Wheat supply chain: a comparative study of sustainability issues concerning Brazil and the United Kingdom through Circular Economy lenses

Submitted for the Degree of Doctor of Philosophy at the University of Northampton

2021

Alvaro Augusto Dossa

## ABSTRACT

Wheat is one of the most important staple crops globally. It covers more planted area than any other grain and is the most traded major cereal. Therefore, by improving the sustainability of wheat food supply chains, all sustainability aspects are enhanced. One of the most prominent schools of thought regarding sustainability is the Circular Economy (CE). Despite previous works addressing the adoption of CE practices in supply chains – no previous research addressed how transactions between actors in those supply chains influence the adoption of CE practices.

The goals of the CE are to overcome the predominant take-make-dispose model of the contemporary economy favouring a restorative and regenerative system. This thesis differed from past research by analysing a long food supply chain, that is, a supply chain with several links from farmers to market. Furthermore, it focuses on the role that transactions between organisations in the supply chain have in the adoption and diffusion influencers of CE practices. To accomplish this, Transaction Cost Economics (TCE) was used as the supporting theoretical body to the discussions of the transactions between the organisations in the supply chain. The unit of analysis were wheat food supply chains in Brazil and the UK. This research is classified as a qualitative and comparative case study.

The investigation identified that all of the CE practices found in the literature with application in the agri-food context were present in the supply chains. Additionally, the material flow was mapped and included potential wastes and by-products flowing in circular loops. There are more similarities than differences in CE practices happening in both countries. The wheat food supply chain transactions have, as a general rule, low asset specificity, mid to high level of uncertainty, long-term contracts, and have varying levels of formalisation.

Transaction dimensions have multiple roles within CE diffusion influencers. The research showed that uncertainty in transactions increases barriers to the adoption of a CE practice, especially concerning market issues. Asset specificity has a double directional role, both strengthening and being strengthened by the drivers, particularly consumer demands. Finally, long-term (repeated), formal or informal transactions facilitate the diffusion of CE practices in the supply chain. These roles are fluid and dependent on negotiations that are affected by the power asymmetry between the actors in the buyer-supplier dyads.

## ACKNOWLEDGEMENTS

In all significant human and personal endeavours, individual accomplishments are rarely done in isolation. We would not have an original contribution from this research if not for the contribution of others:

- The University of Northampton – for its funding, intellectual capital and infrastructure, providing me with the capacity to accomplish this dream.
- Embrapa, and in particular, Embrapa Wheat and all of my peers, that allowed me to come to the UK and focus my efforts in the pursuit of knowledge and growth.
- My supervisory team, Dr Andrew Gough, Dr Luciano Batista and Dr Kathleen Mortimer for their guidance, patience and expertise as mentors in this journey.
- My boss and liaison at Embrapa – Dr Osvaldo V. Vieira, for his steadfast friendship, encouragement and network of contacts without whom would make this research less rich.
- All participants in this research – all of this was dependent on you.
- My wife, Carla C. K. Dossa, and her personal, intellectual and emotional support, companionship and love.
- My family in Brazil, especially my father and my mother – Dr Derli Dossa and Lizete H. Dossa, for inspiring me to be the best that I can be. My in-laws, Sergio O. Kwiatkowski and Marli Kwiatkowski, were also a pillar of support in these trying years.
- My friends and colleagues at the University of Northampton - Seyi, Shalini, Taher and Thuy, that provided me with the capacity to discuss our research, struggles and solutions.
- My friends and colleagues in Brazil, especially Dr Alexandre P. Tognon, Dr Danilo Vasconcelos and Andre Farias, all of whom provided concrete additions to this thesis.

If I did not include you in the list above and you felt I should have, I apologise. It was not done out of malice; rather, it was a result of brevity or memory loss due to old age. Hopefully, I will make it up to you in the future.

**CONTENT**

## LIST OF FIGURES

**LIST OF TABLES**

## LIST OF ACRONYMS

| | |
|---|---|
| BBSRC - | Biotechnology and Biological Sciences Research Council |
| C2C - | Cradle to Cradle |
| CE - | Circular Economy |
| CLSC - | Closed-Loop Supply Chains |
| CSC - | Circular Supply Chains |
| CSCMP - | Council of Supply Chain Management Professionals |
| DC - | Distribution Centre |
| Embrapa - | Brazilian Agricultural Research Corporation |
| FAO - | Food and Agriculture Organization of the United Nations |
| FBI - | Farm Business Income |
| FOB - | Federation of Bakers |
| GSCM - | Green Supply Chain Management |
| PSS - | Product Service System |
| R&D - | Research and Development |
| SCM - | Supply chain management |
| SSCM - | Sustainable Supply Chain Management |
| SESC - | *Serviço Social do Comercio*, in English: Retail Social Service. |
| TCE - | Transaction Cost Economics |
| WAIC - | Wheat agro-industrial complex |

# 1. INTRODUCTION

Global cereal production and stocks are at an all-time high (FAO, 2017). However, addressing the sustainability of cereal production (and consumption) is critical for worldwide sustainable development, especially in terms of future growth of production and population (Reeves *et al.*, 2016). Whilst the environment is the most discussed pillar of sustainability (e.g., deforestation, climatechange, chemical spillage, etc.), policies such as the 17 Sustainable Development Goals (The United Nations - General Assembly, 2015), published research (Shewry and Hey, 2015) and business practices and strategies (nabim, 2007) make it clear that the other two pillars (social and economic) are also being addressed and acted upon by governments, academia and business.

This research draws upon Circular Economy (CE) theory, as well as Transaction Cost Economics (TCE) and related subjects, to investigate issues concerning the sustainability practices and their diffusion in the wheat agro-industrial supply chain in Brazil and the UK, comparing the two countries. These countries were selected for two reasons: the first reason is operational to the thesis, given that access to data is more manageable in those countries, and the second is regarding the importance of wheat production and consumption in these settings: they have opposite trade roles in the world cereal market since Brazil is a net importer of wheat, and the UK is a net exporter.

The Ellen Macarthur Foundation is a UK´s charity launched in 2010 with several corporate partners (The Ellen MacArthur Foundation, 2018), which plays a crucial role in spreading CE throughout the world. It created a platform for the promotion of CE and its concepts, developing programs for business, governments, education and research, and is considered one of the driving forces of CE and its diffusion (Haanstra et al., 2017; Geissdoerfer et al., 2017; Kirchherr et al., 2017). Considering their work and others, CE can be defined here as the economic system that by intention and design, moves past the make-use-dispose model (The Ellen MacArthur Foundation, 2013a), in favour of an approach with loops, both open and closed (Batista *et al.,* 2015a; Vlajic *et al.*, 2018), that maximises utility and/or value of technical and organic products, components and materials (Murray *et al.*, 2017; Kirchherr *et al.*, 2017), and that through operational practices, business models and governmental policies, helps to pave the way for a sustainable, restorative and regenerative triple bottom line development (The Ellen MacArthur Foundation, 2015a; Ghisellini *et al.*, 2016; Kirchherr *et al.*, 2017).

CE is, therefore, not only a framework but also a school of thought, and it consolidates other ideas and practices in academia, industry and government context (The Ellen MacArthur Foundation, 2013a; Weetman, 2017) into a coherent pro-sustainability body of knowledge. It can be said that CE has different schools of thought within itself, which varies from intended outcomes and desired implementation strategies, from waste and resource extraction through economic growth potentials and environmental impact reduction (Zink and Geyer, 2017). This means that CE is both a theoretical and a practical framework, given that it has clear suggested practices for business plans, supply chain management (SCM), policymaking and research.

This thesis falls in the interpretivist paradigm epistemologically. Methodologically, it is a qualitative research, more specifically, a comparative dual case study (Yin, 2018). It is an exploratory-descriptive investigation that follows the abductive processes. The study used primarily semi-structured interviews for data collection, interviewing participants from organisations in Brazil and the UK, each corresponding to one supply chain from farm to market. Thematic analysis was used as the primary form of data analysis.

In the following sections, information regarding the background of the research, such as the agro-industrial complex of wheat is presented, as well as the motivation of the research, research problems and objectives, theoretical and practical justification and the structure of the thesis.

## 1.1 BACKGROUND

The wheat agro-industrial complex (WAIC) can be defined as the landscape of organisations that are directly related to the supply chain of wheat and its by-products from production to consumption (Mori and Ignaczak, 2012). Considering that this thesis deals with a specific supply chain – wheat for food - the definition of the food supply chain used here is an adaptation from the one proposed by Dani (2015), but it encompasses the scope of the present research, and it is used henceforth as: ‘agri-food supply chain is the set of processes, operations and entities that are needed to bring food from farm to market’. Such a definition was selected because it explicitly deals with food and covers the entire process that any of the wheat food sub-products (bread, pasta, biscuits, flour, etc.) can take, independently of the number of links in that chain. Both the term ‘agri-food supply chain’ and ‘food supply chain’ are used interchangeably.

According to Mori and Ignaczak (2012), wheat production accounts for about 30% of world grain crops. Among the most consumed grains, wheat distinguishes itself given its broad usage in flour, bread and dough manufacturing, as well as for its widespread production. The cereal and its products represent approximately 20% of daily food calories intake for approximately 65% of the world - in developing countries, it is second only to rice in importance (Lucas, 2012).

Wheat is produced at around 219 million hectares worldwide, according to FAO (2020b), with a total production of approximately 745 million tonnes in 2018 (Figure 1.1). This means that, if 1975 is considered as a starting point, by 2018, there was an increase of around 106.3% in production with a decrease of 5.4% in area, and therefore an increase of 118.17% in yield.

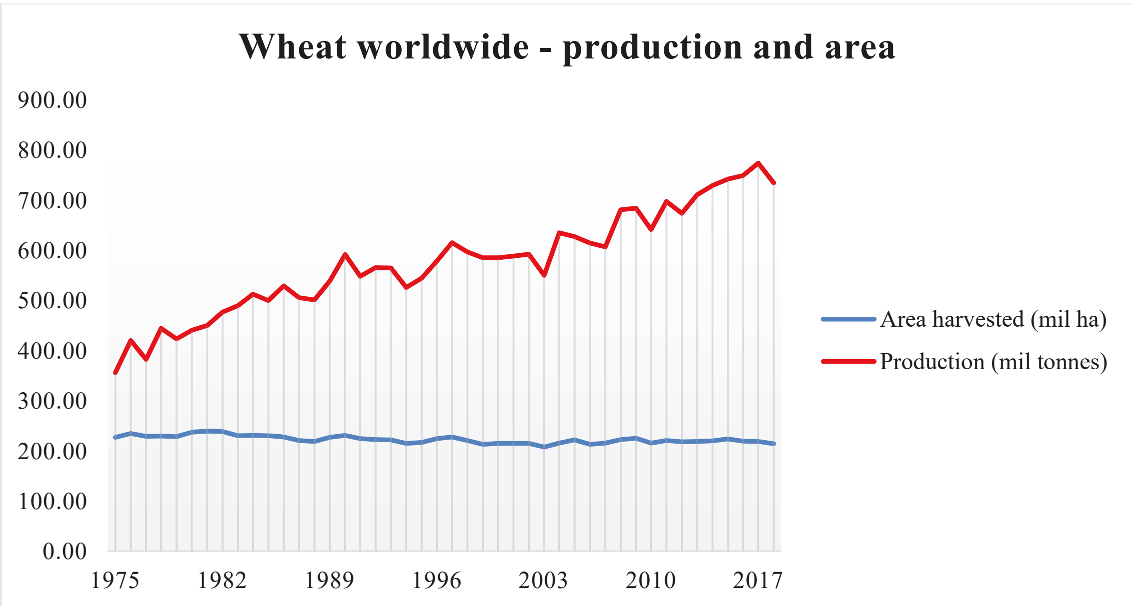



**Figure 1.1** Wheat worldwide production and area (FAO, 2020b).

The consumption of wheat (food) is increasing in the world, keeping pace with the growth of the population and reached 737.7 million tons in 2017 (FAO, 2018a). The average of gross production value worldwide, considering the last five available, according to FAO (2018b), was 105.8 billion dollars a year.

The International Grain Council (2020) identifies the worldwide usage of wheat in basically five categories - food, feed, industrial, seed and other. The average of the period 2014-2018 for the categories can be seen in Figure 1.2.

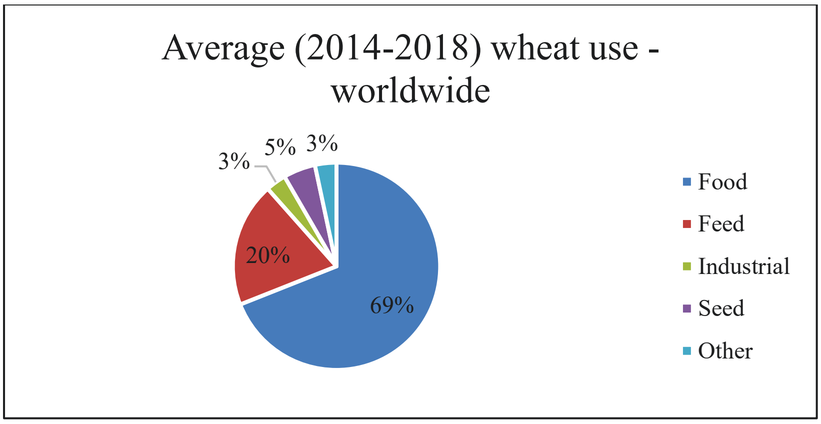



**Figure 1.2** Wheat worldwide usage (International Grain Council, 2020).

Although most of the wheat produced in the world is for human consumption after some form of processing, there is also a large percentage of it that is for animal feed or raw materials for industries (e.g., paper, ethanol, glue) (Kersting *et al.*, 1994; Amico *et al.*, 2010; Wheat Initiative, 2014). However, such uses are more common when weather issues negatively affect the quality of the grain (for instance, too much or too little rain), the fungal level (mycotoxins) makes it improper for human consumption or when the price is too low due to an abundance of wheat available in the market (FAO, 2002). Information regarding what the category 'other' consists is unclear, but waste is probably classified in this category.

Regarding food waste, wheat is different from other food types. The expected life cycle varies throughout the food chain, hence also varying its waste. Upstream of mills, it is a type of non-perishable food (i.e., grain) (Bartholomeu *et al.*, 2016). However, downstream of mills and depending on the type of end-product (i.e., pasta, cookie, bread type, etc.), the product becomes a perishable food. Bread is the main example of that, with an extremely short life cycle.

Wheat also differs from standard commodities like maize and soya beans, because it has different classifications (classes) based on characteristics such as destination, the season of growing the crop (spring or winter) and amount of gluten in the grain (FAO, 2002). This means that different classes of wheat grain produce different types of flour, and therefore different products thus increasing the complexity of the industry in relation to other commodities. Supply chain complexity influences operations in several ways, such as an increased chance of economically motivated fraud (Tibola *et al.*, 2018) and a risk of supply chain disruption (Marley *et al.*, 2014). It can also affect the propagation of policies and/or exogenous economic shocks (Lopes *et al.*, 2012), product quality and customer satisfaction (Perez *et al.*, 2009), the roles and issues that logistics and interdependency between countries and organisations that are part of the sector poses (Batista *et al.*, 2015b) among others.

The two most produced types of flours are white and whole wheat flour. According to Debes (2015) white flour uses only the endosperm of the plant while whole wheat flour uses the bran, the germ and the endosperm (whole kernel) and with 60 pounds of wheat grain (one bushel) it is possible to make 42 pounds of white flour (or 70 one-pound loaves of white bread) or 60 pounds of whole wheat flour (or 90 one-pound loaves of whole wheat bread). More information of other types of flour and milling practices can be found in Winfield (2013) as well as in Appendix A with a simplified model of the milling process provided by the Wheat Food Council (2015).

Besides bread, wheat is a significant part of other bakery products (cakes, pastries, etc.) as well as pasta, biscuits and breakfast cereal. The production of wheat for food reached 499 million tonnes (FAO, 2021) in 2018, about 67% of total wheat production that year. Given the weight of the wheat supply chain for world food sustainability *vis a vis* its large participation of daily calorie intake, the geographical distribution of production, and economic impact, it is important to evaluate it through lenses that use the *triple bottom line perspective* (socio, economic, environmental) to have a clear picture of sustainability in wheat supply chains.

Worldwide, the wheat supply chain is roughly composed of its farmers (and their input suppliers such as seed companies), their buyers, the industry (including mills), and finally the retail and end consumers. To shed light on this complex supply chain context, supply chains in two countries were selected – Brazil and the United Kingdom – and were compared in terms of similarities and differences of their practices. Other factors that influence the decision were ease of access to data and research partnerships between the Brazilian government and the Biotechnology and Biological Sciences Research Council (BBSRC). More details regarding the context of the cases selected for this study (Brazil and UK) are further developed in the third chapter of this research.

## 1.2 MOTIVATION FOR THE RESEARCH

This research, constructed within a PhD program, has three motivations: scientific, institutional and personal. In this section, each of those is explored:

a) **Scientific motivation**: Wheat is one of the most relevant food staples worldwide. Development of sustainability research relating to wheat food is crucial for agri-food sustainability in general. Climate change and resource scarcity require further investigations in the sustainability of food supply chains and what hinders the adoption of more sustainable operations in said context (Ghadge *et al.*, 2020). The investigation into wheat food supply chains in countries that present different perspectives of production and consumption can bring greater clarity on the topic. The development of CE as a field of research and practice in the last decade, leads to a growing body of knowledge and practice that places this theory as one of the more relevant to sustainability research. This is also true in the context of circular supply chains (CSC) and agri-food operations, two elements that still need further investigation. Wheat is a long food supply chain, but most studies on the topic relate to short-food supply chains as Gallaund and Laperche (2016), Vasconcelos *et al.* (2018), Carvalho *et al.* (2018), and Vlajic *et al.* (2018) demonstrate, thus reinforcing that investigations on wheat and long-food supply chains in the CE framework are still needed. Another motivating aspect to this research is that despite several pieces of research focusing on CE practices adoption and diffusion in supply chains (Masi *et al.*, 2018; Govindan and Hasanagic, 2018) no study identified focuses on the role of transactions on the diffusion of these practices. As the literature on the topic of CE and CSC was investigated deeper, it became clear that relationships between organisations in a supply chain are addressed by various theories, including TCE (Ferguson, 2007; Meixell and Luoma, 2015). TCE is one of the most prominent of them, and previous works (Maaß and Grundmann, 2018; Nozharov, 2018; Lahti *et al.*, 2018; Neves *et al.*, 2019) have connected - or proposed the connection - between CE and TCE. The benefits of combining both theoretical frameworks can be summarised in four points: i) the use of the New Institutional Economy perspective (Barbier, 2011; Man *et al.*, 2017) in the CE discussion, improving the theoretical contribution to both bodies of knowledge; ii) paves the way to measuring transaction costs in circular transactions, thus allowing better strategic planning of agri-food supply chains that incorporate CE operations; iii) clarifies uncertainties linked with the adoption and diffusion of circular business models; iv) facilitates the understanding of how to deal with material loops and the creation of partnerships connected to CE issues. Despite the relevance of discussing wheat through CE lenses, and the benefits of joining TCE and CE, no previous work was identified that connected all of these elements, thus showing the gaps in knowledge that leads to the need for developing the understanding of these fields via the present research.

b) **Institutional motivation**: The author of this research works for Embrapa, the Brazilian Agricultural Research Corporation, in its wheat research division (*Embrapa Trigo*). Research on sustainability of wheat is part of the objectives of Embrapa Trigo (Embrapa Trigo, 2018) and therefore sought after by this thesis. At the same time, the University of Northampton, where this research was conducted, has a strong commitment to social sustainability (The University of Northampton, 2018a; The University of Northampton, 2018b), one of the main dimensions considered in this thesis. By working on reducing food waste and improve social standings within the wheat agro-industrial complex through circular economy lenses, this research is aligned with the funding university. Another relevant part of the research being done in the context of Brazil and the United Kingdom is the partnership between BBSRC and Embrapa for joint research, with a particular focus on collaborative wheat research (Jackson, 2014; Antunes, 2015; BBSRC Media Office, 2016).

c) **Personal motivation**: achieving a PhD degree is part of a life-long ambition regarding research development as an independent professional. By following my father's footsteps, who also has a PhD in agricultural economics, but also as an employee of Embrapa, I was encouraged from the start on developing my career on such topics, both personally and professionally. Not only that, but as the son of a wheat farmer and being around farming my whole life, I believe that it is crucial to understand better the sustainability issues facing such endeavour, and the linkages of farming and the rest of the food supply chain.

## 1.3 THEORETICAL AND PRACTICAL JUSTIFICATION

Organisations (companies, governments, non-profit organisations and non-governmental organisations, academia, etc.) have identified that sustainability issues must be dealt with pragmatically, and that sustainability is a pressing concern in all aspects of the economy. As Baumgartner (2011) points out, research in sustainability is essential to support the sustainable development of our society. Agri-food sustainability is also key for long-term survival of our species, and wheat is one of the more important products in that sense as it is produced worldwide and a crucial component in kcal consumption worldwide. Despite this, different countries have different forms of production and consumption of wheat (Espinoza-Orias *et al.*, 2011; Glithero *et al.*, 2013; Smith and Barling, 2014; Carter and Cowman, 2020), thus different perspectives and operations for its sustainability.

One of the ways that organisations, especially companies, are doing that is through improvements in their supply chain, ranging from improvement in their production practices to collaborating with competitors, suppliers and consumers. The coordination of the supply chains in an increasingly complex global economy is challenging, but crucial for the success of the actors' part of it.

Overall, sustainability in food supply chains deals with energy consumption, carbon emissions, water usage, food availability, ethical behaviour and economic sustainability, and such supply chains are influenced by agricultural production, the involvement of various stakeholders (including governments), processing and maintaining quality, consumer and market choices and logistics (Dani, 2015). These elements positioned this research with an opportunity for bridging the knowledge gap that is formed with their superposition in relation to the wheat food supply chain.

According to Batista *et al.* (2018a), supply chain sustainability has been addressed for some time now, with an increase of research publications on the subject in the last few years. Circular Economy (CE) is one of the themes being researched more thoroughly within the Supply Chain and Operations Management disciplines. As already pointed out, this can be illustrated by the increase of publications on the topic (Geissdoerfer *et al.*, 2017; Kirchherr *et al.*, 2017), especially in the last five years. CE practices are gaining increasing relevance in business operations, given its dissemination in several sectors (The Ellen MacArthur Foundation, 2014).

