynamics from resources to labour (The Ex'tax Project, 2022). However, our current economic model presents a challenge to this shift (Milios, 2020). Typically, under the EU's Polluter Pays Principle, companies would bear the costs of the environmental damage they cause (Vomácka, n.d.). Yet, at present, only a minor fraction (6%) of the Member States' tax revenue stems from 'green' taxes, which encompass all natural resources usage, GHG emissions, and pollution (The Ex'tax Project, 2022). Conversely, the majority (52%) of tax revenue originates from labour-related sources such as income taxes, payroll taxes, and social security contributions (The Ex'tax Project, 2022). Consequently, purchasing power diminishes and companies are incentivised to minimise human labour inputs, while resource usage remains relatively untaxed. Moreover, annual subsidies amounting up to 50 billion euros are allocated to fossil

fuels. Consequently, rather than adhering to the principle of ‘the polluter pays’, it is essentially the polluter who is paid.

Therefore, implementing a tax shift that reduces the tax load on labour while augmenting taxes on resource consumption, GHG emissions, and pollution is imperative for the transition toward a circular economy (Milios, 2020). Moreover, research indicates that such a tax shift fosters economic growth, job creation, reduced import reliance, and environmental benefits, making it an economically advantageous solution that is socially inclusive and environmentally beneficial (The Ex’tax Project, 2022).

6 Conclusion

The purpose of this thesis was to investigate the initiatives AFSC businesses can adopt to overcome the challenges associated with embracing circularity within the food industry. As current evidence emphasises, the CFE is promoted as a strategy for achieving a significantly more environmentally sustainable future. Based on this research, it is critical that food businesses make efforts to adopt circular initiatives in contribution to a CFE transition.

Through conducting interviews with employees at both circular SMEs and non-circular MLE companies, this study identified a diverse range of barriers encountered in implementing circular initiatives. Furthermore, this qualitative research approach led us to uncover the opportunities associated with circular business models and to identify strategies that could function effectively within a CFE.

The research question of this thesis served as a basis for researching circular business practices, as well as the construction and development of our CFE implementation framework (***Figure 8***):

How can AFSC businesses implement practically relevant circular initiatives that are both environmentally and economically sustainable?

Ultimately, this study serves insight to the necessary actions AFSC stakeholders must take to progress the CFE transition.

6.1 Contributions and key findings

In line with the research question, we have identified recommendations across four key dimensions; integrating circularity into the corporate strategy, establishing RA, promoting circular product development, and advocating for government support (***Figure 8***). To provide recommendations for the implementation of circular initiatives into corporate strategy, we recognise that circular product development comprises two components: establishing RA, and circular product development based on the four CFE principles (Ellen MacArthur Foundation, 2021). Hence, for a successful CFE transition, businesses must prioritise efforts in both components.

To establish RA effectively, we suggest businesses to provide farmers with both financial and technical support, and implement risk-sharing initiatives within and beyond the AFSC. In terms of integrating circular product development, establishing a circular innovation culture and promoting circular procurement will be essential. Additionally, we recommend that businesses refrain from implementing a sustainability price premium, and instead focus on adapting market strategies to raise consumer awareness and educate them about the benefits of circularity. We acknowledge that both collaborations within the AFSC and the adoption of industry-wide circularity metrics will be essential for implementing each of these recommendations.

Lastly, government support emerges as a crucial element in the transition to a CFE. However, our aim is not to provide recommendations directed at governments but rather to raise awareness among companies regarding the types of policies necessary for the CFE transition. This awareness enables companies to advocate for supportive policies and effectively align their circularity initiatives with government initiatives. Specifically, we propose two main methods through which governments can support the circularity transition. Firstly, governments can assist in the establishment of RA through subsidies, direct payments in line with the recent CAP, and technical and informational support. Additionally, implementing a tax shift from labour to natural resources and pollution is identified as crucial for facilitating the CFE transition.

Adhering to the recommendations outlined above would empower companies to adopt circularity initiatives that are not only environmentally sound but also economically viable. This aligns with the ultimate goal of our study, which was to develop a framework providing practical guidance for AFSC businesses to transition towards circularity, thereby contributing to the success of the CFE and a more sustainable future.

6.2 Limitations

As the framework and recommendations presented in this thesis stem from qualitative research, subjectivity must be recognised as a limitation of this study. While nine case studies arguably provide a solid foundation for a high-quality data analysis, the inclusion of additional cases may have led to further perspectives and insights. Furthermore, conducting more in-depth case studies - such as interviewing with more representatives of each company - could have provided nuance and a more detailed picture of each businesses' situation.

Although the results of this thesis are intended to be generalisable, the applicability of our findings and framework is contingent on several conditions. To elaborate, market dynamics such as consumer interest could remain a large barrier to the CFE transition, even with the implementation of efforts outlined to address the issue. Additionally, as a long-term commitment to circularity is necessary for an effective CFE transition, the sustained success of circular initiatives hinges on an innovative and motivated organisational culture. Without genuine commitment, the transition is unlikely to achieve effective outcomes.

Finally, governmental influence cannot be denied as a major factor impacting businesses' capacity to embrace circularity. While companies are encouraged to advocate for CE support and incentive schemes, they lack direct influence over governmental policy. Therefore, governing bodies and policymakers are essential stakeholders in the CFE transition. Despite the establishment of the EU Green Deal, the extent and pace at which individual EU states achieve the Green Deal's CE objectives dictates the level to which companies can embrace circularity, ultimately affecting both the pace and success of the CFE transition. In addition, as our findings highlighted, social inclusivity values deter

some companies from embracing circularity, due to the inflated prices associated with circular food products. This issue requires systemic change made by governments, rather than a challenge that can be addressed by AFSC businesses.