Several authors have addressed the adoption and diffusion processes of CE practices (Mangla *et al.*, 2018; Jesus and Mendonça, 2018; Kirchherr *et al.*, 2018; Masi *et al.*, 2018). Such processes (Rogers, 1983) have different elements influencing it: drivers (motivators), enablers (facilitators) and barriers (difficulties) (Govindan and Hasanagic, 2018; Kirchherr *et al.*, 2018). It is assumed in this thesis that such adoption/diffusion influencers interact (are associated) with different things such as the relationship between actors, the institutional context (e.g., legislation) and the economy, among others. These interactions allow the diffusion influencers to affect and be affected by said factors. The connection between the different elements affecting CE, CE diffusion and wheat food supply chains have not been addressed in the literature, therefore, investigation into the topic is needed to bridge such knowledge gap.

The role of transactions between organisations is also relevant to the understanding of this phenomenon. The CE paradigm is being used in this thesis as the main theoretical base for the research but has been combined with TCE for an improved view of relationships in the CSC. Previous studies, such as Vlajic *et al.* (2018) showed that only a minority of research in CSC regards the biological cycles of bio-products (namely food), and this needed to be addressed. Also, Maaß and Grundmann (2018) presented the gap between CE and TCE, and point to the need to further connect both perspectives in the literature.

The bibliographical review of the topic did not identify studies comparing the WAIC of Brazil and the UK through CE lenses. Investigations into the role that transactions (and their characteristics) play in CE practices' dissemination were also not identified. Although the connection between CE and TCE was not expected at the start of the investigation, the literature on the topic showed a gap that the present research needed to address in connection to the investigation of CE and wheat food supply chains in Brazil and the UK (section 2.5 addresses this more thoroughly). Therefore, this thesis addressed such gaps in the field of operations, circular economy and food supply chains.

## 1.4 RESEARCH SCOPE

This section addresses the scope of this thesis and encompasses the research problem and aim, as well as the research questions and objectives.

### 1.4.1 Research Problem and Aim

As previously discussed, the sustainability (environmental, social and economic) of the wheat agri-food supply chain in both countries represents a major issue given their importance. As Babbie (2018) points out, the research problem identifies what is being studied and what practical and/or theoretical significance it has. This means that the research problem is closely connected with the scientific motivations (Section 1.2). The exploration of sustainability issues of wheat food supply chain is relevant for the development of the food industry as a whole, with Brazil and the UK being fertile ground for such research. Previous studies regarding CE allowed the identification of the following research gaps (topic and/or setting) that this thesis endeavoured to fill:

a) Despite the importance of sustainability in wheat food supply chains in both Brazil and the UK, and the relevance of CE as a triple bottom line (TBL) school of thought, no research was identified that links this type of food chain and CE practices (and diffusion) in Brazil and the UK. There is, therefore, a lack of benchmarking references for similar practices between both countries, as well as consideration of contextual factors determining different CE operations in each country.

b) Despite the considerable amount of research on the adoption and diffusion of CE practices, fewer studies so far focus on the agri-food supply chain in comparison to other settings (Balboa and Somonte, 2014; Ghisellini *et al.*, 2016; Jesus and Mendonça, 2018; De Angelis *et al.*, 2018; Masi *et al.*, 2018; Govindan and Hasanagic, 2018). This type of setting has its particularities that needed to be investigated to further develop CE as a viable pro-sustainability option for organisations in the agri-food sector.

c) There is no previous research regarding food in CE in the context of long food supply chains involving several dyadic (buyer-supplier) links, as is the case of wheat. Investigations on fresh fruits/vegetables and meat have fewer links (actors) than the wheat food supply chains (Vasconcelos *et al.*, 2018; Carvalho *et al.*, 2018; Vlajic *et al.*, 2018). The increase in the number of organisations and industrialisation activities also increases the complexity of the supply chain, the types and number of products derived from it, the potential for waste and finally, the modes of interaction in the chain and other negative externalities (Gallaud and Laperche, 2016). Further understanding is needed on these elements.

d) To understand the diffusion of practices within a supply chain, it is vital to comprehend how the organisations interact with each other. With the analyses of the current literature on the topic, it became clear that different theoretical frameworks can be used to that end, including social contagion theory, network theory, resource dependence theory and TCE. However, despite TCE being one of the most relevant frameworks to evaluate transactions and relationships between entities (Davies and Lam, 2001; Kolmar, 2017), there was no research using such paradigm in the context presented here (wheat and CE). While some research (Maaß and Grundmann, 2018; Nozharov, 2019) has been conducted to join TCE and supply chain management perspectives, no research was identified that unites both the diffusion of CE practices in a CSC and the dimensions of the transactions (TCE) in wheat food supply chains. Considering the benefits of joining both theories as expressed in the motivations for this thesis (Section 1.2), the present research can be regarded as an innovation in the discussion of CE, CE practices adoption and diffusion, and CSC. It also decreases the distance between Economic Science and CE research – the number of publications regarding CE in economics studies (Nozharov, 2018; Maaß and Grundmann, 2018) shows that there is little proximity between Economics and CE. Additionally, TCE has well-defined elements to understand actors' behaviour relating to transactions and decision-making regarding suppliers or buyers. In this thesis, the focus is on the dimensions of transactions.

To summarise, considering the importance of wheat food supply chains in both Brazil and the UK, it is relevant to improve the sustainability of such a supply chain. CE is a prominent school of thought in this regard, but further research on CE adoption in complex agri-food supply chains is still needed. The investigation into the contemporary literature on the topic of CE revealed that it is particularly important to understand the role that the transactions between organisations in the supply chain (namely suppliers and buyers) have in the diffusion of CE practices. Therefore, it is necessary to investigate these aspects in order to advance the sustainability of the wheat food supply chain in both countries. We therefore arrive at the following problem statement:

| |
|---|
| Problem statement: CE literature has shown that there are many influencers – drivers, barriers and enablers – in the adoption/diffusion of CE practices within a supply chain, including the relationships between actors. However, the ways in which transaction dimensions in buyer-supplier dyads affect the diffusion influencers in wheat food supply chains is a phenomenon still requiring further study and understanding. |

Given this research problem, the aim of this thesis is to investigate the role that the transactions between organisations in the UK's and Brazilian wheat food supply chains can have in the diffusion of Circular Economy practices.

### 1.4.2 Research questions and objectives

To address the problem and achieve the research aim described in the previous section, the following research questions are outlined:

- What are the main Circular Economy practices in wheat food supply chains in Brazil and the UK?
- What are the material flows, including wastes and by-products, in a wheat food supply chain in Brazil and the UK?
- What are the similarities and differences of the Circular Economy practices between the wheat food supply chain in Brazil and the UK?

While the first three research questions derived from the original intent of the research – the investigation of sustainability issues of wheat food supply chains in Brazil and the UK through CE lenses – the study of relevant literature showed additional knowledge gaps, which the fourth and fifth research questions address, tackling the topic of TCE:

- What are the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated?
- How the characteristics of the transactions between the organisations of the supply chains studied interact with the Circular Economy diffusion influencers?

From the research questions, we derive the following Objectives for the study:

- To identify the Circular Economy practices in a wheat food supply chain in Brazil and the UK.
- To map the material flows, including wastes and by-product outputs, in the wheat food supply chain in Brazil and the UK.
- To compare the similarities and differences of Circular Economy practices between the wheat food supply chain of Brazil and the UK.
- To identify the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated.

- To verify how the characteristics of the transactions between the organisations of the supply chains studied interact with the Circular Economy diffusion influencers.

## 1.5 THESIS STRUCTURE

Besides this current chapter (*Introduction*), this thesis has the following sections: *Theoretical Basis* - comprising of Supply Chain Sustainability, Circular Economy, Circular Supply Chain and Transaction Cost Economics; *Wheat Agro-Industrial Complex in Brazil and the UK* - with the main information of the wheat industry of each country where the research is set; *Research model* – with the conceptual and operations definition as well as the research framework; *Methodology* – with research specification, ontological and epistemological considerations, categories of analysis and research design and delimitation; *Research Findings and Analysis* – containing the Brazilian and the UK cases, their comparisons, the diffusion influencers and the dimensions of transactions, and the influences of transaction dimensions on CE practices adoption; it is followed *Discussion* – organised following the research questions, with the first five sections answering said questions and discussing the findings, and the final section addressing the research problem directly*; Final Considerations* where the research is summarised, and implications for theory (knowledge) and practice are presented, as well as research limitations and suggestions for future studies; *References* and *Appendixes*.

# 2. THEORETICAL BASIS

This chapter presents the literature review of the core subjects that conceptually sustain this thesis. It contains four sections - supply chain sustainability, Circular Economy, circular supply chains and Transaction Cost Economics. In relation to the present research, each section presents a broad view of these subjects that formed the research framework used with subsequent application to the data collection and analysis (Chapters 5 and 6). Given that the structure of the chapter flows from broad to narrow, it is necessary first to comprehend the overall argument around sustainability, presented in the next section. Although the presentation of the WAIC of both countries studied (Brazil and UK) is a key aspect of the context permeating the thesis, it was allocated its own chapter (Chapter 3), following the more theoretical aspects of this thesis, since such structure also keeps the broad to narrow principle.

## 2.1 SUPPLY CHAIN SUSTAINABILITY

Sustainability is an established concern and at the same time, a growing one. This is demonstrated by the number of published documents in the academic literature, by practitioners' outputs (e.g., reports, practices description, strategy implementation, etc.), by governmental guidelines and policies and by the development goals of the United Nations (The United Nations - General Assembly, 2015; The United Nations - General Assembly, 2018).

Although the mainstream discussion on the topic overlaps both the concept of sustainability and the concept of sustainable development, they are not the same thing (Ehrenfeld, 2005). The most widely adopted (Gimenez and Tachizawa, 2012) definition of sustainable development was proposed by the Brundtland Commission report (United Nations, 1987): "*meeting the needs of the present without compromising the ability of future generations to meet their own needs*". The definition provided by the commission also implies that the capacity to maintain sustainable supply and consumption levels needs to be kept without jeopardising food safety and security for current and future generations.

The United Nations General Assembly (over 190 countries) outlined a plan with five critical areas (people, planet, prosperity, peace and partnership) that should reach the 17 goals by 2030 (The United Nations - General Assembly, 2015). This thesis is closer to goals 12 (*"Ensure sustainable consumption and production patterns"*), and 2 (*"End* *hunger, achieve food security and improved nutrition and promote sustainable agriculture"*) (The United Nations - General Assembly, 2015, p.14) since it deals with production and consumption of food in a sustainable way.

Both the term 'sustainable' and the concept of sustainability have a long history of use (Bolis *et al.*, 2014) and are linked to balance (equilibrium) and maintenance of an activity (or process) for an extended period of time. Linking sustainability with sustainable development, Bolis *et al.* (2014) defined sustainable development as:

> "*(...) the kind of development aimed at satisfying the human needs of society as a whole (including future generations) beyond a minimum level, which is enabled by an axiological perspective in decision-making, considering environmental limits*" (Bolis *et al.*, 2014, p.18).

With a more critical view, Ehrenfeld (2005) defines sustainability based on the potential of all forms of life to flourish. In a different approach to reviewing the concept of sustainability, White (2013) identifies the linkage of sustainability with the interaction of different systems and need to maintain it over time. This, in turn, is influenced by a limitation of world resources but a need for growth. Therefore, the author gives the concept of sustainability as the balance of economic, environmental and social concerns (White, 2013).

Reefke and Sundaram (2017) define sustainability in the business context as the balance and integration of economic, social and environmental issues in a manageable way. Sustainability as a concept formed by three pillars - the triple bottom line (TBL) - was first proposed in the seminal work of John Elkington (Elkington, 1997; Gimenez and Tachizawa, 2012). Research on the topic of sustainability has, at times, not looked at the TBL, instead choosing to focus on just one or two aspects of it (Seuring and Gold, 2012; Ashby *et al.*, 2012).

Sustainable development, therefore, is closely linked with a balanced future, while sustainability is linked to balanced concerns and practices to reach said sustainable future. This means that this thesis deals more with sustainability than it deals with sustainable development. Given such a background, for this research, sustainability is defined as follows:

| |
|---|
| The balance between social, economic and environmental concerns and practices that meets present and future needs, without one compromising the other. |

Since the present work deals with a specific type of sustainability, that is, the sustainability of food supply chains, it is essential also to specify what is understood here as a supply chain. As is with sustainability, the definition of a supply chain is also debatable (Kozlenkova *et al.*, 2015; Stock *et al.*, 2010; Reefke and Sundaram, 2017). Textbook definitions vary considerably. Examples include Brennan (2011) who considers it as the procurement and flow of products and information by the transformation system, and Foster (2017) who proposes it as the network of organisations and actions from purchasing of raw materials, transformations of it and deliverance to consumers by the distribution systems. Hill and Hill (2011) adopt a more straightforward stance, defining it as the steps needed to supply a customer with the services or products required.

Professional associations also have definitions of the concept. For instance, the glossary of terms provided by the Council of Supply Chain Management Professionals (CSCMP) has two distinct definitions of supply chain, as follows:

> "*1) starting with unprocessed raw materials and ending with the final customer using the finished goods, the supply chain links many companies together. 2) the material and informational interchanges in the logistical process stretching from acquisition of raw materials to delivery of finished products to the end-user. All vendors, service providers and customers are links in the supply chain*" (Vitasek, 2013, p.186).

Without proper management, the capacity to reach sustainability is jeopardised (Ashby *et al.*, 2012), including in supply chains. The management of supply chains deals with the coordination of activities that are related to it (i.e., logistics, procurement, production, among others). One of the early schools of thought on the subject is the Supply Chain Management (SCM). Stock *et al.* (2010) identified 166 different SCM definitions and classified them in three themes:

a) Activities: 'internal and external networks' and 'material and information flows.
b) Benefits: value-added, customer satisfaction, efficiency creation.
c) Components/constituents.

Stock *et al.* (2010) highlight the network aspect of supply chains, considering part of SCM the establishment of "*networks of relationships between interrelated and interdependent organisations, as well as across business units*" (Stock *et al.*, 2010, p.34). Therefore, supply chains can also be described as a network of organisations that, through production, transformations and exchanges of funds, materials and information, delivers products and/or services to customers. For the present research, by joining both concepts (sustainability and supply chain), 'supply chain sustainability'[1] is defined as follows:

| |
|---|
| The provision of products and/or services to meet customers' needs, through the production, transformation and exchange of funds, information and/or material, by a network of organisations/business units, without compromising future generation's needs, whether they are social, economic and/or environmental. |

Section summary: Section 2.1 presented a baseline discussion of sustainability, including its definition for the present work and the TBL perspective used. It also included a brief presentation of supply chain's definitions and the meaning of supply chain sustainability used in this thesis. It is also essential to understand the state of the art of the supply chain management sustainability and the schools of thought developed so far. This is done to provide the bases that support the current paradigm of research on the topic of CE. The next section addresses such evolution and schools of the topic 'supply chain sustainability', considering primarily papers that conducted systematic literature review thus presenting a broader view on the topic.

### 2.1.1 The evolution of the different schools of thought

Several authors have addressed the development of the link between sustainability and SCM (Ahi and Searcy, 2013; Rajeev *et al.*, 2017), as well as the development of the field (Beske and Seuring, 2014) throughout the last three decades. Consequently, it is possible to construct an evolutionary description of said linkage in the academic research and/or organisational practices as well as frameworks for its understanding. This section presents an analysis of the former – the evolution of the scholarly views of supply chain management and sustainability.

SCM can be considered as an evolution of the fields of Logistics and Operations Management, which went through an expansion of the boundaries of the analysis beyond the frontiers of the organisations[2]. Ashby *et al.* (2012) argue that SCM is an evolution of

[1] This definition is not the same thing as Sustainable Supply Chain Management, a school of thought (both for research and practical application) that will be discussed later in the thesis.
[2] There are at least four views on this subject: Inter-sectionist, Re-labelling, Traditionalist and Unionist (Larson and Halldorsson, 2004). However, this discussion is outside the scope of this thesis.

logistics since it integrates co-operations management with flows of materials and information, adding that the original "motivators" of the field were economic sustainability through increased efficiency and profits, and reduction of risk.

The evolution of SCM research on firm obligations started to identify the companies as responsible for their products and/or services in a broader sense, from product design to product disposal. With the introduction of reverse logistics and closed-loop supply chains, this responsibility increased even more (from cradle to cradle, better discussed in the next section) given that it is expected for the organisations to take part in not just disposal of waste, but also reusing, recycling and remanufacturing (Ashby *et al.*, 2012). Following such rationale, Dubey *et al.* (2017) argued that the development of reverse logistics networks was needed in order to allow the reuse and recycling of products and to increase the use of resources without increasing the carbon footprint or energy required within the supply chain.

Reverse Logistics has several definitions (Agrawal *et al.*, 2015), starting in the late 1980s, and evolving from then on. Among them, both Agrawal *et al.* (2015) and Govindan *et al*. (2015) use Rogers and Tibben-Lembke's (1998) definition[3] of Reverse Logistics in their work. Said concept considers the capacity and the necessity for value creation as well as environmental concern, into the idea of Reverse Logistics.

Activities within reverse logistics encompass the transport and reprocessing of collected products from the consumers back through the supply chain (Cardoso *et al.*, 2013). In a more detailed manner, such activities are comprised of: product acquisition, also called gatekeeping - giving that it is the main starting point for reverse logistics; collection; inspection and sorting; disposition (followed by disposal); repair; reuse; remanufacturing and recycling (Agrawal *et al.*, 2015).

Addressing the TBL, its components and interconnections, as well as balance, is the main way to perceive if something is sustainable or not. All pillars must be present for a practice to be sustainable or analysis to be on sustainability. However, early research on SCM tended to focus on financial or economic aspects of the operations (Beske and Seuring, 2014; Rajeev *et al.*, 2017), even when dealing with waste reduction (Beske and Seuring, 2014). According to Speakman *et al*. (1998 cited by Ashby *et al.*, 2012), SCM

[3] Agrawal *et al*. (2015) also claims that Rogers and Tibben-Lembke (1998, p. 2) definition ("*the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal*") as the most widely used one.

research traditionally looked into risk and cost reduction for procurement, but evolved to include analyses on relationships between organisations/business units for design, research and development (R&D), efficiency gains (optimisation) and management of components of the supply chain, both internal and external. SCM investigates material and information flows, risk, culture and resilience, performance and governance of networks, both internal and external relationships (Ahi and Searcy, 2013; Whiteside and Dani, 2020).

Green Supply Chain Management (GSCM) developed with the inclusion of explicit environmental practices and concerns within the topic of SCM (Beske and Seuring, 2014; Rajeev *et al.*, 2017). Green supply chain management links the traditional concern of SCM (an improvement on costs, benefits and risks through the relationship of firm and suppliers) with ways to manage, reduce or even eliminate waste and other environmental impacts from their operations and products/services (Ashby *et al.*, 2012).

According to Ashby et al. (2012), GSCM started to appear in the academic literature in the early 2000s and differs from the more traditional practices and research on Environmental Management and Environmental Management Systems given that they are constrained to the firms "frontiers".

The incorporation of practices linked to the collection and treatment of products at the end of their life cycle through methods such as recycling or remanufacturing was called Closed-Loop Systems or Closed-Loop Supply Chains (CLSC). Govindan *et al.* (2015) define CLSC as the network resulted from the consideration of forward and reverse logistics simultaneously. A similar definition of CLSC is that it is the supply chain in which forward and reverse logistics are integrated (Cardoso *et al.*, 2013). CLSC could also be defined as logistics systems designed and operated to maximise the value creation to the product during the entire life-cycle of it, with returns and volumes varying in said life-cycle (Barbosa-Póvoa *et al.*, 2018; Govindan *et al.*, 2015).

According to Cannella *et al.* (2016) generally, the processes and costs associated with the return of the products (the reverse logistics) are the responsibility of the manufacturer. The returned products are then processed for correct disposal or reselling, after going through recycling/recovery or remanufacturing, if needed. Research conducted by those authors points out that the more complex supply chain network, the bigger the overall time and cost for the return, reprocessing and remanufacturing of the products. This can be mitigated by transparency between the organisations that are part of the supply chain, if the reduction of the number of participants is not possible (Cannella *et al.*, 2016).

Both GSCM and CLSC put environmental and economic considerations in evidence within their models. Although they can be understood in parallel to each other or linked, they are not the same thing. The differentiation of such schools of thought is necessary both for practical reasons (they have different practices) and research purposes - they are different things but follow similar philosophies in terms of sustainability. The evolution of the discussion and research on GSCM and CLSC, together with the criticism of the lack of analysis of the social constructs within this field, has led to the development of the Sustainable Supply Chain Management (SSCM) by adding the social pillar of sustainability to it (Rajeev *et al.*, 2017).

According to Reefke and Sundaram (2017) both 'supply chain' and 'sustainability' are complex issues, and the different elements that constitute them need to be understood as integrated for truly achieving SSCM. Seuring and Müller (2008) define SSCM as:

> *"the management of material, information and capital flows as well as cooperation among companies along the supply chain while integrating goals from all three dimensions of sustainable development, i.e., economic, environmental and social, which are derived from customer and stakeholder requirements"* (Seuring and Müller, 2008, p.1514).

In a similar consideration, both Ashby *et al.* (2012) and Barbosa-Póvoa *et al*. (2018) argue that environmental and social concerns slowly evolved within the SCM to form the SSCM. Seuring and Müller (2008) identified the triggers for sustainable supply chain management, highlighting the pressures and incentives that stakeholders, governments and customers apply on focal companies. The companies then exert pressure in their suppliers, also creating methods and processes for the evaluation of risk, performance and 'sustainable products'. Therefore, supplier evaluation (criteria, standards required, social and environmental practices, etc.) in SSCM also serves as means to avoid risk and to improve the performance of the whole chain (Seuring and Müller, 2008).

In contrast to this, Barbosa-Póvoa *et al.* (2018) argue that most companies fail at defying tangible measures of adherence to the sustainability of their suppliers and the network that they are part. Barriers to measuring the adhesion of supply chains to sustainability vary from the understanding of what is the full scope of sustainability and sustainable practices of the organisations, to the number of possible methods to undertake such measurements (as well as their complexity). Organisations tend to avoid such complex problems, and this is also complicated by the global size of the supply chain network that most organisations are a part of.

In recent years, some criticism regarding SSCM was developed. Examples include the lack of discussion on pro-sustainability business models, the need for further research in developing countries (Rajeev *et al.*, 2017), the lack of research on the practices of the more polluting industries, (Rajeev *et al.*, 2017) and the need for a better understanding of institutional pressures on sustainable operations (Dubey *et al.*, 2017). This led to new pro-sustainability practices and researches gaining prominence, namely the CE approach. The next section presents the CE and its evolution in the last few years.

Given the information highlighted, mostly based on papers that rely on systematic reviews (Easterby-Smith *et al.*, 2015) of the literature on sustainability and SCM, it is possible to create a simple outline of the evolution of the field considering the last three decades, presented in Figure 2.1. The last point in this outline (Circular Supply Chain Management) is discussed in Section 2.3.

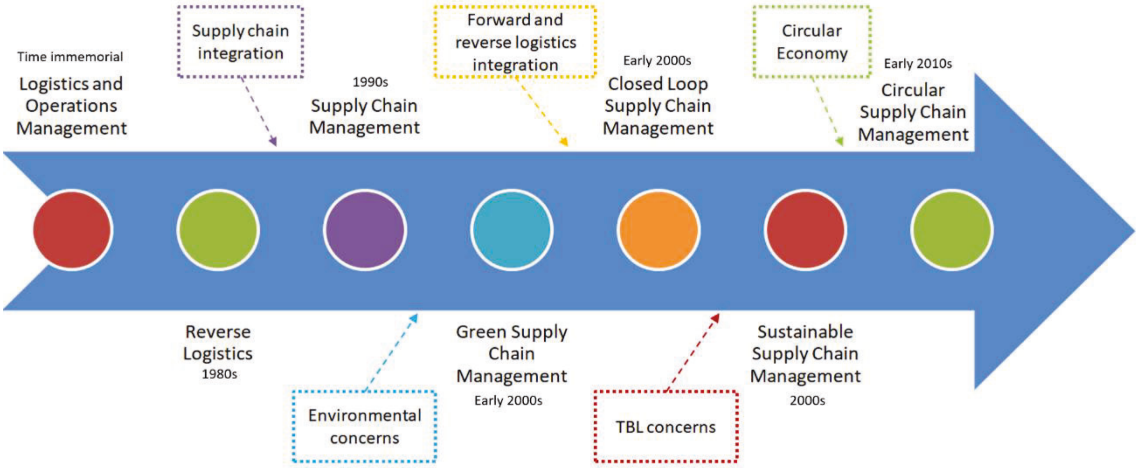



**Figure 2.1** Sustainability and SCM - evolution of the field (source: the author).

<u>Section summary</u>: Section 2.1.1 addressed the evolution and schools of supply chain sustainability. In order, it included SCM, GSCM, CLSC and SSCM. As is with biological evolution, the development of the field into other schools of thought does not eliminate the steps already taken or the development of said steps into the future. This means that research and management practices in all the fields so far, as well as in Circular Supply Chain Management, continues to be developed and generate new areas on related themes not foreseen yet. The next section discusses Circular Economy, its history, defining characteristics and schools of thought.

## 2.2 CIRCULAR ECONOMY

This section discusses first the background the CE, alongside constructs that give support to it, followed by an exploration of some its underlying themes and concepts, outlining at the end the definitions being used to conceptualise CE and the one that was used for this thesis. Several pieces of research (e.g. Ghisellini *et al.*, 2016; Sauvé *et al.*, 2016; Geissdoerfer *et al.*, 2017; Kirchherr *et al.*, 2017) have attempted to clarify the concepts as well as the definitions of CE, showing that this is a complicated issue worth exploring.

Circular Economy has been described in the literature as a school of thought, a new system/industrial paradigm, a new business model and a generic framework for policy, for business models, for relationships and for production (The Ellen MacArthur Foundation, 2013a; Ghisellini *et al.*, 2016; Weetman, 2017; Michelini *et al.*, 2017). Part of the reason for these diverse ways to describe CE is that the overall idea has been developed since the 1970s – with discussions on substituting 'manpower for energy', 'industrial economics and waste costs' and 'potential for value'. The Ellen MacArthur Foundation (2013a), although agree that the major components that influence CE have been gaining momentum since the 1970s, which questions the notion that there is a single author or work that can be described as initiating or proposing CE.

Early influencers of the central philosophy of CE were Walter Stahel and Genevieve Reday in their 1976 report '*The Potential for Substituting Manpower for Energy'* (The Product-Life Institute, 2017) and David W. Pearce and R. Kerry Turner in their 1989 book '*Economics of Natural Resources and the Environment'* (Su *et al.*, 2013; Geissdoerfer *et al.*, 2017).

The early work of Walter Stahel, in what is now understood as Circular Economy, proposes that it is possible to substitute manpower for energy and decentralized workshops for central factories. Stahel (1982) argues for the need to go beyond the take-make-dispose model into a production system that increases product life and cycles of use, thus reducing the amount of waste generated and the resources needed to fulfil demands, as well as the energy needed for its production. The author called this the spiral model. Loops with varied sizes form the spirals. Smaller loops are better than bigger loops (i.e., 1. reuse > 2. repair > 3. recondition > 4. recycle) (Figure 2.2).

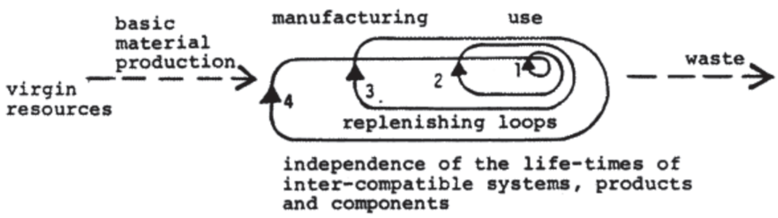



**Figure 2.2** The self-replenishing system (Product-Life Extension) (Stahel, 1982, p.2).

This concept would in later publications (The Ellen MacArthur Foundation, 2013a) be maintained as one of the more critical parts of CE, given its natural result of waste reduction and economic efficiency. Not only that, but it starts to present `R` practices (discussed further along in the thesis) as important for sustainability. The two main components of the Stahel (1982)`s argument are:

a) Products with a longer life cycle might be perceived as more expensive but presents an opportunity for both producing company and clients, and that the private sector should lead the charge for a sustainable society with the consideration that sustainability is also profitable; and

b) Selling service (utilisation) instead of goods is a sustainable business model since it allows continuous profit with reduced risk and waste costs. This concept was later called Performance Economy (Balboa and Somonte, 2014).

The CE as proposed by Pearce and Turner (1989) discuss the environmental inputs to the economy (resource supplier), the waste flows from the economy to the environment (waste assimilator), how both environment and economy interact and the environment as a direct source of wellbeing. It uses the first and second laws of thermodynamics to argue on the cyclical nature of resource as a generator of waste and waste as a source of the resource. This circular flow in the interaction between environment and economy was called 'materials balance model' (Pearce and Turner, 1989)[4].

Waste reduction and waste as a resource have been maintained throughout the development of CE as both a research subject and as a business/policy practice, being one of the core tenants of CE. For instance, CE has also been discussed as a waste management approach (Ghisellini *et al.*, 2016). Connecting with the previous section of

[4] The authors (Pearce and Turner, 1989) also argue that environmental resources (such as the aesthetics of a place) could also be marketable, but does not advances much further this idea, given that at the time of the book publication, there was almost no market for such services/products. This goes beyond the scope of this research, but 3 decades after the publication, such markets have increased in part because of their work.

this thesis, there is an early link between SCM and the need for waste reduction, both for environmental concerns and improved economic profitability (Beske and Seuring, 2014). Therefore, CE and SCM have links that join both ideas since almost their inception.

Urbinati *et al.* (2017) point out that there are four key principles in Circular Economy: **product life extension**, **redistribution/reuse**, **remanufacturing** and **recycling**. In a similar vein, Gladek (2018) proposes that CE has seven pillars that are based on sustaining complexity, diversity and value through resilient systems, for as long as possible, but in a useful manner (Table 2.1).

**Table 2.1** Pillars of Circular Economy

- Incorporation to the economy of materials that maintain the highest possible value throughout different cycles of use;
- Energy from renewable sources;
- Biodiversity maintenance and support throughout human activities;
- Preservation of human society and culture;
- Preservation of health and wellbeing of the ecosystems (humans included);
- Human impact evaluated not only through financial measures, but also aesthetic, emotional, ecological, among others;
- Water extraction must be at a minimum viable rate and cycled through the system as most as possible.

Source: (Gladek, 2018)

Similar to this, Batista *et al.* (2018a) identify three core structures in CE: a) closed and open loops, where products keep being used in the economy through reuse, repair, remanufacture and recycle; b) functionality and experience are preferred over ownership of a product, and c) collaborative and shared consumption models are favoured.

The information presented so far shows that CE can be understood in several ways. To further discuss the development of CE as both a ‘philosophy’ for policy, planning, production and research as well as a ‘framework’ with practical applications, it is essential to highlight the Butterfly Model proposed by The Ellen Macarthur Foundation since it is used in several documents (Weetman, 2017; Batista *et al.*, 2018a; Haanstra *et al.*, 2017; Leube and Walcher, 2017; Sharpe and Giurco, 2018) to outline Circular Economy (Figure 2.3).

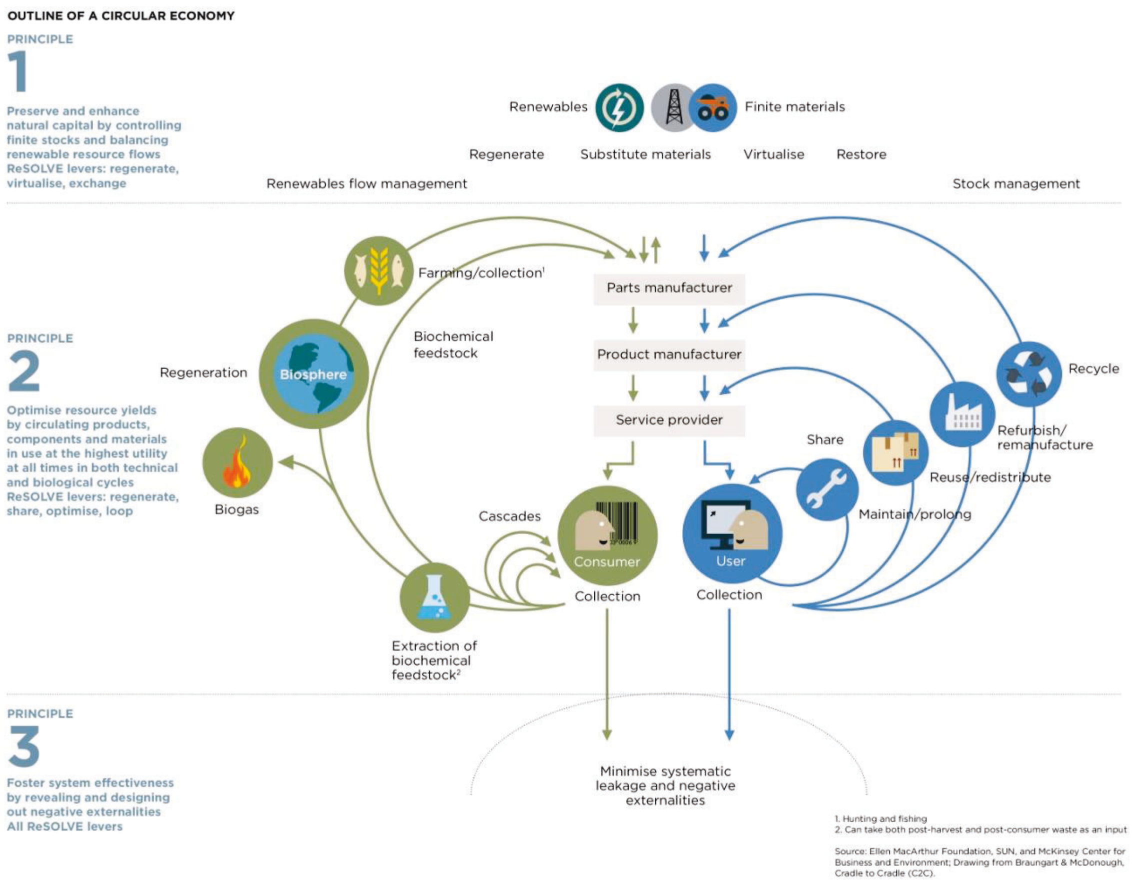



**Figure 2.3** Outline of a Circular Economy (aka Butterfly Model) (Ellen MacArthur Foundation, 2018).

The diagram, known as the Butterfly Diagram because of its two sides (biological and technical), is not a finished work, given that it has been updated from earlier works, nominally the publication 'Towards the Circular – economic and business rationale for an accelerated transition (The Ellen MacArthur Foundation, 2013a, p.24). The diagram is composed of two sides that represent different cycles for biological and technical products, materials etc., and three distinct parts, each linked to three principles of CE:

a) Preservation and enhancement of finite natural resources with renewable resource flows, creating a more sustainable balance between them.
b) Optimisation of resource yields aiming at the highest utility throughout the lifetime of the products, resources and material. This is achieved by the circulation of such items within both biological and technical cycles.
c) Systems optimisation by the eliminating (first revealing and then designing out) negatives externalities, that is, problematic effects caused intra and inter systems.

The principles that underline CE, as presented in the Butterfly Diagram, are formed by different pro-sustainability philosophies or schools of thought that were developed almost concomitant with each other, and alongside CE, thus influencing it. Weetman (2017) highlights the service/performance economy, industrial ecology, cradle to cradle, blue economy and natural capitalism. The Ellen MacArthur Foundation (2013a) also considers those concepts, but adds regenerative design and biomimicry as major influencers of CE as well, with other authors such as Balboa and Somoente (2014) adding *permaculture* and the *natural steps*. Homrich *et al.* (2018) extend the list by identifying Laws of Ecology and Industrial Metabolism, industrial symbiosis and eco-parks.

Section summary: Section 2.2 presented the evolution of CE, the initial contributors to it, its main pillars (e.g., closed and open loops of materials that avoid waste, service over ownership, restorative and regenerative practices, renewable energy use, etc.) and the Ellen MacArthur Foundation. It is important to briefly discuss each of the schools of thought of CE and its definitions since these elements foster a better understanding of the background that gives support to CE as a pro-sustainability framework. The next section presents a summary of some of the major influencers of CE in its current format. Considering the importance of The Ellen MacArthur Foundation to CE, their analysis served as guide to that end. A discussion of CE definition and criticism of the CE paradigm are also included.

### 2.2.1 CE schools of thought and definitions

Different authors have different concepts of CE. In the same fashion, it is also possible to identify in the literature, several works and overall philosophies that are described as circular and/or influencing CE (Homrich *et al.*, 2018). In this sense, a list of some of the more frequently cited is shown below, summarising each one and aiming at better understanding CE as a supra-philosophy, since it covers more than one pro-sustainability philosophy/school of thought.

- Service/performance economy:

The service economy is the substitution of products purchasing for service hiring, delimitated by previously agreed performance standards, thus deriving the name of performance economy (The Product-Life Institute, 2017). In a Product Service System (PSS), an economic transaction can be from one extreme (pure product) to another (pure service) with several possibilities in the middle, such as servitisation (integration of services and products) (Batista *et al.*, 2017; Lazarevic and Valve, 2017). A service economy as discussed within CE lenses changes the perspective of customer ownership of products to customer contracting services that attend its needs, going from pay-per-own to pay-per-use, pay-per-result or pay-monthly (i.e., leasing/renting). Sale of products are no longer considered a top priority, but the retention of paying clients is (Urbinati *et al.*, 2017; Leube and Walcher, 2017). This puts the focus of the business model in demand fulfilment rather than product sales (Haanstra *et al.*, 2017) or in profit rather than demand (Farsi and Erkoyuncu, 2021). De Angelis *et al.* (2018) argues that the increase in environmental awareness, information and communication technologies use, and geographical dispersion, increases the potential for services over products.

The performance economy, also called 'functional service economy' as proposed by Walter Stahel (Balboa and Somonte, 2014; Weetman, 2017) also include pro-sustainability innovations in technical, commercial and systems design and proposes four aims in such an economy: "*product-life extension, long-life goods, reconditioning activities and waste prevention*" (The Ellen MacArthur Foundation, 2013a, p.26).

- Industrial Ecology:

Industrial Ecology can be defined as a systems science that is concerned with understanding and improving material and energy flows in relation to industry systems (Chertow, 2008; The Ellen MacArthur Foundation, 2013a). According to Ghisellini *et al.* (2016), the Industrial Ecology perspective sees industrial and environmental systems as linked (joint eco-systems), while previous views perceived them as separate. Industrial Ecology looks into flows of materials, energy, information between organisations as well as resource extraction from the biosphere.

In this sense, the connection between organisations (or different divisions of one organisation) is important, because it allows the transfer/exchange of energy, water and materials (including waste and by-products), thus making undesired outputs into desired inputs for other types of operations (Batista *et al.*, 2015b).

They usually occur within close geographic proximity and with economically independent industries, although geographically distant and/or financially linked organisations can be a part of a symbiotic relationship (Yu *et al.*, 2014; Herczeg *et al.*, 2018). An outline of the levels that Industrial Ecology operates can be seen in Figure 2.4, as proposed by Chertow (2008, p.4).

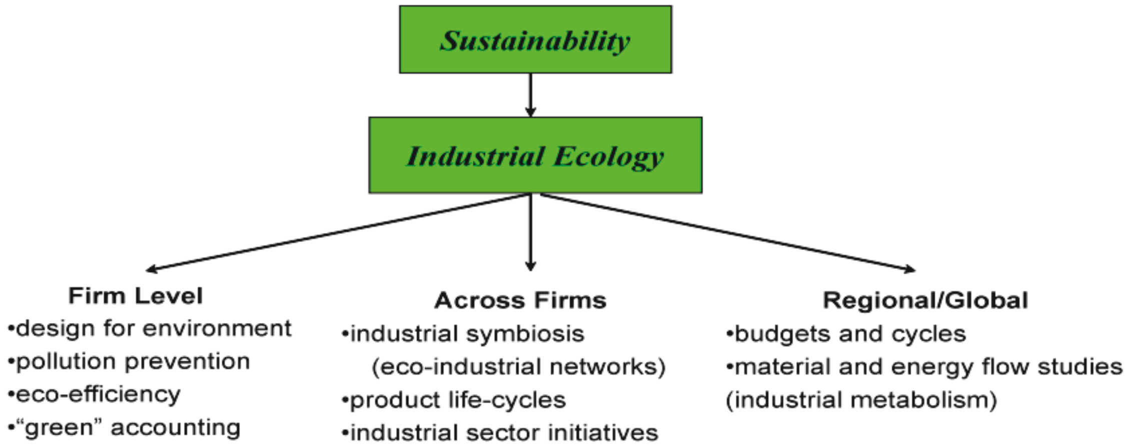


**Figure 2.4** Industrial ecology operates at three levels (Chertow, 2008, p.4).

- Cradle to Cradle:

Cradle to Cradle (C2C) is a design and science philosophy that proposes the development and use of products, components, materials and energy in a circular perspective. This generates technical and biological 'nutrients', maintaining its usefulness not only throughout its lifecycle, but also after its life, eliminating the concept of waste and emulating natures and the cycles that occur in the biosphere (Jawahir and Bradley, 2016; McDonough, 2018a; Korhonen *et al.,* 2018a).

C2C philosophy is credited to Michael Braungart and Bill McDonough (The Ellen MacArthur Foundation, 2013a; Balboa and Somonte, 2014; Jawahir and Bradley, 2016) with the publication of the Hannover Principles (McDonough and Braungart, 1992; McDonough, 2018b)[5] that include the elimination of the concept of waste, the need for redesign of products and extended life-time (and use) of materials. Overall, designing products and components with C2C means bringing technical developments (such as electronics or machinery) closer to the biosphere natural cycle of transformation, therefore changing the flow of the current production of industrial goods (Balboa and Somonte, 2014).

[5] Walter Stahel also claims to be one of the proponents of this school of thought (The Product-Life Institute, 2017) given his 1986 proposal of cradle-back-to-cradle

C2C, as an eco-design framework has three guidelines for the eco-effective creation of products that aim at positive impact, instead of just reduction of adverse effects (Braungart *et al.*, 2007; The Ellen MacArthur Foundation, 2013a; Balboa and Somonte, 2014; McDonough, 2018a): everything is a resource for something else, use clean and renewable energy, and celebrate diversity as different places have different design needs that should be considered and adapted (McDonough, 2018a).

- Blue economy:

Blue Economy can be described as a philosophy of entrepreneurship, innovation and management that emphasises a nature-based business model for a sustainable future. The Blue Economy was initiated in 2004 by Gunter Pauli as the practical application of the Zero Emissions Research Initiative (ZERI) (Pauli, 2016a).

According to Weetman (2017), there are two themes present in the Blue Economy: i) substitute something for nothing; and ii) cascading nutrients and energy. It is possible to argue that in the Blue Economy, the business model must go beyond a search for standardised production and cost reduction through economies of scale. Firms must search for innovations that generate multiple benefits, such as more jobs and environmental benefits, and therefore, not just increased profits, but a TBL approach (Pauli, 2016b; Weetman, 2017). For this, Blue Economy highlights the importance of diversifying revenue sources, with nature as a symbiotic partner of firms. Blue Economy also relies on new firms that use on inputs sourced from local economies, with locally available natural resources and influenced by the local culture, eliminating everything that is not needed (Pauli, 2016b; Weetman, 2017).

- Natural Capitalism:

Natural Capitalism is a proposal for a “new industrial revolution” where economic (business) and environmental interests are superimposed on each other, thus making profits and ecological improvements possible simultaneously, and depleted natural capitals stocks[6] and environmental systems[7] are restored and

[6] Natural capital stocks: natural resources like water, minerals, oil, trees, fish, topsoil, air, among others.
[7] Ecological systems:  coral reefs, savannas, wetlands, forests, grasslands, etc.

regenerated (Hawken *et al.*, 1999; The Ellen MacArthur Foundation, 2013a; Balboa and Somonte, 2014; Weetman, 2017).

Natural Capitalism was first proposed by Paul Hawken, Amory Lovins and Hunter Lovins and has four interlinked principles (Hawken *et al.*, 1999): increase productivity of natural resources; use biological models as the basis for business, operations, products and materials; service (flow) business models; and reinvest in natural capital (Hawken *et al.*, 1999; The Ellen MacArthur Foundation, 2013a; Balboa and Somonte, 2014; Weetman, 2017). It is possible to summarise Natural Capitalism as the need for a modification of systems design using innovative technologies and better practices to correct problematic allocation of capital and governmental policy (Weetman, 2017).

- Regenerative design:

Regenerative design can be defined as an approach to design that goes beyond sustainability (seen as maintenance) in favour of a regenerative approach that improves on the current state of eco and human systems (Motloch, 1995; The Ellen MacArthur Foundation, 2013a; Brown *et al.*, 2018). It means that design (of processes, of landscapes, of products, etc.) must strive to regenerate the eco-system where they are situated (The Ellen MacArthur Foundation, 2013a; Balboa and Somonte, 2014).