6.3 Direction of future research

It should be noted that the made recommendations are suggestions based on the challenges highlighted by our data analysis. Each business will benefit differently from the proposed recommendations, so further research on their transferability to other businesses in the food industry is necessary. Additionally, further research is needed to quantify the environmental and economical sustainability of each initiative. More specifically, it is important to elaborate on the proposed circularity metrics and develop an exhaustive list of metrics that comprehensively covers the four CFE principles (Ellen MacArthur Foundation, 2021), while remaining practically relevant and feasible to measure.

Lastly, from an international trade perspective, further research should focus on the impact of the EU's transition towards a CFE on its global position. Such a shift holds significant potential to redefine international trade dynamics and the EU's competitive advantage. Therefore, investigating how increased resource efficiency and supply chain resilience position the EU in the global market is crucial to understanding the CFE's impacts and for developing proactive policies that maximise economic benefits while ensuring a sustainable future.

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8 Appendix

Appendix I: Interview Guide

Introduction to research

- *Purpose of research*: building a framework for implementation of circularity in the food industry. For this purpose, circularity is viewed across four pillars; regenerative agriculture (RA), shift towards lower impact ingredients, diversification of ingredients, and the valorisation of waste streams
    - RA: food production with positive outcomes for nature (e.g. healthy and stable soils, improved local biodiversity, and improved air and water quality)
    - Lower impact ingredients: adapting product portfolios, as such that the crops used have lower environmental impact or shift from animal-based proteins towards plant proteins
    - Diversification of ingredients: shift in product portfolio to incorporate more diverse ingredients
    - Valorisation of waste streams: prevention of waste and upcycling of waste streams
- *Purpose of interview*: we want to get a better understanding of how corporations could incorporate this into their already existing business models. Therefore, we aim to identify the challenges corporations face in their adoption of circularity initiatives.
- Recording & Data usage in line with GDPR reglementation

Phase 1: Introducing the business

- Can you briefly describe the company's business model?
- What is your role within the business?

Phase 2: Discussion of challenges & opportunities

Topics to discuss	**Proposed questions**
Previous sustainability / circularity endeavours: Challenges, organisational strengths, and learnings	- What challenges has the company faced in previous years with regard to implementing sustainability or circularity initiatives? - What was done to overcome this? What were the strengths of the company? - If anything was learned from these experiences, what would it be?
Practical feasibility of circularity initiatives	- What circularity aspects has the company already adopted? - What are your thoughts on investing in RA? - Do you consider a change in product portfolio towards lower impact products feasible? Why? - Is there any way the company recovers or prevents the generation of waste streams? - What waste streams does the company produce (if so), and has there been any discussion on what to do with them?

Challenges with implementation of circularity initiatives	- What do you consider as the main challenges when implementing any of the mentioned circularity initiatives
	  ○ On an organisational level?
	  ○ On an industry level?
	  ○ Concerning government policies and regulations?

Future outlook	- How do you see the future of the company with regard to sustainability, and what are possible challenges that this brings?

Appendix II: Overview of 1st order data analysis

Emergent 1st order concept	**Number of citations in category**	**Number of involved interviewees**
Laying the basis for defining RA	3	2
More clarity on the future would help companies in their investments and change	5	3
Farmers lacking knowledge to invest in RA	1	1
Farmers lacking financial incentives to invest in RA	8	4
Differing governmental and business expectations of farmers	2	1
SMEs establishing RA	1	1
Cooperative arrangements to establish RA	9	4
Pilot farms lay the groundwork of RA	8	3
Direct collaborations with farmers gives insights in the reality of farming	1	1
Consumer trends and buying patterns	12	8
Developing nutritionally sound products	7	3
Shift towards plant-based proteins	4	2
Maturation of market for circular products	3	2
Sustainability premium as a differentiation strategy	3	3
Marketing opportunities	5	3
Using traceability to establish consumer trust	3	1
Company knowledge and awareness of circularity	5	4
Affordability and funding on investment	4	3
Struggle for uncertainty in developing profitable circular initiatives	10	7
Conflicting circularity and business values	6	4
Ensuring social inclusiveness	3	1
Management attitudes and openness towards circularity	6	3
Progress in waste prevention from farm to fork	6	5
Foodgrade regulation as barrier to waste prevention	3	2
Digitalisation and information exchange for production planning	6	3

Technical barrier for valorisation higher up the waste hierarchy	3	2
Product portfolio diversification for valorisation of waste streams	5	2
Conversion of waste streams into fertiliser or bio-energy makes a difficult business case	3	2
Valorising waste in a way that is profitable for planet, business, and customers	11	3
Logistical barrier to waste valorisation	3	2
Production dilemma's: in-house vs outsourced manufacturing	3	2
Large scale manufacturing is key to achieving sustainability	5	3
Challenges of shifting to large scale operations	6	3
Cost of environmental damage not reflected in pricing	3	3
Regulation to aid creation of a level playing field	8	3
Call to broaden sustainability metric labelling	5	3
Companies voicing for other stakeholders	1	1

Appendix III: Complete data structure