Developed by John Lyle in the 1970s and with the hallmark publication of the book '*Regenerative Design for Sustainable Development*' in the early 1990s, the regenerative design was influenced from the start from the idea of regenerative agriculture, but argues that regenerative systems must go beyond that (Motloch, 1995). Therefore, the concept of regenerative design encompasses all aspects of life, not only human society, but also animals, plants, and ecological systems. Regarding agriculture, Lyle argues that water usage is a concern that must be dealt with, given the potential for water scarcity in the future. For the author, regenerative agriculture revitalises the soil, maintains diversity, controls pests, integrates animals, as well as farming and economic and social systems, also adapting markets to ecological circumstances (Motloch, 1995).

It is important to stress that regenerative design is not limited to the unit of design being worked on, but to the overall system where it is inserted. For instance, if a new type of biscuit (or a re-design of an existing one) is being developed through the regenerative design school of thought, all the aspects of its production - from the wrapping to the inputs used in the wheat production and the logistics of it, must be considered and worked on (Motloch, 1995; Balboa and Somonte, 2014; Brown *et al.*, 2018).

- Biomimicry:

Biomimicry can be defined as having Nature as a model to be learned, copied and/or adapted to solve human problems. The word Biomimicry is derived from the Ancient Greek: bio for life and mimicry for imitation. It is, therefore, possible to assert that biomimicry is an ancient concept, since humanity has been following Nature`s example for millennia (Benyus, 1997; Biomimicry Institute, 2018b). From milk production to housing, and even aeronautics (such as Leonardo da Vinci's design), Nature is a part of humanity source of knowledge.

The term biomimicry, as a pro-sustainability school of thought, has gained traction with the work of Janine Benyus, namely with the publication of the book "*Biomimicry: innovation inspired by Nature*" (The Ellen MacArthur Foundation, 2013a; Dicks, 2016; Fisch, 2017; Biomimicry Institute, 2018a). For the Biomimicry Institute, founded by Benyus, the definition of Biomimicry is "*an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies*".

Weetman (2017) considers that, with the schools of thought discussed above, three key elements for CE arise: **business models**; **materials and product design**; and **circular flows**. It is also possible to argue that nature as a model is part of several schools of thought, and that waste should be used productively.

While these points of intersections exist and there is considerable overlap in the concepts presented so far, some differences can be pointed out (Figure 2.5). To call such elements 'differences' does not mean that they are not given in other schools of thought, instead, that they are more strongly discussed or highlighted in each school. Identifying these points is useful to understand the influences that each one of the described concepts above play on CE.

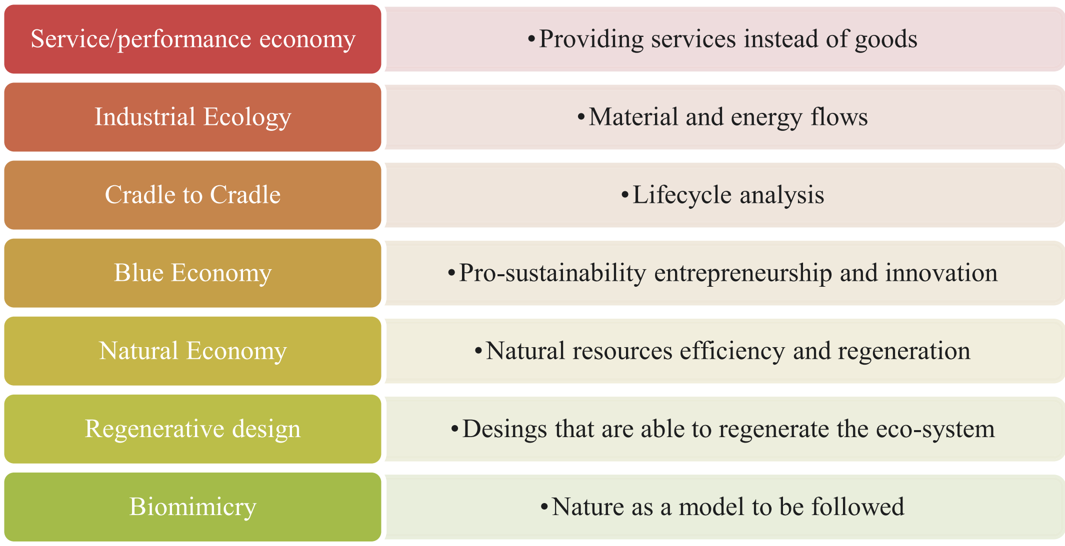


**Figure 2.5** Different emphasis of the CE schools of thought (the author).

It is possible to consider that organisations operating with pro-sustainability practices and that follow such principles (e.g., circularity, product-life extension, waste as a nutrient, nature as model, etc.) can be classified within the CE scope. Given that CE is a highly detailed framework, organisations might need to adapt these practices, and therefore not necessarily having all the points presented in their operations.

Going beyond the schools of thought that form CE, different management practices in operations have also approached CE in recent year, for example, Lean and Waste Management (Pires and Martinho, 2019; Gebremikael *et al.*, 2020). Those management practices tend to have a considerable amount of overlap with CE, although they tend to differ in some respects. For instance, in the case of Lean, optimisation (especially reduction of waste), continuous improvement and servitisation are similar elements present in both fields (Romero and Rossi, 2017; Nadeem *et al.*, 2019). On the other hand, the circularity of materials, the use of waste as a resource and the focus of the disciplines differ between CE and Lean (Romero and Rossi, 2017; Nadeem *et al.*, 2019). This thesis does not, however, further explore other disciplines as it focuses on CE and TCE and doing so would result in a diversion from the scope of the research.

It is relevant to make clear the definition of CE so the risk of confounding practices, concepts and behaviours are minimised (Kirchherr *et al.*, 2017), both for the thesis itself, as well as for any communication of the findings. Appendix B presents some examples of definitions found in both peer-reviewed and not peer-reviewed sources (reports, books, websites, etc.). The list is not intended to be in-depth nor a comprehensive presentation of the topic, but to serve as an illustration of the variety of definitions possible for CE.

These examples were selected given that they represent significant influences in other definitions - such as the Ellen MacArthur Foundation definition[8] (Kirchherr *et al.*, 2017; Geissdoerfer *et al.*, 2017) - or that they are consolidations of definitions for both overall analyses of the topic or criticism of it. For a complete analysis of CE definition, see Kirchherr *et al.* (2017), where the authors analysed 95 different ones out of 114 identified.

The definitions shown in the appendix are quite varied from one to the other. It is possible to conclude that CE definitions (and practices in a more pragmatic sense) are still being developed. This proposition is supported by Sauvé *et al.* (2016). According to Gladek (2018), no organisation has the monopoly over the definition of CE. It is possible to identify overall themes that encompass the schools of thought, philosophies and framework of CE - and that it is linked with this thesis - thus proposing a definition linked to food supply chains as follows:

> Circular Economy can be defined as the economic system that by intention and design, moves past the make-use-dispose model, in favour of an approach with loops, both open and closed, that maximises utility and/or value of technical and organic products, components and materials, and that through operational practices, business models and governmental policies, helps to pave the way for a sustainable, restorative and regenerative triple bottom line development.

The definition proposed here allows for an understanding of CE that goes beyond industrial systems, as it includes business models, human decisions and governmental policies. As an economic system, it encompasses the economic and financial needs that organisations have, especially companies (profit, cost reduction, contractual obligations, etc.). It also considers the need for a balance and an improvement of all the pillars of sustainability (economic, social and environmental) by including strategic changes (business models, R&D, policies, etc.) and better operational practices. The definition considers both technical and biological, thus having food supply chains encompassed. In a similar sense, with both open and closed loops, maximisation of utility and value are highlighted, and waste and by-products practical usage are also considered.

Despite CE and its related concepts being beneficial to sustainability, it is not

[8] The definition provided by The Ellen MacArthur Foundation links Circular Economy to restorative and regenerative practices.

necessarily equal to it, nor conditional to it (for more information on the potential relationships between CE and sustainability, see Geissdoerfer *et al.* (2017)). Therefore, in this thesis, CE is not seen as conditional to sustainability, but helpful to it and often overlapping with it.

To better understand CE, it is useful to understand the limitations of CE according to the literature. Korhonen *et al.* (2018a) criticise the most common definitions of CE, arguing that they are confusing and not scientifically well constructed.

The natural linkage of CE and Sustainability is also disputed by some authors, as identified by Geissdoerfer *et al.* (2017). These authors organised such views (the linkage between CE and sustainability) in three different dimensions: CE as necessary (conditional) for sustainability; CE helping sustainability (beneficial); or CE having trade-offs with sustainability (it can harm and support different aspects of the TBL). Geissdoerfer *et al.* (2017) identified 12 similarities between both subjects (CE and Sustainability), presented in Table 2.2 and showed that several of the discussions surrounding one concept can also affect the other (including barriers, drivers and enablers). CE and Sustainability differ in other respects, such as the origins of the term, institutionalisation methods for wide diffusion and prioritised systems (Geissdoerfer *et al.*, 2017).

**Table 2.2** Similarities between sustainability and the Circular Economy

| | |
|---|---|
| a) | Intra and intergenerational commitments |
| b) | More agency for the multiple and coexisting pathways of development |
| c) | Global models |
| d) | Integrating non-economic aspects into development |
| e) | System change/design and innovation at the core |
| f) | Multi-/interdisciplinary research field |
| g) | Potential cost, risk, diversification, value co-creation opportunities |
| h) | Cooperation of different stakeholders necessary |
| i) | Regulation and incentives as core implementation tools |
| j) | Central role of private business, due to resources and capabilities |
| k) | Business model innovation as a key for industry transformation |
| l) | Technological solutions are important but often pose implementation problems incentive |

Source: (Geissdoerfer *et al.*, 2017, p.764).

According to Korhonen *et al.* (2018a), part of the overall problem with CE is that the concepts and definitions of it are being generated mostly by business practitioners as well as policy-makers, making them superficial and lacking critical analysis. This is because they are a collection of semi-scientific concepts or pieces of scientific fields of study. The same authors identified six limits to CE (i.e., thermodynamics, systems boundary, physical economic growth, path dependency and lock-ins, governance and management, social and cultural definition) and some challenges that are hampering the adoption of CE in a wider scale such as different people, organisations and cultures, define waste in different ways.

It is valid to expand on Korhonen *et al.* (2018a) six challenges of CE. The Second Law of Thermodynamics (which relates to entropy) imposes a limit on recycling given the need for energy and the generation of waste in such operations. In other words, it is (physically) impossible to continuously recycle all materials. The second challenge relates to spatial and temporal systems boundaries. Simply put, much of the world's production functions is in global supply chains, but CE mostly operates in local or regional levels, thus creating a gap in the net global sustainability considering the CE perspective. The third issue of CE relates to the potential increase in production/consumption, given the rise in the understanding that these products are more sustainable. This issue can also be called the rebound effect, Jevon's paradox or boomerang effect. The fourth challenge relates to path dependencies or lock-ins, where an economic innovation (including uses of recycled product) will create a set of constraints that tend to keep it within the same path (e.g., existing infrastructure and operations, investments made, established relationships, etc.), thus reducing the possibility of change in favour of CE. Intra versus inter-organisational strategy and management is the fifth issue, as CE requires multiple actors working together, thus sometimes conflicting with a single player's individual strategy and operations. Finally, the definitions of physical flows can differ based on the history or culture of the individuals' part of the CE flow. In other words, waste for one context might not be considered so in another cultural context. It is thus imperative to address the different perspectives when investigating such topic.

Zink and Geyer (2017) outlined another critical perspective of CE. The authors discuss the rebound effect from CE adoption in terms of production increase and materials/energy use by the increase in CE practices, therefore reducing the positive impacts (in environmental terms) of such practices. The authors also consider that even though the CE can be a school of thought, it also has different schools of thought within itself that vary from intended outcomes and desired implementation strategies, therefore making the CE diffusion complex and facilitating adverse outcomes. Said authors focused mostly on the waste aspect of CE, but barely considered other components of the CE such as the proposal for new business models with reduced ownership (sharing, pay per use, lease, etc.) of services and products or the selection of partners (suppliers, clients, etc.) with sustainability-related requirements. However, such issues with CE criticism are common (Geissdoerfer *et al.*, 2017), given that most authors centralise the arguments around CE in said aspects (resource input, waste and emission outputs).

Section summary: Section 2.2.1 presented a brief description of the CE schools of thought: Service/performance economy; Industrial Ecology; Cradle to cradle; Blue economy; Natural Capitalism; Regenerative design; Biomimicry. The section also presented the definition of CE used in the thesis, some of the criticism towards CE and the overlap between CE and sustainability. Considering the information given so far, it is important now to organise the practical features of such concepts, beyond the elements that the Ellen MacArthur Foundation has laid out and developed. The next section summarises the Circular Economy practical framework with examples of operations that companies might consider for their operations and that are aligned with CE.

### 2.2.2 CE practices

The information discussed so far presents a broad view of CE and the schools of thought that form the core of the philosophy of CE. However, CE is also a framework, and therefore it is important to present how organisations might apply it to their operations.

One of the major ways that companies are implementing CE into their business models and operations is by providing a service instead of selling a product (Batista *et al.*, 2017). This is part of the idea of service/performance economy, that reduce the need for resources, waste generated, idle time of products, etc. (Michelini *et al.*, 2017; Batista *et al.*, 2017; Yang *et al.*, 2018). Several examples of this can be found, such as leasing/rental of cars, contracting services such as providing light (instead of selling lightbulbs), operational hours of flight (instead of engines), car-sharing (instead of ownership of a car) (Stahel, 2016; Weetman, 2017; Batista *et al.*, 2017).

Another possibility is what is known as R practices, the most well-known being the 3R's: reduce, reuse, recycle (Jun and Xiang, 2011; Govindan and Hasanagic, 2018). As the discussion on sustainability and supply chains evolved, a greater collection of 'Rs' was added, from 6Rs (Jawahir and Bradley, 2016), 9Rs (Kirchherr *et al.*, 2017), and above, encompassing other concepts such as recover, redesign, remanufacture, refurbish, etc. This makes it necessary to clarify those aspects since they are related to the overall framework of CE. The terms discussed below should not be understood as all-encompassing, given that the CE framework is still being developed and new 'R concepts' are currently being generated. These terms were selected because they were identified in more than one of the cited publications in this thesis and/or they can be connected to agri-food supply chains. Furthermore, the following list (Table 2.3) is not presented in particular any order.

**Table 2.3** 'R practices' linked to Circular Economy

| 'R Practice' | Description | Sources |
|---|---|---|
| **Reduce** | To use fewer resources for the creation (first phases of the lifecycle) of products, components or materials, therefore creating less waste than before. It is thus connected to the reduction of negative externalities, or in other words, the reduction of resource usage in a way that diminish negative consequences for welfare and environment. | (Jawahir and Bradley, 2016; Kirchherr *et al.*, 2017; EPA - Environmental Protection Agency, 2018). |
| **Reuse** | It is using a product, component or material in the same way and purpose that was originally intended, without modification. Other authors consider that it must be more specific by arguing that the product must have been previously discarded and then used by a different consumer than before. The product or material has to be in good condition and fulfil the original function. | (Weetman, 2017; Kirchherr *et al.*, 2017) |
| **Recycle** | It is the extraction (scrap) of raw materials from a product and using said materials in new products. These materials can be high grade (same as before) or low-grade quality. Recycling is the most common practice linked to CE. | (Stahel, 1982; All-Party Parliamentary Sustainable Resource Group, 2014; Weetman, 2017; Kirchherr *et al.*, 2017) |
| **Redesign** | It is using an existing product, service tor process to develop a new one. It is one of the levels of eco-design (industrial way of developing products with a pro- | (Balboa and Somonte, 2014; Weetman, 2017) |

| | | |
|---|---|---|
| | environment mindset), alongside product enhancement, new product innovation and new systems innovation. | |
| **Repair** | It relates to maintenance to prolong a product or components lifecycle and therefore its availability to the overall system as well as the capacity of a product to fulfil its original objective after it has been maintained because of a defect. | (All-Party Parliamentary Sustainable Resource Group, 2014, p.2; Weetman, 2017, p.384; Evans and Bocken, 2013; Kirchherr *et al.*, 2017) |
| **Redistribute** | Changing products, components or materials from one market where they were not demanded (not needed) to another place where there is demand (they are needed). | (Weetman, 2017) |
| **Remanufacture** | It is the return of a used product to its original performance and appearance, for it to recapture the value to the material as it was when produced initially, and with a warranty at least equivalent of a new product. It is procedural by nature of given its serialised steps. Another possible definition is the production of a new product or component (with the same functions) using parts of discarded products. | (Evans and Bocken, 2013; All-Party Parliamentary Sustainable Resource Group, 2014; Weetman, 2017; Kirchherr *et al.*, 2017) |
| **Recover** | The term recover presents two distinct definitions in the CE literature: one connecting it to the recovery of products and components for processing and further use and another material incineration for energy recovery. | (Jawahir and Bradley, 2016; Kirchherr *et al.*, 2017) |
| **Refurbish** | Refurbishes are mostly aesthetic improvements (to make it look as new) but without improvements on functionality or to an "as new" state. Some authors dispute this concept since they argue that the product is returned updated. | (Evans and Bocken, 2013; All-Party Parliamentary Sustainable Resource Group, 2014; Kirchherr *et al.*, 2017) |
| **Recondition** | It is to turn an existent product, component or material back to a state of usefulness (working order), but not necessarily to its original specs (brand-new). It is different from refurbishing because it does not place greater importance on the appearance of the product (as the previous one did), only in its functionality. | (Stahel, 1982; All-Party Parliamentary Sustainable Resource Group, 2014; Weetman, 2017) |
| **Reclassify** | It is the identification of additional value in materials, products or components that are approaching the end of its life cycle, thus allowing further use or reuse. | (Ghisellini *et al.*, 2016; Vasconcelos *et al.*, 2018) |
| **Repurpose** | It is the transformation of discarded products, components or materials to a new purpose or use, from | (Weetman, 2017; Kirchherr *et al.*, 2017) |

| | | |
|---|---|---|
| | what it was originally designed or planned. By this definition, repurpose differs from reclassification because the latter does not require transformation. | |
| **Renewable** | It is the use of renewable energy based on non-fossil fuel energy such as wind and solar-powered sources. | (Ghisellini *et al.*, 2016; Vasconcelos *et al.*, 2018) |

Given the present research focuses on wheat (a type and an input of food), and that the R practices presented in Table 2.3 tend to have their origins from the industrial (technical) sector, not all the concepts presented above are useful for this thesis. Because of this, Section 2.2.4 identifies which of the Rs are better suited for organisations linked to food supply chains and their practices. However, the identification of the CE practices present in wheat food supply chains in Brazil and the UK is the first research question of the present thesis. This is because the identification of sustainability issues through CE lenses, requires first that the CE operations in each case be identified and described to make it clear if there is CE in such contexts. No previous work has tackled the topic of identification and description of CE practices throughout wheat food supply chains, thus presenting a gap in the academic research that is addressed in the present investigation. This is discussed in more detail in section 2.5.

Govindan and Hasanagic (2018) identified a series of practices coming from different stakeholders (consumers, society, suppliers, the organisation and the government) that look into the external or the internal environment of the supply chain. The practices were clustered into eight groups: a) Governance initiatives; b) Economic initiatives; c) Cleaner production; d) Product development; e) Management support; f) Infrastructure; g) Knowledge; and h) Social and Culture. Another approach was described by Masi *et al.* (2018), with six clusters: a) resource and energy utilisation efficiency; b) investment recovery; c) eco-design; d) green purchasing; e) customer cooperation; f) internal environmental management. Most of the operational practices discussed in Table 2.3 have parallels with these clusters identified in these two papers by Govindan and Hasanagic (2018) and Masi *et al.* (2018), with the exception of the following:

- Performance measure of indicators regarding CE practices adopted into the operations (audits).
- Setting the right price for the product (more expensive products, even if complying with CE, are less likely to be purchased) .
- Cleaner purchases from the suppliers.

- Cooperation with other organisations to use CE practices.
- New pathways of logistics systems.
- Education and training to staff and managers.
- Environmental certifications (e.g., ISO 14000).
- Targeting the market of "green customers".

Another important aspect to consider when discussing CE practices, is how they relate to one of the core tenets of CE: waste. Some examples of Waste Hierarchy Models are shown in Figure 2.6. It is possible to identify the overlaps between waste hierarchy models the 'R practices' discussed above.

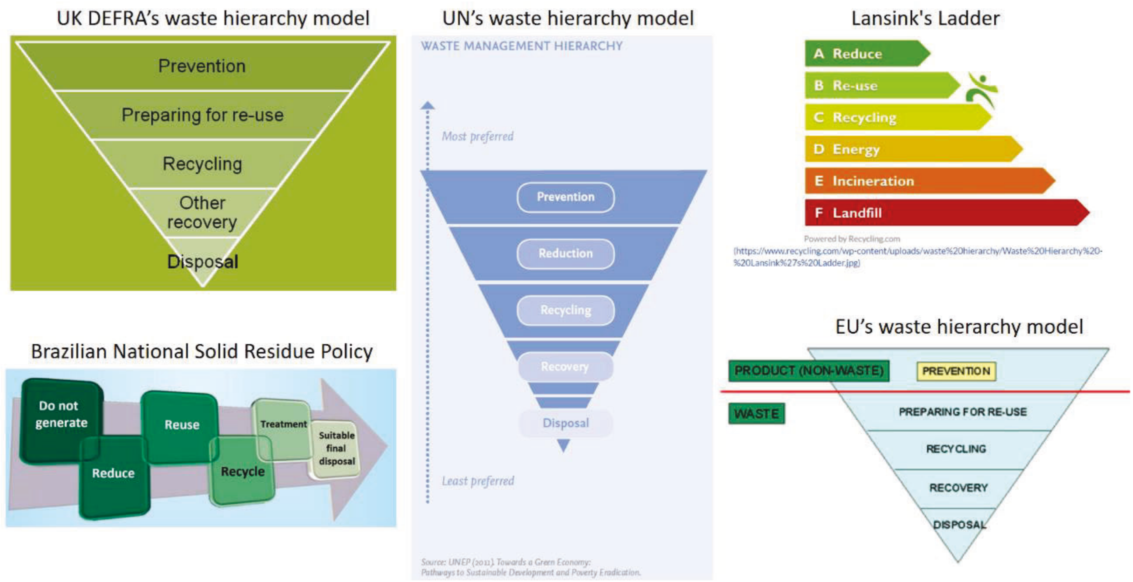



**Figure 2.6** Examples of waste hierarchy models (European Commission, 2008; DEFRA - Department for Environment Food and Rural Affairs, 2011; Ministerio do Meio Ambiente - Brasil, 2011; Hyman *et al.*, 2013; Lansink, 2018).

The waste hierarchy models presented above were based on the 1979 Dutch government policy proposed by Ad Lansink, that identifies various kinds of waste treatment options, ranking them from more desirable to least desirable, considering material and energy loss from cascading effects. This means that from the top options (i.e., reduce, reuse), to the bottom ones (i.e., incineration, landfill) there is a hierarchy of desirability, where the disposal is the least preferred. This system, even though presenting some flaws (such as costs and social impact), was adopted by other countries and supranational bodies like the European Union and the United Nations and became part of the recommended approach to dealing with waste (Braathen, 2007; Wolsink, 2010).

Section summary: Section 2.2.2 presented a set of the CE practices ('R practices' plus a few others) and their definitions as identified in the literature. However, CE is sometimes delimited by the idea of the 3Rs motto (reduce, reuse, recycle), the other practices cited in so far present pro-sustainability aspects that are also in accordance with CE. Additionally, the waste hierarchy model was also discussed, considering that there is overlap with the 'R practices' and that waste is one of the main aspects of CE. It is relevant now to consider the process of CE practices adoption by organisations and diffusion within a supply chain. For this, the next section delves into such issues.

### 2.2.3 Influencers of CE diffusion

Having discussed the formation of CE philosophy, and examples of CE practices, this section presents influencing factors in the diffusion of CE practices. These factors can be barriers, drivers and enablers of adoption. Even though adoption and diffusion are not the same things, they are intimately related. According to Rogers (1983), adoption is the decision to use an innovation; likewise, Kee (2017) defines adoption as the decision to implement, discontinue and/or modify a new object, technology, behaviour, practice, program or idea.

An actor adopts new practices in a given social setting (or system), defined by Rogers (1983, p.24) as "*a set of interrelated units that are engaged in joint problem solving to accomplish a common goal*". For this thesis, wheat food supply chains are the social systems. Diffusion (Rogers, 1983; Kee, 2017) is the communication process by which an innovation spreads in a social system, through certain channels, over time. In other words, adoption relates to one unit of decision-maker changing its operations, products or services, while diffusion relates to more than one in the same setting.

The definitions of barriers and drivers for this research were based on those presented by Jesus and Mendonça (2018):

| |
|---|
| Circular Economy drivers are factors that motivate the transition to CE practices. |

| |
|---|
| Circular Economy barriers are impediments or bottlenecks that obstruct the transition to CE practices. |

It is possible to have one or more barriers and drivers at the same time, that jeopardise or motivate (respectively) the adoption of CE practices by firms and its diffusion within supply chains, industrial sectors or economies (Jesus and Mendonça, 2018). Another possibility is the impact that an issue might have in terms of direction (Jesus and Mendonça, 2018). In other words: a barrier can become a driver if the set of conditions change. For instance: a technical problem, once solved, might become a driver for other CE practices.

As there are motivators and bottlenecks to the transition to CE, there are also factors that facilitate the process. These enablers are defined as follows for this research:

| |
|---|
| Circular Economy enablers are operational, organisational, institutional and/or cultural elements that facilitate, speed, increase the interest (or need) and/or reduce the risks and/or costs of adopting CE practices. |

As Kirchherr *et al.* (2018) point out, it is not easy to implement CE, whether it is in an organisation, a supply chain or an economy; hence the discussion of barriers takes precedent over drivers or enablers. Kirchherr *et al.* (2018)'s research identified 15 barriers, divided into 4 clusters (Kirchherr *et al.*, 2018, p.268), plus it characterised the connection between the barriers, as well as the most important (key) and how concepts can function as bases for others (shown on Figure 2.7), where the superposition of one barrier over the other, identifies the earlier steps to the later ones (e.g., operating in a linear system is the cultural basic barrier that support the others in that cluster):

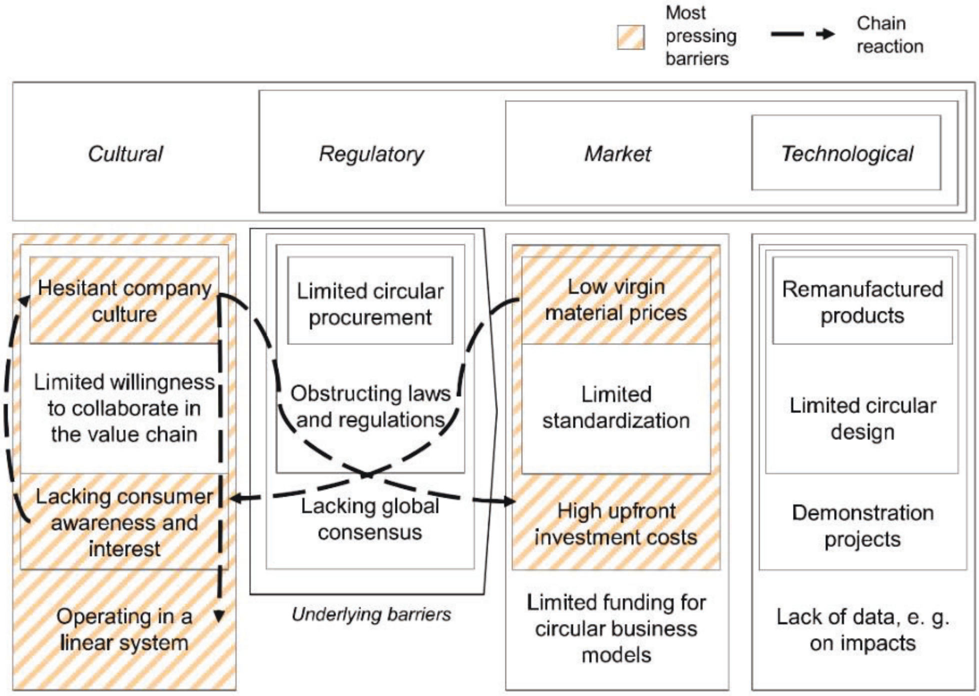



**Figure 2.7** Key CE barriers and their interaction (Kirchherr *et al.*, 2018, p.270).

Govindan and Hasanagic (2018) identified a set of barriers through a systematic literature review that examined 60 articles and clustered the barriers into 8 groups (Table 2.4):

**Table 2.4** Clusters of barriers for the adoption of CE practices

| | |
|---|---|
| a) **Governmental issues** – Examples include the lack of standards for performance assessment, inefficient policies regarding recycling, lack of coordination and existing laws that do not support CE. | e) **Management issues** – priority of the organisation (top managers or other structures in the organisation) is elsewhere, reducing support for these practices. |
| b) **Economic issues** – financial and economic difficulties to implement CE practices, e.g., high short-term costs with low short-term profits even without taking externalities into account; weak stakeholders incentives; difficulties in establishing correct prices for CE products. | *f)* **Circular Economy framework issues** – framework might be too confusing and/or contradictory; other solutions might be easier/cheaper to implement. |
| c) **Technological issues** – technical problems that are difficult and expensive to overcome. Examples include design challenges, technical problems to | g) **Culture and social issues** – lack of enthusiasms towards CE practices, by the environment where the organisation is situated (supply chain, market, |

| | |
|---|---|
| keep track of products throughout the lifecycle; quality and environmental balance, especially at the end of the lifecycle. | government, region etc.) and especially by consumers and staff/managers; some of the business models that are CE compatible (service system, sharing products, reuse of products, etc.) may not attract consumers that want to own the product (i.e., own a car instead of leasing one). |
| d) **Knowledge and skill issues** – lack of training or information awareness for consumers and staff/managers. | h) **Market issues** – externalities might reduce the ability of the organisation to implement CE practices, such as regulations, standards, consumer demands, etc. |

Source: (Govindan and Hasanagic, 2018)

The barriers identified so far are also comparable to the ones presented by Mangla *et al.* (2018) when discussing SSCM in developing countries, and Masi *et al.* (2018) for CE adoption of focal firms in supply chains. Although SSCM and CE are not the same things (as previously discussed), their similarities indicate a possible parallel between them in this regard.

The clusters presented and discussed by Govindan and Hasanagic (2018) were selected to be the set used in this thesis, because they were constructed using a comprehensive systematic literature review, have a broader scope in their definitions, and are focused on the supply chain perspective, thus a better fit for this research. The clusters were selected as the category, because they present a broader perspective that is more adequate for the agri-food supply chain since most of the barriers cited were connected to the technical products rather than biological.

Having discussed the barriers, it is now important to present possible drivers for CE adoption. As already pointed out, a barrier, given a change in circumstances, might be a driver (Jesus and Mendonça, 2018). For the Ellen MacArthur Foundation (2015b), drivers include economic losses and structural waste, price and supply risks, natural systems degradation, regulatory trends, advances in technology, acceptance of alternative business models and urbanisation. For Kirchherr *et al.* (2017), both Business Models (e.g., PSSs) and consumer demands can act as drivers of CE for companies. Jesus and Mendonça (2018) groups drivers into technical (availability of technologies), economic (demand trends, supply-side trends), institutional (legislation) and social (consumer-driven), as potential drivers to adopt CE.

For this thesis, the list of drivers proposed by Govindan and Hasanagic (2018) was also selected to be the primary reference on the topic, since there is considerable overlap between different works that discuss drivers for CE adoption, as presented in the previous paragraph. Having a coherent framework facilitates data collection and analysis (Cooper and Schindler, 2014) and therefore keeping the same authors for both barriers and drivers remains within that logic. The authors identified in the literature 13 different drivers, subsequently clustered into five groups (Table 2.5) (Govindan and Hasanagic, 2018). Some adaptation to the drivers were made to better fit into this research.

**Table 2.5** Drivers for CE practices adoption

| Cluster of Drivers | Description of the cluster | Driver | Description of the driver |
|---|---|---|---|
| A. **Policy and economy** | Drivers such as laws and regulations that promote cleaner production, consumption and products end-of-life management, enforcing mandatory adaptation to products, processes, business models and influence economy growth. | A.1 **Compliance to regulation** | - Keep practices within laws and policies of waste management and other CE pro-sustainability practices. |
| | | A.2 **Governmental incentives** | - Organisations economic and financial growth by implementing CE in its SC and being able to access governmental incentives |
| B. **Health** | Drivers aiming at increasing animal and public health, given the importance that these have on society, and the ethical links that animal wellbeing has with pro-sustainability business practices | B. 1 **Concern with public health** | - Overconsumption of resources and energy affects negatively the Public health and therefore organisations can act on it, both to save costs as well as a business opportunity |
| | | B.2 **Concern with animal health** | - Overconsumption of resources and energy affects negatively animal health, therefore organisations operations must comply with pro-sustainability (thus including ethical) practices |
| C. **Environmental protection** | Drivers in this cluster are related to climate change, sustainable agriculture and protection of renewable resources | C. 1 **Fight climate change** | - SC must implement CE practices due to climate changes that will affect their environment and stakeholders. |

| | | | |
|---|---|---|---|
| | | C. 2 **Adapt agriculture** | - Overconsumption of resources and energy affect negatively agricultural production, despite the increase of productivity by modern agriculture, thus making important for organisations to adapt to pro-sustainability CE practices that affect the rural environment |
| | | C. 3 **Reduce environmental impact** | - Use of renewable energy sources and reduce environmental impact |
| | | C.4 **Concern with sustainable development** | - Populational growth affects sustainability and CE practices are important for sustainable development |
| D. **Society** | Drivers that are related to population growth, urbanisation, job creation potential and consumer awareness | D.1 **Urbanisation and its influences** | - Urbanisation is increasing and negatively affecting the environment, as well as affecting business models, available labour, among other issues that organisations have to adapt to. |
| | | D. 2 **Organisations expansion** | - Job creation (organisational expansion) potential in SC are affected by CE practices |
| | | D. 3 **Consumer demands** | - Consumers' environmental awareness influences organisations to develop CE into their operations and SC |

| | | | |
|---|---|---|---|
| E. **Product development** | Drivers linked with improving the materials and energy efficiency and product value. | E. 1 **Increase product efficiency** | - Need to improve the efficiency of materials and energy use into its own operation and their SC |
| | | E. 2 **Increase in product value** | - Potential to increase the value of products by increasing the quality, as proposed by CE philosophy |

Source: (Govindan and Hasanagic, 2018).

Motivated by the drivers (listed above) to overcome the barriers, the stakeholders can employ enablers for the diffusion of these practices into the supply chain. Often in the CE literature, enablers are overlapped with drivers. However, they are not the same thing, as the motivation for something (driver) is different from what facilitates (enablers) the adoption over the difficulties (barriers). Mishra *et al.* (2018), discussed several challenges and building blocks to adopt and manage CE supply chains. From those, the system's enablers (Table 2.6) were chosen as the categories of enablers used in the present investigation. They were chosen because they directly relate to CE adoption in supply chains and are adaptable to the agri-food supply chain setting.

**Table 2.6** CE adoption enablers.

| |
|---|
| Partnerships and collaboration across the value chain. |
| Digital tools. |
| New internal incentives. |
| Working with regulators and policymakers. |
| Access to finance. |
| Existing systems of support. |
| Organisational characteristics. |
| Partnerships and collaboration across the value chain. |

Source: (Mangla *et al.*, 2018).

Section summary: Section 2.2.3 discussed the influencing factors in the adoption (single organisation) and diffusion (more than one organisation) of CE practices. The process involves barriers that need to be overcome, drivers that motivate the adoption and enablers that facilitate the procedures. The definitions of each of those factors, plus the set used in this thesis were also presented. So far, the discussion on CE is all-encompassing, without customisation to a specific sector or industry. However, this thesis address food (wheat, in particular), requiring a specific discussion on it, and the next section addresses this issue.

### 2.2.4 The Circular Economy of food

According to Ghadge *et al.* (2020) an increase in requirements from customers and regulations has led to a paradigm shift in sustainability policies in food supply chains. Bearing in mind that food is produced initially in farms, it is relevant to consider said actors when discussing food supply chains. Recently some authors (e.g. Gallaud and Laperche, 2016; Weetman, 2017; Vasconcelos *et al.*, 2018; Carvalho *et al.*, 2018; Vlajic *et al.*, 2018) have addressed some aspects of the agricultural side of food supply chains in their CE discussions. However, they do not thoroughly address the farmers 'link' of the food supply chain within CE. There is scarce literature on the relationship of CE and farming. A systematic literature search was conducted to reach such conclusion in the journals with the most published papers in CE (as pointed out by Geissdoerfer *et al.*, 2017). A total of 1,152 papers mentioning CE were identified, but of those, only 95 (8.2%) deal with agricultural farming beyond just mentioning it. For a broader reach, the term (in quotes) "circular economy" was searched in the six main journals of agricultural economics[9], classified by InCites with only five papers identified.

Expanding the search by using the *AgEcon* - a database of papers on agricultural economics and management - out of 117,258 papers existing in the said database, only 33 mention CE. Across all sources considered, after eliminating duplicity, 133 papers overall deal with both CE and farming in specific ways. The most cited practices and/or processes involving CE within farming were waste/residues for the production of fertilisers, energy (biofuel, biogas, and bioenergy) and animal feed. Alternative examples were also identified, such as pest control and reduction of pesticide usage, although in lesser quantity than the previous.

As it was discussed in Sections 2.2.1 and 2.2.2, waste is a core concept of CE. The definition of food waste can vary, from food that it is inedible, to food that does not fulfil client demands in terms of size, shape, visual presentation, softness, etc. even though it is still edible; as well as surplus of food that was produced but did not have enough demand in the market and was discarded later (Batista *et al.*, 2015b).

The Food and Agriculture Organisation of the United Nations (FAO) defines food loss as food lost before retail level - from production up to transportation to retail; while food waste is defined as food lost occurring at retail and consumer level (Gustavsson *et al.*, 2011; FAO, 2014). In this thesis, both terms are used interchangeably as the investigation encompasses the supply chain from wheat production up to retail, thus not requiring the differentiation between both terms. In this sense, food waste is understood here as all food that for any reason (e.g., not edible, does not pass standards evaluation, not enough

[9] With the inclusion of the journal *Food Policy*, those are the journals dealing with agriculture ranked 2 stars or above by the 2018 ABS – the Association of Business Schools ranking.

demand, etc.) is removed from the original supply chain where it was intended for (Batista *et al.*, 2015b).

Another important concept relates to by-products. By-products can be defined as "*output from a process designed for the production of some other product*" (Bannock and Baxter, 2011, p.42). Within a CE context, by-products can be used in other production processes, and its use will not lead to health or environmental problems (Batista *et al.*, 2015b). Wheat by-products are, therefore, products that are a result of wheat production and processing and that have economic value and usefulness in other production processes. When considering the wheat food supply chain, there are different examples of wheat food by-products both in wheat production (i.e., straw) and in wheat milling (i.e., mainly bran) (Shewry, 2009; Winfield, 2013; Kanojia *et al.*, 2018). Conversely, in agriculture literature wheat straw is also referred as residue instead of by-product (Reeves *et al.*, 2016; Bateman *et al.*, 2017; Ye *et al.*, 2019).

It is therefore important to have a structured framework to define such issues, as it facilitates the identification of the waste and its flow within a CSC. Some of the waste hierarchy models previously presented have suggestions on how to deal with food waste, but it is also useful to have a dedicated approach to food. In this sense, the Food Recovery Hierarchy of the Environmental Protection Agency (EPA) fulfils this objective (Figure 2.8).

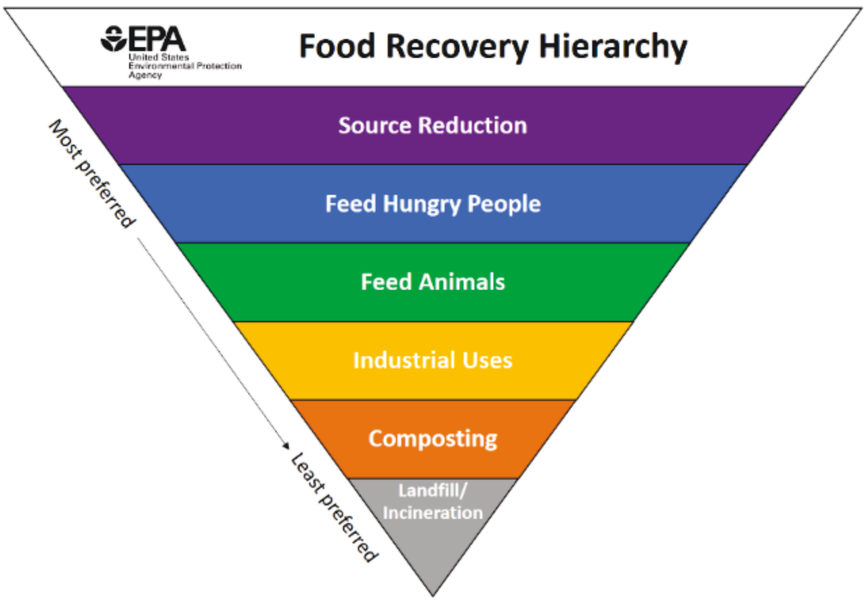



**Figure 2.8** EPA Food Recovery Hierarchy (EPA - United States Environmental Protection Agency, 2017).

The Food Recovery Hierarchy presents six different layers (EPA - United States Environmental Protection Agency, 2017):

a) Source Reduction: The volume surplus of food generated must be reduced, and this can be achieved with waste audits, implementation of reduction habits (e.g., balance customer demands with customer consumption, ensure proper storage facilities, etc.), among others.
b) Feed Hungry People: through donations of extra food to charitable organisations such as non-profitable organisation, religious institutions, among others. Legislation differs between countries (and possible between states within countries) and must be followed to avoid health and legal risks, such as appropriate storage, expiration dates, fungi presence, etc.
c) Feed Animals: this is a widespread practice in farming for centuries, but as already discussed, it must be done carefully and following the legal standards required in the region.
d) Industrial Uses: unused food can be converted into biofuel, into the rendering industry (converting to animal food, cosmetics, soap, etc.) and anaerobic digestion (where it becomes biogas and/or soil amendment).
e) Composting: food scraps (inedible parts) can be turned into feed and soil amendment. Despite its risks to soil and food contamination, composting, if done correctly, can help increase food productivity (next crop), reduce methane emissions, increase water retention in the soil, among other advantages.
f) Landfill/incineration*:* The last resort to disposal. It must be done correctly (logistics standards) and into adequate facilities, that are part of the urban infrastructure that governments and other organisations built and operate.

Crop supply chains losses can occur in any of the production phases, from mechanical damages, spillage during harvest and transportation and post-harvest selection because of product specification (The Ellen MacArthur Foundation, 2013b). The last one is more common in legumes, fruits and other vegetables, but also present in wheat, given industrial quality requirements.

Several agricultural technologies can be classified within the CE framework, such as:

- Use of waste: waste can be used as both soil protection as well as fertiliser. For instance, in a no-till system of farming, the soil does not go through tillage (digging, stirring and overturning), and the residues such as straw and fallen leaves from the harvested crop remains in the soil. That way, the soil is better protected from heat, reducing water loss, as well as directly contributing to lesser greenhouse gases emission and improving the overall biological matter available in the soil, thus improving fertility. This system also reduces the number of mechanical operations, therefore reducing costs, labour needed, and fossil-fuel consumption (Denardin *et al.*, 2012; The Ellen MacArthur Foundation, 2013b; Denardin, 2015). Similarly, composting, or the controlled use of organic waste as fertiliser or mulch (Bateman *et al.*, 2017) is a pro-sustainability practice that can be used in both farming and urban agriculture and is especially recommended to make food waste useful (The Ellen MacArthur Foundation, 2013a; Weetman, 2017).

- Genetic improvement: is the improvement of animals (e.g., cattle, chickens, etc.) and plants (e.g., soya beans, maize, etc.) through breeding (Bateman *et al.*, 2017) and this can be through traditional breeding methods or genetic modification (GMO's). Although not commonly mentioned in the CE literature, it is possible to consider genetic improvement as a potential pro-sustainability practice linked to CE. There are two reasons for that: the increase in productivity (more production with equal or less land and/or water usage); or increase in resistance to pests (diseases, insects, etc.), which leads to a reduction in inputs needed (e.g., pesticides) and operation in the farm (e.g., fewer tractors using fossil fuels), (Alexandratos, 2005; Foley *et al.*, 2011; Wulff and Dhugga, 2018).
- Internet of Things: also called IoT, it is the interconnection of devices through communication technologies, where these equipment's "talk" to each other without the intervention of the human user. One of the potential uses for these technologies in CE is facilitating traceability of food products and inputs, thus allowing reduction and reuse of food waste (Dossa *et al.*, 2018). Other examples of benefits of IoT in agri-food supply chains can be cited (Dossa *et al.*, 2018), such as:
  - Cost reduction - from inputs needed and logistical efficiency gains.
  - Environmental risk reduction - from the reduction in agrochemicals used and reduction of human mistakes.
  - Social risk reduction - from higher safety standards both in the food and in worker's health.

- Reduction of labour needed - important for countries where there is a lack of available labour in rural areas.
- Efficiency gains from productivity increase.

- Agriculture intensification: it is the use of as much of the available land (or farm) as possible by growing crops close together or several different crops in the same year (Bateman *et al.*, 2017), not to be confused with intensive livestock production. Intensive agriculture reduces the need for a resource - land (The Ellen MacArthur Foundation, 2013b) and as a secondary benefit, the reduction of deforestation and environmental damage. However, intensive agriculture can jeopardise sustainability if not done correctly, such as producing only one culture in every season (monoculture) (Denardin *et al.*, 2012). To intensify agriculture with a process such as crop rotation, on the other hand, can improve farm sustainability in areas such as the increase in organic matter in the soil, reduced water losses, increase in productivity, etc. (Denardin *et al.*, 2012; Denardin, 2015).
- Integrated systems: integrated systems are the production of different realms of agriculture in the same farm, such as crops (e.g., wheat), livestock (e.g., milk production) and forestry (e.g., wood). These integrations can also be partial: crop-livestock, crop-forestry, livestock-forestry. These systems allow better use of land resources (and therefore is also considered a form of agricultural intensification, as described above), but also improve carbon sequestration and a reduction of other resources input. Some examples include the use of wood produced in the forestry aspect of the system, to make wood fences for the animals of the livestock system; dual-purpose wheat system allows a reduction in operations of planting (seeding) and increase profits for the farmers (Balbino *et al.*, 2012; Lollato *et al.*, 2017; Cordeiro *et al.*, 2017; Embrapa, 2018a; Embrapa, 2018b).

Some authors, such as Pimbert (2015), argue that a complete change of farming systems are needed to consider farmers as CE practitioners. However, the predominantly biological nature of farming allows a broader perspective of CE in agriculture. The practices recommended above are already used on a large scale in some countries (no-tillage in Brazil, IoT in the United States, genetic improvement worldwide, etc.).

However, the adoption of some of the CE core tenets in farming, such as the use of waste (e.g., for fertiliser production) and contracting of services instead of ownership (e.g., for agricultural machinery like harvesters) is not simple. For instance, although animal waste recovery is a common recommendation of CE practice in the agri-food supply chain, technical aspects like Ph levels and microbial safety must be taken into account when proposing the use of animal waste in farms, due to the risks for animals and consumers of using feed from untreated waste and/or unregulated sources or runoffs in water sources (Murrell *et al.*, 2004; Toop *et al.*, 2017).

Likewise, the transmission of pests (viruses, mites, bacteria, weeds, etc.) by machinery is already well established in the agricultural literature, with examples being found in tubers, cereals, legumes, etc. (Fortnum and Gooden, 2008; Miller *et al.*, 2012; Mackie *et al.*, 2015). Therefore, contracting machinery services (i.e., for harvesting instead of the farmer having its own harvester) might facilitate the distribution of pests (or resistant strains of an existing pest) between regions, resulting in economic problems. Environmental issues might also arise from CE practices within agriculture, such as the dispersion of exotic animals, insects, or plants into new regions of the world. One of such cases is the dispersion of a resistant weed within Brazil, called *Amaranthus palmeri*, through the importation of used machinery from Argentina and the United States (Andrade Jr *et al.*, 2015; Carvalho *et al.*, 2015; Landgraf, 2016). These examples show that CE practices can also cause harm in the biological realm, if the necessary precautions are not taken.

In a broader perspective than the practices described above, Gladek (2018) makes a case for hierarchical preferences within CE practices. For instance, if possible, materials cycles should be organised to be geographically short. Also, materials should not be mixed with others if this will make their recovery too complex and reduce their chances of continuing as high-value products/components to the economy. Geography plays a key role given cultural practices and the timeframe that biological products are viable. This means that there are differences between the potential CE practices to be used in biological (namely food) and technical products. As the overall food supply chain goes beyond farming, it is relevant to discuss the used practices in the food sector that relate to the Rs presented in Section 2.2.2. Most of the literature is connected to technical products, and therefore does not necessarily correlate with degradable products that may pose biological risks to consumers. This means that it is essential to adapt the concepts to this sector.

Table 2.7 is proposed considering such adaptations. The table was constructed based on the definitions presented in Table 2.3, and the potential application to the agri-food supply chain.

**Table 2.7** Proposed adaptation of 'R practices' to agri-food supply chains

- **Reduction** – considered here in two forms:
  - *Reduction of inputs*: using less resources (capital, energy, land, materials, etc.) to produce and distribute food.
  - *Reduction of waste*: less waste generated from food production, distribution and consumption.
- **Reuse** – using a food product, component or material in the same way and purpose that originally intended, without modification.
- **Recycle** – conversion of food waste to a new product by scraping the original product into smaller parts of itself. One example of this is the production of breadcrumbs from dry bread for stuffing poultry, thickening stews, crunchy cover for fried foods, etc., while another possibility, but less desirable (further discussed below) is composting.
- **Redesign** – considered here as innovation based on previous design, that allows for more sustainable (fewer inputs, less waste, greater lifecycle, etc.) approaches, and that can have three forms:
  - *Redesign products* (e.g., new type of pasta or new plant variety that is more resistant to pests).
  - *Redesign services* (e.g., innovative approach to supply retail stores).
  - *Redesign processes* (e.g., new method of making a product).
- **Redistribution** – market substitution, such as Brazil selling chicken giblets to East Europe or wheat grain with low gluten content to African countries, both products that are not well received in the South American country.
- **Recovery** – understood in two forms:
  - As products to be recovered from consumers for adequate disposal.
  - As material to be incinerated for energy generation/use.
- **Reclassify** – to take a product such as fruits, legumes, or bread, that are approaching the end of the lifecycle and to classify at a lower grade, thus selling cheaper, and therefore not wasting said product.
- **Repurpose** – namely to take a food product or component (such as grain) that was destined for human consumption and repurposing to another segment, such as animal feed or industrial input.

- **Renewable energy use** – using renewable sources such as solar and wind, to power the activities for food production and distribution.

Considering that food that it is not eaten becomes unsafe for human consumption after very little time (e.g., bread with mould in it), the legislation regarding food safety, both in the UK and in Brazil makes it clear that food that presents risks must be withdrawn and not allowed to be eaten by consumers (Ministerio da Saude - Brasil, 1993; Ministerio da Saude - Brasil, 1997; The European Parliament and Council of the European Union, 2002; ANVISA - Agencia Nacional de Vigilancia Sanitaria, 2004; ANVISA - Agencia Nacional de Vigilancia Sanitaria, 2005; Secretary of State, 2013).

Because of this, the following CE practices were considered not appropriate for food supply chain: repair, remanufacture, refurbish, and recondition. This is because it is not possible to remove parts of a food after it was produced and substitute by another like it would be possible for a technical product. Such changes would increase the risk to consumers, thus making it illegal and this difference is reinforced and illustrated in the CE model presented in Figure 2.3 (Butterfly Diagram) where the biological side has fewer loops than the technical one. The other practices identified from the works of Govindan and Hasanagic (2018) and Masi *et al.* (2018) can be executed in biological products as well as in technical products. A different position is presented by Vlajic *et al.* (2018), given that the authors identify remanufacturing[10] as possible within a food CSC. Some of the operations considered by the authors are identified by other categories (such as repurpose) in Table 2.7; thus, the perspective of eliminating other 'R practices' remains.

<u>Section summary</u>: Section 2.2.4 presented the CE perspective in the agri-food context. It showed CE-related operations in farming, CE practices connected to food - and used in this research – and the structured approach to food waste and preferred methods in dealing with it. The next section deals with the application of CE framework into the supply chain.

## 2.3 CIRCULAR SUPPLY CHAIN

Traditionally, supply chain perspectives consider the flow of materials and information as unidirectional (from consumer to supplier or the inverse) (Stock *et al.*, 2010; De

[10] The authors consider remanufacturing as reconditioning, repair, upgrade or refurbishment.

Angelis *et al.*, 2018). The development of the CE paradigm in the last few years has modified such perspective, with newer research viewing the supply chain as more of a network where materials and flows can return at any given point in the link, but also can also cascade to other supply chains (Batista *et al.*, 2015a; Batista *et al.*, 2018b).

With this scenario as the backdrop, several definitions of Circular Supply Chains (CSC) are identified in the literature. Vlajic *et al.* (2018, p.523) describe CSC as *"a connected network of organisations involved in the design and management of value-adding processes and value recovery of a product, component or material"*. A more elaborate definition is put forward by Batista *et al.* (2018a) as follows:

> *"The coordinated forward and reverse supply chains via purposeful business ecosystem integration for value creation from products/services, by-products and useful waste flows through prolonged life cycles that improve the economic, social and environmental sustainability of organisations"* (Batista *et al.*, 2018a, p.446).

With this definition, the authors identify more than one supply chain in a CSC: a main (or primary/original) one, that comprises the forward supply chain with the original product/service; and a secondary supply chain, for additional materials (products, parts, by-products, waste). Both return circularly, either in closed-loop or in open loops, cascading into other industries. These loops support the restorative and/regenerative processes required within the CE theory (Batista *et al.*, 2018a). More straightforward definitions are also found in the literature. Batista *et al.* (2018b) give an encompassing definition of CSC as supply chains with CE features, that is, remanufacturing, reuse and recycling processes. With a similar position, De Angelis *et al.* (2018) defines CSC as embodying Circular Economy principles in supply chains.

According to Vlajic *et al.* (2018) and Masi *et al.* (2018), in the CE, materials and practices implementation flows through three levels:

- Micro-level: organisations and pro-sustainability practices.
- Meso-level: industrial systems.
- Macro-level: regions and regulation.

One of the main advantages of CE as an overall framework is that it bases its argument for the diffusion of sustainability practices in the potential economic gains that organisations can have with them (Masi *et al.*, 2018). This has facilitated the engagement of the business community in the discussion of CE and CSC (De Angelis *et al.*, 2018). In this sense, adaptations from the traditional practices to newer ones need to be understood, and how the trade-offs are positive in favour of circular operations.

De Angelis *et al*. (2018, p.430) explored differences between CSC and other views of supply chains, presented in Figure 2.9 and Table 2.8.

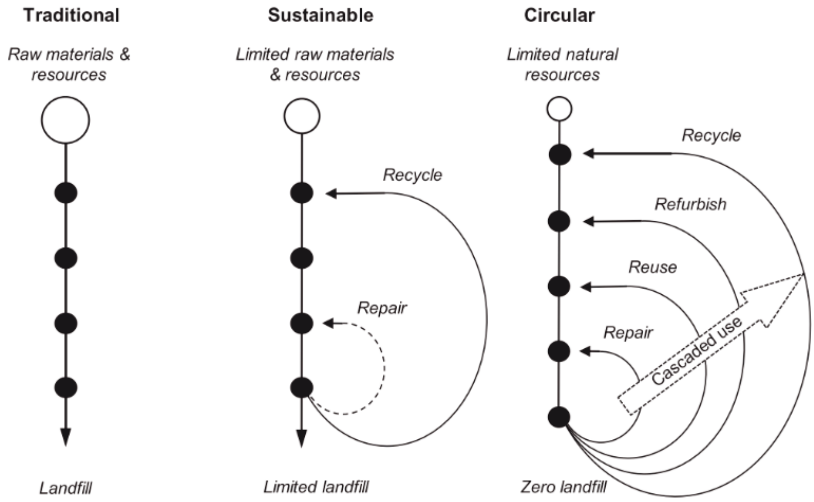



**Figure 2.9** Graphical representation of the distinct types of supply chains (De Angelis *et al.*, 2018, p.430).

**Table 2.8** Traditional, sustainable and circular supply chains

| | Traditional | Sustainable Supply Chains | Circular Supply Chains |
|---|---|---|---|
| **Strategy** | Component price | Cost of ownership | Leasing and service outcome |
| **Structure** | Linear and open | Partially closed | Closed, short and cascaded loops |
| **Flow** | Input-output | Mixed throughput | Biological and technical cycles |
| **Focus** | Efficiency | Customer effective | Collaborative value capture |
| **Scale** | High volume | High-medium volume | Medium-low volume |
| **Scope** | Global | Global and regional | Regional and local |

Source: (De Angelis *et al.*, 2018, p.430)

The increase in the number of loops shown in the CSC (Figure 2.9) compared with the other two, points to the overall CE practice of materials circling longer and resulting in more significant value capture throughout the life of the product. Therefore, CSCs are more complex than traditional forms of supply chains (Batista *et al.*, 2018a) given the number of operations that they entail at product, organisation and supply chain levels. Vlajic *et al.* (2018) present (Figure 2.10) a schematic model of a CSC that links the different types of organisations, operations and logistical elements in it.

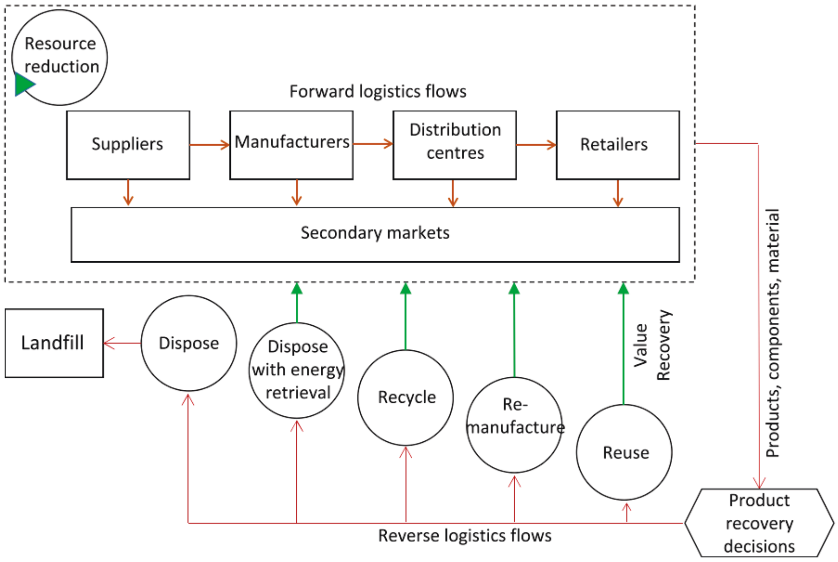



**Figure 2.10** Circular Supply Chain and its elements (Vlajic *et al.*, 2018, p.524).

It is possible to conclude that CSCs go beyond waste and circular flows since it involves at least six dimensions, that differentiate it from other forms of supply chains and mere circularity: strategy, structure, flow, focus, scale and scope (De Angelis *et al.*, 2018). This position is supported by Batista *et al.* (2018a) when the authors propose that CSC expand the Reverse Logistics or CLSC narrative regarding both scope and focus of the value chain systems considered. This is because CSC involves elements of Reverse Logistics, CLSC, SSCM and GSCM, not being constrained to one characteristic or perspective, and adding 'regenerative' and/or 'restorative' dimensions to the overall framework.

As different authors (Batista, Gong, *et al.*, 2018; Vlajic *et al.*, 2018; De Angelis *et al.*, 2018) showed, it is beneficial to map the circular flow of materials in a supply chain, ensuring therefore, that there is a CSC in the case under analysis. For wheat food this is no different. Considering the research problem presented in section 1.4.1, it is thus necessary to map the flow of the materials in the wheat food supply chains investigated, therefore shedding light on the circularity of said materials. This generates the second research question (section 1.4.2).

Different types of loops have different levels of benefit, especially environmental impact. The more "inner" a loop is, the better in terms of resource efficiency for reprocessing materials. Therefore, CSC must aim at maximising inner loops (e.g., reduce, reuse, repair) (De Angelis *et al.*, 2018; Batista *et al.*, 2018a; Vlajic *et al.*, 2018). Products that cannot be used repeatedly or repaired, through cascading to other supply chains, still maintain value longer than in traditional supply chains. This is also the case for agri-food supply chains.

The work of Vlajic *et al.* (2018) deserves special attention in this topic since it explicitly analyses circular food supply chains. The authors investigated value recovery in three networks of fresh food (brassica vegetables and root vegetables) supply chains. Specifically, three questions were discussed: How circular flows in food supply chains are created by the influence of critical factors, how recovery processes are affected by residual products; and what is the form of circular loops in such CSC. The critical factors are value from recovery, residual value, available quantities and the market for recovered products.

The first objective led the authors to identify that financial value, although fundamental to the forward supply chain and to the value recovery operations, is not a pre-condition for the creation of a circular flow in food CSC. This is because other forms of value also play a role, such as new business opportunities, helping social organisations (such as Food Banks), and supporting local farmers. Another relevant finding from their study is that the market for recovered products can be different in food CSC. Traditional CLSC point that reused and remunerated[11] goods return to the primary chain. Still, in Vlajic *et al.* (2018)'s investigation, these products return both to the original forward supply chain or cascade to other supply chains in open loops.

Finally, the form of the loop in the food supply chain is influenced by the residual value. The more 'outside the loop' is in the mapped CSC (as shown in the lower half of Figure 2.10), the more expensive the recovery process employed will be, and this is especially true for large volumes. However, if the source of the product is international, it becomes too expensive to return, repackage or resort the product (costly value recovery procedures). Also, small companies will not spend or risk reputational damage, if the volume of products is not large enough, so they will attempt to resell or even donate the products to other links in the chain (namely small farmers) (Vlajic *et al.*, 2018).

One of the significant elements in an agri-food CSC is waste and how the organisations deal with it. Several pieces of research in supply chain addressed the topic by looking at one or two focal companies - that is, the organisations that have the most significant

[11] Once again, in this thesis remanufacturing is not considered an option for food supply chains since other terms (operations) are more adapted to what the authors here considered as remanufacturing. For more information, see section 2.2.4.

capacity to dictate the operations of the rest of their suppliers and/or its clients, either by its direct contact with end-consumers or by designing the product/service offered (Seuring and Müller, 2008; Ashby *et al.*, 2012) - and deriving the research from there. However, the present thesis addresses the supply chain by looking at the raw-material (wheat) and deriving from there.

According to Batista *et al.* (2015a), when discussing food waste in CSC, it is relevant to consider that manufacturing operations are not necessarily close to farming, thus requiring logistical activities to mediate between them. This allows a supply of inputs both in terms of time (varying seasons) and variety (different types of products). These elements facilitate waste production and increase the complexity of studying food waste in a supply chain since different actors might influence various factors of waste. It is crucial, therefore, to address such aspects when considering the material flows in agri-food CSC, as it is the case for the present research.

Section summary: Section 2.3 summarised the main aspects of CSC and how they differentiate from other perspectives in supply chain management. The section also discussed the perspectives of material flows in CSC used in the thesis, including the relevance of waste, residue and by-products and their consideration in agri-food supply chains. The next section discusses TCE and how it relates to supply chains, as well as the dimensions used in this investigation.

## 2.4 TRANSACTION COST ECONOMICS

Every time a product or a service is provided to a consumer, a transaction occurs that carries costs. Economic transactions function within an interlocking network of culture, norms and institutions (Kolmar, 2017) influencing and being influenced by the said network. Supply chains, both linear and circular, are affected by transactions since the relationships between buyers and suppliers are an integral part of any supply chain. It is possible to say, therefore, that TCE is the field that studies the costs related with buying and selling products and/or services and that it is a viable approach to clarify how these relationships can influence the diffusion of CE practices in a supply chain.

TCE was introduced by Ronald Coase and further developed by Oliver E. Williamson, and falls within the New Institutional Economics school of thought (Defee *et al.*, 2010;

Kolmar, 2017) that focuses on the roles of institutions concerning economic behaviour. Davies and Lam (2001) identified different sources of transaction costs:

a) Buyer and seller identification.
b) Information acquisition on prices, attributes (quality and reliability) and accessibility.
c) Negotiations and successful concluding contracts.
d) Coordination of responsibilities between the parties.
e) Monitoring the execution of contract(s) term(s).
f) Corrective measures of any performance errors.
g) Opportunity costs.

Williamson (1998) asserts that different forms of governance structures – markets, hybrid, vertical hierarchies - are the mechanisms available for the control and coordination of the transactions. According to said author "*transactions, which differ in their attributes, are aligned with governance structures, which differ in their cost and competence, so as to effect a transaction cost economising outcome.*" (Williamson, 2007, p.17). These governance structures are, therefore, operationalised by contracts, to the point where these terms are discussed jointly within the broader TCE literature (Davies and Lam, 2001; Williamson, 2007; Wander, 2013; Mondelli and Klein, 2014). Organisations may benefit from the asset value of partners if the correct governance structure (e.g., contract) is formed (Defee *et al.*, 2010). However, developing contracts is costly and partially responsible for market imperfections (demand-price system), affecting organisational decisions regarding production, outsourcing, partnerships, and so on. Thus, transaction costs have implications for industrial organisations, supply chain management and competition policy (Batalha, 2001; Williamson, 2008; Buainain *et al.*, 2014).

Williamson (2008) argues that TCE and SCM have commonalities since both theories deal heavily with procurement, although traditionally TCE is more commonly linked with separate (individual) transactions - make or buy - while SCM aggregate and manage similar transactions as chains. Vertical integration is one of the ways organisations avoid high transaction costs, turning the costs into intra-firm transfers. According to TCE theory, transactions can be seen in pure-market perspective (unassisted market); with asset investments without any guarantee (unrelieved hazard); internal to the organisation (vertical or hierarchical); or as a hybrid, using contracts to guarantee the investment, the product, etc. (Figure 2.11). The last one being the more recommended type, according to Williamson (2008).

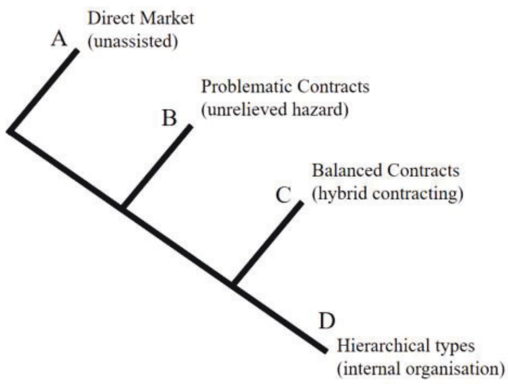



**Figure 2.11** Types of contracts. Adapted from Williamson (2008, p.9).

Williamson also adds that the difficulty in joining TCE and organisational theory (for the author, SCM, for this thesis, CSC), is that TCE relates to the autonomous adaptation systems, while organisations theory requires coordinated adaptations (Williamson, 2008). Coordinated adaptations are a key part of CSC if we consider the need for planned supply chains in the CE paradigm. Adequate contracting is a critical element necessary to join the different aspects of trade in CSC - the autonomous decision of the organisation and the need for coordination in the organisations (Williamson, 2008; Lahti *et al.*, 2018; Neves *et al.*, 2019).

According to Williamson (2008), TCE and supply chain research and operations have differences in boundaries, where supply chain management might be too broad of a field since it deals with several aspects of organisational processes, while TCE is more restricted to dyads of transactions between companies. For him, the TCE framework can be adapted into supply chain operations for the development of predicting models regarding procurement, partnerships and/or verticalisation of components. Two assumptions briefly discussed above underline the choice between market and hierarchy: First, *bounded rationality,* that is, the limited capacity that people have in storing (memory) and processing information - it is impossible to know everything (Simon, 1972); Second, *opportunism* that is the possibility of people acting in self-interest with guile (Teo and Yu, 2005).

Zipkin (2012) tackled the issue of SCM in relation to TCE, arguing that 'trust' is also an essential factor among partners in a supply chain. While traditional TCE claims that it is not recommended to depend or require trust between organisations in transaction conditions (pre, during and post), SCM considers trust a social lubricant in the relationship between organisations, facilitating organisational transactions (both intra- and inter- firms) (Zipkin, 2012).

Other differences between SCM literature and TCE exist, especially on 'real-life applicability'. An example of this is the discussion on inventories and their role in transactions between organisations. While Williamson (2008) argues that inventories are not addressed in a relevant matter in TCE, Zipkin (2012) stresses that this is one of the most appropriate ways to reduce transaction costs and uncertainty. This is because transactions occur in time and space, and therefore are directly linked to inventories since they allow for flexibility in this sense (time and space).

Wever *et al.* (2012) proposed a framework for TCE with a supply chain-wide outlook. By discussing interdependent transactions, that is transactions where supply-side risks affect demand-side risk exposure, and vice-versa, the authors developed five models to integrate TCE (dual, by nature) and supply chains (multiple, by nature). In their perspective, transactions should aim at minimal cost and the most value possible for both parties.

With the above proposition, when considering supply chain transactions, it is also relevant to evaluate not only dyadic relationships (buyer-supplier) but also how transactions and their requirements can affect the other players of the supply chain. The upstream, direct supplier, to a particular organisation is the Tier 1 supplier (or first-tier), and the Tier 1's supplier is the Tier 2 (or second-tier), and so forth (Brintrup, 2010; Smith and Barling, 2014; Liu *et al.*, 2014; Essila, 2018). Changes in end-client requirements affect not only the dyad with the Tier 1 supplier but also how the Tier 2 supplier responded to the change. There is a form of bullwhip effect acting throughout the supply chain, and a CSC can also have such responses in the organisations part of the loops, requiring adaptations based on contractual requirements and dimensions (Lahti *et al.*, 2018).

In agri-food supply chains, five basic types of transaction arrangements can be identified that influence the wheat trade (Batalha, 2001; Rossi and Neves, 2004; Schofield, 2007; Buainain *et al.*, 2014): barter, spot-market, futures contracts, options and guaranteed price contract (special purchasing programs).

- **Barter** relates to the practice of exchanging a certain amount of grain for input, services or other products (e.g., machinery). This can be arranged pre- or post-harvest, with the sack value determined in the negotiation (e.g., spot price, Chicago exchange price, etc.). With barter, there is no monetary exchange or is partial to the overall transaction value.

- **Spot-market**, also called direct market or unassisted market (Williamson, 1998), wheat price is determined most often in the day of the sale, with other characteristics such as grain quality and date of delivery also being part of the transaction.
- **Futures contracts** are standardised contracts with predetermined prices, to buy or sell grain at a predetermined time in the future. The agreements themselves can be purchased and sold, thus the requirements for standardised contracts and products. UK´s farmers also have the option of pools of farmers (Smith and Barling, 2014) where a group of farmers join together (supported by a marketing organisation such as the grain-merchants) and pool their grain to be sold in the future, with three to four pools of grain a year available.
- **Options contract** are similar to futures contracts, however instead of the obligation of purchasing/selling a product, options give the right of purchase/sale in a given date, in exchange for a premium payment.
- **Guaranteed price contract,** part of special programs, is different from future contracts because there are premium payments for particular assets to be produced and sold. They can include unusual varieties (e.g., legacy variety of wheat or barley for whisky), use of inputs (e.g., organic produces) or operations.

Four characteristics define the relative costs of organising a transaction (Davies and Lam, 2001): the amount to which a complete agreement (formal or informal) is possible, defining every potential problem, the contingencies and what are the responsibilities of each part; the amount to which exists the threat of opportunism from one of the parties and how this is going to be verifiable (e.g., performance and compliance measures); how specific is the investment of the transaction (cost of asset specificity capability building); how often the transaction is repeated (frequency of transactions).

Transactions have several dimensions, and the three more important ones are **asset specificity**, **uncertainty** and **frequency** (Williamson, 1998; Shin, 2003; Lamminmaki, 2005; Wever *et al.*, 2012). For the present research, the fourth type of dimension was included, considering Williamson's works on governance and the debate with Zipkin (2012): **type of contracts**.

**Asset specificity** relates to how much investments an actor makes to support a transaction, tying the actor to the other party of the trade and considers that the value of the asset is reduced if deployed to a different transaction (Davies and Lam, 2001; Shin, 2003; Altman *et al.*, 2007; Zschocke, 2019). It encompasses *site-specificity* (location); *physical specificity*; *dedicated asset specificity*; *human capital specificity, brand name specificity* and *temporal specificity*.

**Uncertainty** (Davies and Lam, 2001; Shin, 2003; Bannock and Baxter, 2011; Wever, 2012) occurs when the number of potential outcomes for a given decision is greater than the number of actual outcomes. It is important to stress that uncertainty cannot be measured, thus making it different from risk (Kolmar, 2017; Ghadge *et al.*, 2017). Three types of uncertainty are commonly discussed in the literature and are used here: *behavioural*, *environmental* and *measurement*. While some authors such as Shin (2003) argue that TCE focuses on behavioural uncertainty as it is the main influencer of market failures relating to transactions, others like Oliveira and Zylbersztajn (2018) point that other forms of uncertainty should be considered in agri-food transactions including environment (e.g., prices affected by surplus production) and capacity to measure quality (e.g., grain quality). Uncertainty can affect the decision of an organisation to be more or less vertical in its operations.

**Frequency** is the number of times a transaction is expected to take place; it can be *occasional* ('on-off'') or *recurrent* (Williamson, 1998; Davies and Lam, 2001). Finally, **types of contracts**. Only three types are considered here: *formal* and *informal* contracts and *verticalisation* processes (hierarchical contracts). The first two categories encompass the five types of common wheat agreements discussed previously and include the issue of trust, as discussed by Zipkin (2012). Formal contracts are those that are written and have identifiable clauses, including responsibility, requirements, quantities, financial value, dates, among others. They can be standardised (Batalha, 2001). Informal contracts are those that are unwritten, based on trust and with specifications that are not so well defined as a formal one. The last category (verticalisation) addresses internal transactions, and material flows within the same institution as discussed by Williamson (2008).

The identification of the dimensions of transactions, for greater clarity on the role that transactions can have in the diffusion of CE practices, is the fourth research question. The integration of CE diffusion influencers and transaction dimensions is the fifth research question. Both research questions originated from the review of the relevant literature on TCE and SCM, demonstrated so far in the section. No previous literature was identified integrating TCE and CE diffusion influencers, thus presenting an academic research gap, despite its relevance. Therefore, this thesis aimed at filling such knowledge gap, as demonstrated by research questions 4, 5 and the research problem itself.

The connection of food waste (CE) and transactions is still an underexplored theme. Some authors (Maaß and Grundmann, 2018; Carvalho *et al.*, 2018) have identified that governance systems part of transactions and contracting (e.g., governmental bodies and formal or informal associations) are critical parts of collaborations between organisations. These elements reduce the risk of opportunism and increase both performance and relationship satisfaction, facilitating the use of waste in the operations within the supply chain.

Food waste and contracting are also influenced by legislation, power, compliance requirements and performance of the participants (Carvalho *et al.*, 2018). Considering the legislation, food safety regulations can reduce the capacity and the will to use unwanted but edible food and increase the need for other stakeholders (such as Non-Governmental Organisations, or NGOs) to act in the supply chain. For power, the more relevant part relates to power asymmetry, as it reduces the capacity that organisations, especially producers/farmers have to negotiate prices and food standards. In terms of compliance, requirements regarding procedures and product quality are determined by the subsequent stage in the food chain, often only existing in a dyad perspective, and not through a supply chain view. Finally, in terms of performance, the responsibility for issues occurring in the production, transportation and distribution of products is attributed to another actor, and the costs to reduce food waste are not shared, thus becoming a problem for someone else and not been solved.

The lack of well-developed formal contracts and long-standing relationships without trust and collaboration increases food waste since no one assumes the responsibilities for it. High power imbalance can also increase food waste, given the difficulty in implementing negotiations for better performance measurement and different quality requirements (Carvalho *et al.*, 2018).

As there is scarce research on agri-food CSC and TCE (with no study identified connecting CSC and TCE in the wheat setting), a broad approach was chosen for this study. The focus is on the dimensions of the transactions in the cases studied rather than in more detailed aspects of the governance systems. Therefore, the four dimensions (asset specificity, uncertainty, frequency, and types of contract) and their subsequent types (subcategories) are the major components of TCE used for the thesis.

Section summary: Section 2.4 presented a brief overview of TCE, with a brief history of the field, the main elements that underline transaction costs (e.g., sources of costs and main characteristics), its connection with supply chain (including criticisms), and the four dimensions used in this research: asset specificity, frequency, types of contracts and uncertainty.

## 3. WHEAT AGRO-INDUSTRIAL COMPLEX IN BRAZIL AND THE UK

This chapter presents an overview of the Brazilian and the UK´s wheat industry. The overall worldwide wheat situation was presented in chapter 1, as well as some of the characteristics of wheat and wheat-based products. This section of the thesis is divided into two parts (Brazil and the UK) to better organise the information and present the differences that constrain the actors in each supply chains.

### 3.1 THE WHEAT AGRO-INDUSTRIAL COMPLEX IN BRAZIL

In Brazil, the national production of wheat fluctuates between 5 and 6 million tons a year since 2003 (IBGE, 2018a), but that only makes 50 to 60% of the total consumption of the country (USDA, 2017). The rest is imported from countries like Argentina and the United States. The Brazilian WAIC had US$ 6.8 billion of gross domestic product (GDP) in 2016 and generated almost 350,000 jobs in that year (Figure 3.1) (ABITRIGO, 2017c).

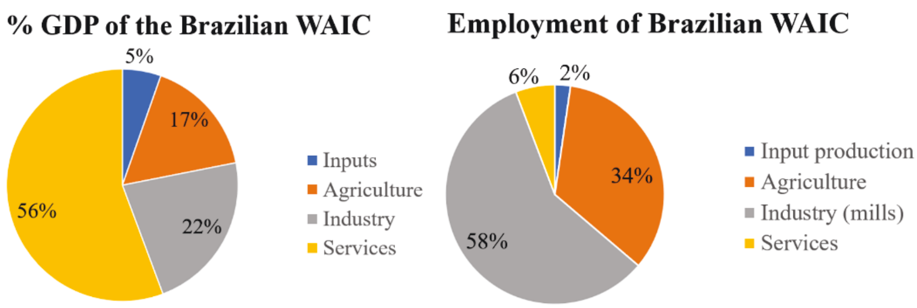



**Figure 3.1** GDP and Employment distribution of the Brazilian WAIC (Adapted from ABITRIGO, 2017c).

According to Mori (2011), WAIC are composed of: the service and support industry; agricultural production; first, second and third level transformation industry; wholesale and retail trade; and consumers. The first transformation industry consists of the flour, mixtures and bran industry. The second transformation industry produces pasta, bread, biscuits and non-food products (*e.g.,* glue), and the third transformation industry produces pizzas, ready to eat dishes, bread and other wheat-based products from bakeries or supermarkets, among others. Figure 3.2 presents the WAIC of Brazil. Although this model shows the Brazilian WAIC, it can be used as the basis for mapping the WAIC of other countries, as DEFRA (2012) and Smith and Barling (2014) show.

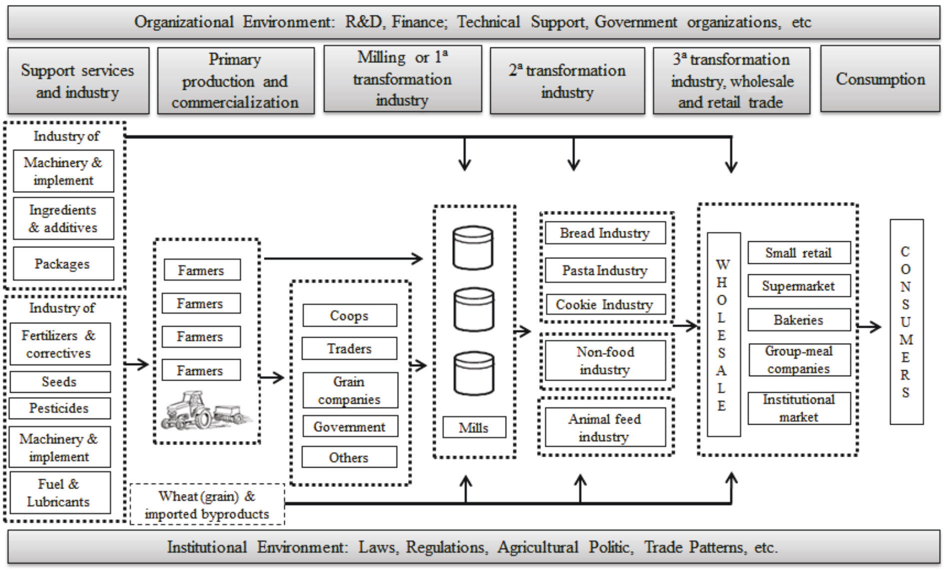



**Figure 3.2** Brazilian Wheat Agro-Industry Links (De Mori, 2011, p.37).

Most of Brazil's wheat production is concentrated in the South of Brazil[12], accounting for about 90% of the yearly output (IBGE, 2018a). The South of Brazil is characterised by a high percentage of descendants of European immigrants (late 19 century and early 20 century), that led to a rural scenario more similar to Europe's (namely Germany and Italy) than the rest of Brazil: small-scale family-driven farms, with farmers connected to cooperatives (mostly established between 1950-1970s) that facilitated market access and technical support (Buainain *et al.*, 2014). According to the latest rural census in Brazil (IBGE, 2017), there are 35,195 rural properties that produce wheat with almost 93% of them being in Parana and Rio Grande do Sul.

Most Brazilian wheat farmers are associated with cooperatives (Acosta *et al.*, 2018). This is because farmers realised that economies of scale were possible if done in an association, both for input purchasing and product commercialisation. Throughout the years, agricultural cooperatives developed a range of different functions[13] within the WAIC, such as:

- Technical support (extensionists).
- R&D.
- National and international commercialisation.
- Logistics (transportation and storage).
- Input purchasing and commercialisation.

[12] Parana, Santa Catarina and Rio Grande do Sul.
[13] This varies from cooperative to cooperative, depending on management choices, size, region, etc.

- Milling.
- Industrialisation (own-label of wheat-based products).

Some farmers have direct transactions with traders and/or other companies that buy food wheat, especially larger grower (Bartholomeu *et al.*, 2016). According to Bartholomeu *et al.* (2016), often farmers sell their products to the nearest cooperative that, in turn, store the grain and can proceed with three different options (more than one can happen at the same time):

a) Selling to mills.
b) Selling to traders and/or exporters.
c) Using in the cooperative own mill, when available.

Mills (whether they are associated with cooperatives or not) commonly import wheat to blend with the domestic production in order to achieve the industrial standards (Bartholomeu *et al.*, 2016). At least 29% of Brazilian wheat production goes through mills owned by cooperatives (Acosta *et al.*, 2018). Traders can act as intermediaries between farmers/cooperatives and mills, both within the country and outside (imports and exports).

The Brazilian WAIC is a mature economic sector with well-defined characteristics but is currently facing changes (Dossa and Eichelberger, 2016), such as:

- New areas are producing wheat (*e.g,.* in Brazil's 'cerrado', the savannah-like region).
- New key-players in the international trade (*e.g.,* Western Europe and Paraguay).
- Multinational corporations are doing research both on GM and traditional wheat improvement.
- Greater food quality and security concerns (*e.g.,* gluten, mycotoxins, carbon footprint, etc.).
- Concerns of climate change influencing the crop.

Despite the changes listed above, the most meaningful change in Brazilian wheat production and industrialisation came in the early 1990s. From the 1960s to early 1990s, the Brazilian government regulated the wheat sector (specifically, wheat production and grain commercialisation), guaranteeing prices well above the global market (in 1986 wheat prices were US$ 130.00/ton in the international market, but in Brazil, it was US$241.00/ton) and buying from farmers, cooperatives and traders what the regular market would not, later selling at lower prices (Brum and Muller, 2008; Mori and Ignaczak, 2012; Acosta *et al.*, 2018).

When Brazil opened its markets and stopped with the subsidies, Brazilian wheat production plummeted, with grain imports compensating the demands for the industry (Brum and Muller, 2008; Mori and Ignaczak, 2012; Bartholomeu *et al.*, 2016). This led to a transformation in the Brazilian WAIC, with cooperatives investing in mills and their own lines of wheat-based products (e.g., pasta, cookies, etc.), to add value and compensate for the loss in income (Acosta *et al.*, 2018).

Because of edaphoclimatic conditions, Brazilian wheat has a high production cost (fertilisers, pesticides, number of operations, etc.), thus reducing farmers interests. Two other factors make Brazilian wheat production complex (Brum and Muller, 2008):

a) The standards required based on the industrial classification (gluten strength, colour of the flour made, falling number, etc.). Historically, Brazilian wheat does not meet Brazilian industry requirements (namely bread flour), for climatic and technological (varieties) reasons, thus requiring the mills to import wheat with the required specifications. In the last ten years, several actions were (and are) undertaken by the industry and governmental bodies to solve these problems, such as R&D and different market identification for selling surplus wheat grain (Guarienti *et al.*, 2017; Pires *et al.*, 2017).
b) Brazilian climate allows more than one agricultural season a year. The main cash-crop in Brazil is soya bean, therefore farmers and cooperative focus their attention on this product. Wheat production is constrained by soya bean seeding period and inventory capacity since silos are allocated for soya bean storage. This requires wheat commercialisation to be limited to periods that soya beans are not using the space, reducing bargaining power and financial returns (traders have to sell it whenever possible, not when it is more interesting financially) (Brum and Muller, 2008; Mori and Ignaczak, 2012; Acosta *et al.*, 2018).

Despite other issues affecting wheat market (e.g., legislation, international trade, etc.), these three elements (high production costs, industrial aptitude and agricultural production system) significantly influence supply chain operations and waste generation in the country. Post-harvest losses are estimated at around 12%[14] in the wheat supply chain before reaching the mills, mostly in the farmers' side (Bartholomeu *et al.*, 2016):

- 6% in the farms due to operational issues such as inadequate implements, machinery speed while harvesting, etc.
- 0.5% transporting to the cooperative (roads and truck problems).
- 5% at the cooperative due to storage problems (pests, temperature, etc.).
- 0.3% from cooperative to the mills (roads and trucks problems).

Considering an average of 5 million tonnes of wheat produced a year in the country, this amount of lost wheat means around 600,000 tonnes of food waste, or over US$ 100 million a year (average last five years of production value) (IBGE, 2018b). The other 5 to 6 million tonnes of wheat that the industry requires to supply the Brazilian market is imported mostly from Argentina, United States, Canada and Paraguay (ABITRIGO, 2018f). To supply mills in the North and Northeast of the country, the companies installed milling facilities directly into the ports, thus reducing time, cost and waste. It can be cheaper to import wheat from Canada to supply those mills, than to transport them from producer states in the south, especially considering transportation costs (Brum and Muller, 2008; Mori and Ignaczak, 2012; Bartholomeu *et al.*, 2016).

After leaving the silos (from farmers, cooperatives or traders), the grain goes to the mills (cooperative-owned or not). Brazilian milling industry has 203 mills operating as of April 2018 (ABITRIGO, 2018d), with most of them (148) in the South, but less than 50% of the total wheat is milled in that region, despite the presence of 74% of mills (ABITRIGO, 2017b; ABITRIGO, 2018a) (Figure 3.3), thus showing that milling capacity is not linked to the number of mills nor the geographical location of production.

[14] Research conducted in the state of Rio Grande do Sul. No distinct information was identified regarding other states or different figures; therefore, this percentage was used for the whole country.

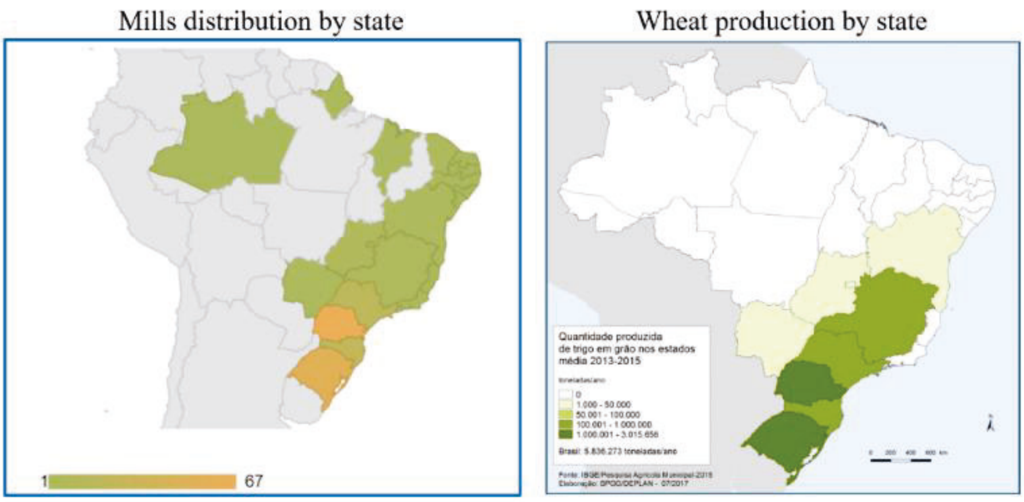



**Figure 3.3** Number of mills x Wheat production (Adapted from ABITRIGO, 2017a; and Estado do Rio Grande do Sul, 2016).

The milling process (Appendix A) forms basically two types of products: wheat bran, a by-product of processing wheat that originates from the (hard) outer layers of the grain and used mostly for animal feed; and wheat flour. As expressed in Chapter 1, there are different types of flour, used for bread (the most consumed element in Brazilian wheat market), pasta, cakes, home-flour and biscuits.

Brazilian mill industry produced 7,964 tonnes of flour and 2,655 of bran in 2017 (ABITRIGO, 2018c). It also imported 275.5 thousand tonnes of wheat flour (ABITRIGO, 2018e). This means that Brazilians per capita wheat consumption is around 40 kg a year (Figure 3.4). Another critical point to make is that in the last few years, Brazil not only imported wheat but also exported it to countries such as Thailand, Philippines, Vietnam and Egypt. The exported wheat comes mostly from Rio Grande do Sul and averages around 900,000 tonnes a year. This is because farmers, cooperatives and traders from that state identified in different markets demand the type (quality) of wheat produced there, reducing financial costs and food waste (Pires *et al.*, 2017; Acosta *et al.*, 2018; ABITRIGO, 2018b).

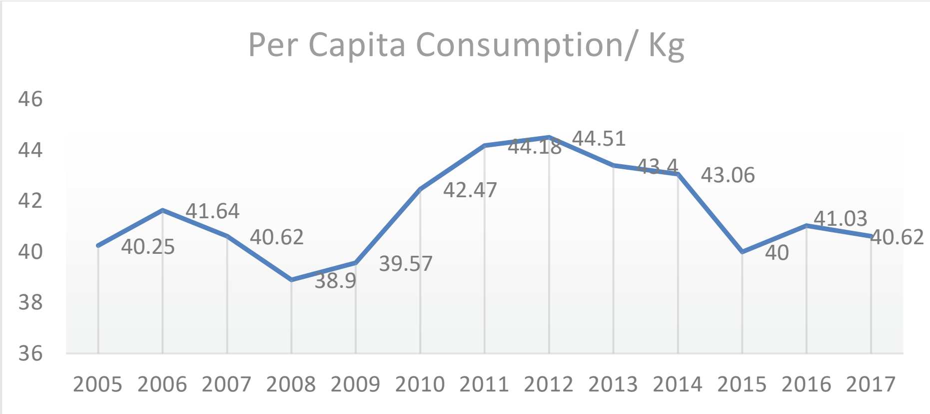


**Figure 3.4** Brazilians per capita consumption of wheat (ABITRIGO, 2018g).

In Brazil there are four groups of wheat flour (ABITRIGO, 2017d):

a) Industrial flour: flour that will be industrialised and transformed into cookies, pasta and industrialised bread, found more commonly in supermarkets. It is produced by 88% of mills and represents 46% of flour sales.
b) Domestic: flour for home use (commonly found in supermarkets). Accounts for 29% of sales and produced by 85% of mills.
c) Pre-mixture: flour mostly for bread making in industries and bakeries. Represents 24% of flour sales and is produced by 84% of mills.
d) Other uses: Despite only representing 2% of sales, it is produced by 18% of the mills.

Wheat grain classified as *bread wheat* accounts for 62% and is the most used input by mills. Since the Brazilian farmers are unable to completely supply the demand of grain for pre-mixture, the mills have to import it, as discussed. Bread wheat production is followed by improving wheat (for blending with other classes in order to reach necessary standards) (23%), wheat for biscuit (cookies) (14%) and other uses (1%) (ABITRIGO, 2017d). Figure 3.5 shows the distribution of products to different type of firms:

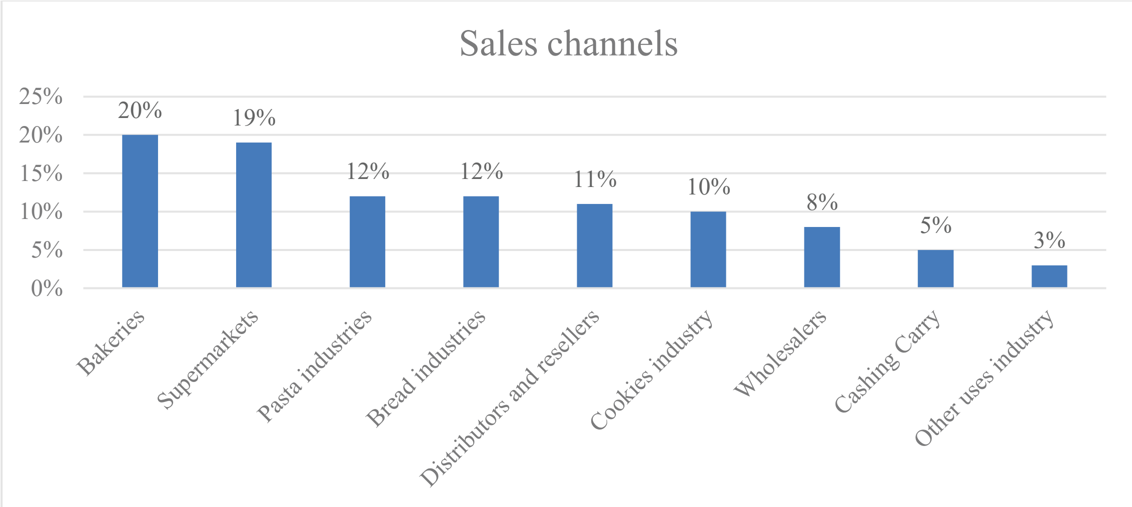



**Figure 3.5** Sales channels for the milling industry in Brazil (ABITRIGO, 2017d).

The second transformation industry is mostly represented by the Brazilian Manufacturers Association of Biscuits, Pasta and Industrialised Breads & Cakes (ABIMAPI), and with 94 companies it represents 80% of the national market, generating over 100,000 direct jobs. These companies produced 3.4 million tonnes of products and had US$ 8.64 billion gross income in 2017 (ABIMAPI, 2018a). They are distributed around the country, but with a more significant percentage in the Southeast and South regions (the most industrialised regions in Brazil). Table 3.1 summarises the information of consumption within the referred Brazilian industry, the average of the two last available years (2016/2017).

**Table 3.1** Biscuits, Pasta and Industrialised Breads & Cakes (average 16/17)

| Type of Product | Sales (billion US$) | Sales (mil tonnes) | Per Capita (kg/year) |
|---|---|---|---|
| Biscuits | 6.51 | 1,844.22 | 8.91 |
| Pasta | 2.39 | 1,226.84 | 5.92 |
| Industrialised Breads & Cakes | 1.74 | 477,380.50 | 2.31 |
| **Total** | **10.64** | **480,451.56** | **17.14** |

Source: (Adapted from ABIMAPI, 2018b)

The third transformation industry can also act as the link between the end-consumers and the rest of the supply chain, either as wholesalers or retail. The mixture of transformation industry and retail are the bakeries and the supermarkets, the two biggest sales channels for the WAIC (as Figure 3.5 shows). These actors also sell the products made by the other sales channels (i.e., pasta, bread, cookie, wholesalers, etc.).

According to SEBRAE (2017), the Brazilian bakery industry is the second biggest food distribution channel for consumers behind supermarkets. Between the years of 2000 and 2014, the sector had to change to counter the reduction in sales that resulted from an increase in supermarkets sales into their markets. The most notable change was the increase in product mix sold into their stores, ranging from bread baked in the bakery to industrialised ones (pre-baked or semi-finished bread), industrialised goods, ready to eat meals and others. This led bakeries to become a mixture of restaurants, mini-markets and bakery, and their range of products is only behind supermarkets. Table 3.2 summarises a set of information on bakeries (SEBRAE, 2017; ABIP, 2018):

**Table 3.2** Summary of the bakery sector in Brazil

- 6th largest industrial market in the country;
- Accounts for 36% of the food industry and 6% of the transformation industry;
- Grossed US$ 24.4 billion in 2017;
- There are almost 70.000 bakeries in Brazil;
- 95% of the bakeries are small family-owned and family-managed companies;
- Generates around 800,000 direct jobs and 35% of these are involved in production;
- 76% of Brazilians eat bread in their breakfast, and 98% eat baked goods;
- 86% of purchased bread in Brazil is artisanal;
- In 10 of the major markets - Belem, Belo Horizonte, Fortaleza, Recife, Brasilia, Salvador, Sao Paulo, Goiania, Porto Alegre and Rio de Janeiro – consumers prefer bread from bakeries over supermarkets;
- Yearly bread per capita consumption is 22.61 kg;
- Besides bread, bakeries are also part of the beverage, frozen, dairy, cigarettes and sweets industry;
- Artisanal bakeries account for 79% of baked goods in the sector, while industrial bakeries are 14% and supermarket bakeries 7%;
- Own production accounts for 64% of income, while de rest (36%) is from reselling industrialised products;
- Given the increase in wheat flour costs – the primary raw material used – bakeries started using other inputs such as maize and cassava;
- French bread is the name of the most consumed bread by Brazilians, and the main product sold in bakeries;
- The European market (and its evolution) is seen as a role model for the Brazilian market;
- Frozen food is seen as a major risk for traditional bakeries, as well as the increase in quality from the main competitors – supermarkets;
- New competitors are bakery-chains, convenience stores, mini-markets and frozen products.

- Diversification in the range of product is the recommended strategy for competitiveness in the industry, as well as the increase in quality, especially for traditional bakeries;
- Healthy, fresh and tasty products are the main recommendations for ‘quality products’;
- Priorities for competitiveness are, in order: quality of products, supply, price, operational efficiency, range and service/communication.

Source: (SEBRAE, 2017; ABIP, 2018)

The supermarket sector is a much bigger player in Brazil, despite being the bakeries biggest competition. According to the Brazilian Supermarkets Association (ABRAS), in 2017, the supermarket sector reached US$ 95.3 billion turnover, with over 89,000 stores in the country, and generates 1.8 million direct jobs (ABRAS, 2018b). Most stores are in the Southeast of Brazil (49.5%), followed by South (29.5%), North-Northeast (15.3%) and Midwest (5.7%). Three major companies represent 35.7% of the total revenue (DEPEC, 2017).

In 2017, the supermarkets’ food waste (product losses) resulted in US$1.73 billion of costs for the supermarket industry. Supermarket’s bakeries and confectioneries had a 4.1% of gross income loss because of this (US$175.4 million). Regarding food waste, from just four departments (meat, fruits and vegetables, bakery and fish), US$1,06 billion were lost (ABRAS, 2018a; ABRAS, 2018c). Several programs in the sector aim at minimising this.

<u>Section summary</u>: Section 3.1 presented the overall context of the Brazilian wheat agro-industrial complex, including its recent history. It also discussed the profile (regions, types of products, numbers and main issues) of the wheat food supply chain actors: farmers, cooperatives & traders, mills, industry, and retail. Wheat in Brazil is mostly produced in the South of the country and has three main problems: low-profit margin, industrial aptitude, and influence of the soya beans production. Wheat in Brazil is mostly consumed as bread produced and sold in bakeries, that in turn are transforming their business given the increase of supermarkets competitions. Wheat grain needs to be imported to fulfil the Brazilian demand for quality (wheat for bread) and quantity reasons. The next section explores the UK´s wheat agro-industrial complex (WAIC).

## 3.2 THE WHEAT AGRO-INDUSTRIAL COMPLEX IN THE UNITED KINGDOM

The UK´s WAIC is similar in some respects to the Brazilian counterpart, including types of flour and chain overall structure. Agriculture in the UK covers 72% of land area (17.5 million hectares), and 18.3% (3.2 million) of this is covered by cereal crops. Wheat is the cereal with the biggest area in the UK, with 1.8 million hectares and its output at market prices averaged £2.1 billion (2013-2017). Wheat production in the UK averaged at around 15 million tonnes a year considering the period 2015-2019 (DEFRA, 2020a).

Agriculture accounts for less than 1% of the UK´s GDP and 1.48% of total employment. The agri-food sector as a whole represents more than 6% (£111 billion) of the national GDP (and 5.9% of all employment) (DEFRA, 2018a). According to DEFRA (2019a), in the 2018/19 farming season, over 20% of the UK's farms failed to make a positive Farm Business Income (FBI). On the other hand, around 28% had an FBI of over £50,000, thus showing a considerable variation between them. The UK remains a net importer of food, despite an increase in food exports. In 2019, the trade gap in food, feed and drink was £24.3 billion, even with exports of £23.6 billion (2.9% from the previous year), but since imports reached £47.9 billion (0.3% increase), the country is still depended on foreign production (DEFRA, 2019a).

Most of the UK´s wheat[15] comes from England (92.6%), followed by Scotland (5.9%), Wales (1.1%) and Northern Ireland (0.5%) (DEFRA, 2019b). Wheat production in England is quite widely distributed throughout the country, although it is possible to identify two regions with greater relevance to it: Eastern England and the East Midlands (Figures 3.6 and 3.7). Roughly speaking, there are two types of wheat produced in the UK: winter wheat and spring wheat. Most of the production (around 95%) comes from winter wheat, where the seed is planted between September and November and harvested between August and September. Spring wheat, on the other hand, is planted between January and March (usually March) and harvested between late July and August. Winter wheat tends to have greater yield and there is variation in the characteristics for flour production made from each (Grain Chain, 2016; AHDB Cereals & Oilseeds, 2017; DEFRA, 2018a).

[15] Average 2015-2019

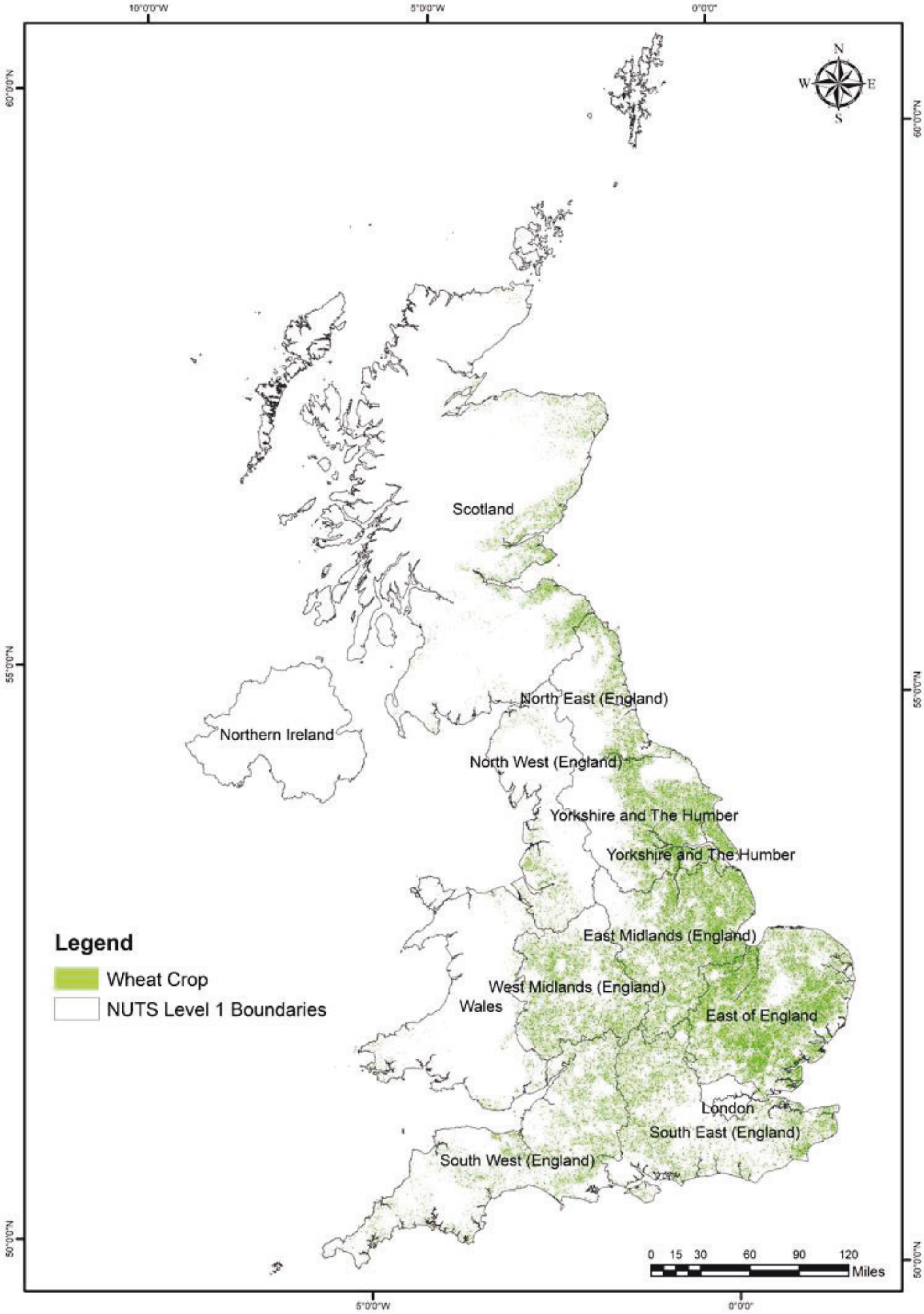



**Figure 3.6** Areas of wheat production in the UK in 2019 (CEH - UK Centre for Ecology and Hydrology, 2020).

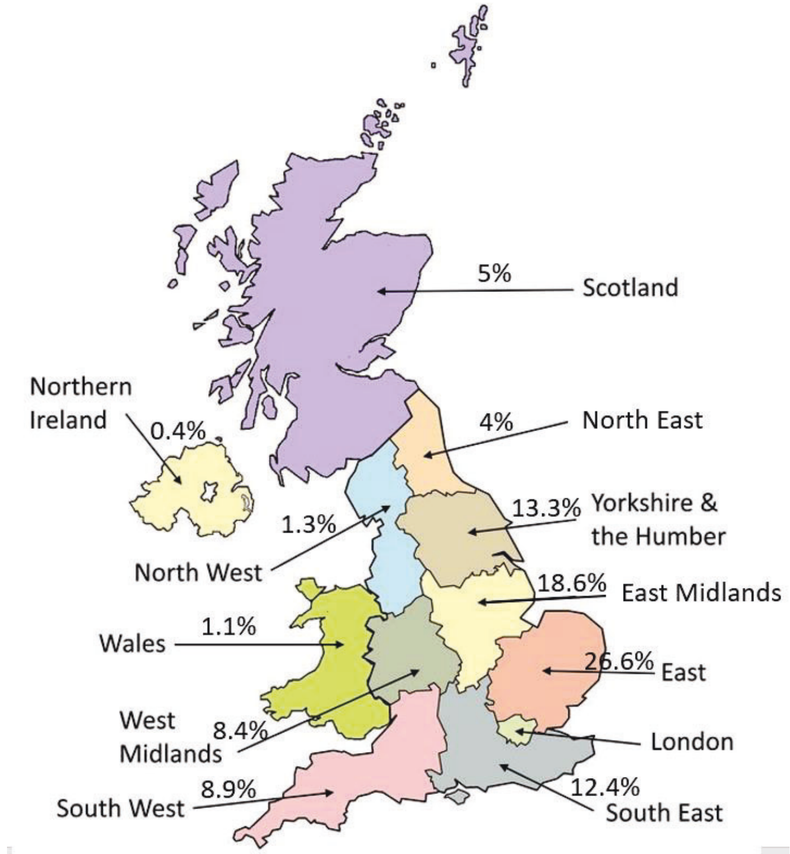



**Figure 3.7** UK Wheat production by region – percentage of total tonnes (2018) (author with data from DEFRA (2020b)).

The UK imports around 750,000 tonnes of wheat each year to supply its industry demands, especially regarding quality requirements for different types of flours. Most of the foreign trade is with the European Union – both export and import – although Canada and the USA also export to the UK (Grain Chain, 2016; AHDB Cereals & Oilseeds, 2017; nabim, 2017; DEFRA, 2018a).

While in Brazil almost all wheat is used for human consumption, with some of it becoming animal feed or other forms of industry feed (e.g., glue), in the UK wheat is also used bioethanol production (average 2.1% of total wheat area 2010-2016) (DEFRA, 2017) and animal feed. Table 3.3 shows the distribution of wheat usage in the UK according to DEFRA (2019a), in million tonnes. Approximately 45% of the wheat area planted in the UK are bread or biscuit types (nabim, 2018a)

**Table 3.3** UK wheat domestic uses (mil tonnes)

| | 2017 | 2018 | 2019 |
|---|---|---|---|
| **Flour milling** | 7,138 | 6,589 | 5,814 |
| **Animal feed** | 7,347 | 7,667 | 7,348 |
| **Seed** | 278 | 271 | 281 |
| **Other uses and waste** | 964 | 952 | 963 |
| **Total use UK** | **14,906** | **15,405** | **15,610** |

Source: (DEFRA, 2019a, p.67).

Like Brazilian farmers, most UK farmers commercialise their wheat harvest through an intermediary before the grain reach the millers (DEFRA, 2012; Smith and Barling, 2014) although there are very few grain-merchants in the UK after some consolidation in the last few years because of low-profit margins and increased volatility. Merchants also play a role in future markets and risk reduction for farmers, given the possibility to negotiate prices beforehand (DEFRA, 2012). Like farmers cooperatives, these actors in the supply chain also have a regional element to their connection between farmers and mills but differentiate from the cooperatives, because they provide a hired service in exchange for a fee (DEFRA, 2012).

Farmer cooperatives also play a role in this stage of the supply chain in the UK. There are around 420 farmer cooperatives in the UK (falling from 621 in 2015), but less than a third of them play a significant role in the market. Overall, less than half of UK farmers are part of farmer cooperatives (approximately 143,000 farmers are partners in such ventures, but in 2015 there were 155,000), with a turnover of over £7 billion. They have roles in supplying agricultural input and supplies to farmers, grain trade, storage, and processing (Evans, 2015; COOP, 2015; COOP, 2018).

Contrasting to this, the UK´s milling sector is quite structured and serves as focal actor that link farmers, industry and market. Most millers in the UK are part of nabim (National Association of British and Irish Flour Millers), the trade association that represents the sector, and accounts for 99% of flours produced in the UK and Republic of Ireland (nabim, 2018a). Nabim is composed of 30 companies operating 51 flour mills (Figure 3.8). By comparing Figures 3.6 and 3.8, it is possible to note that mill distribution, like in Brazil, is also associated with wheat areas of production, as well as proximity with consumers. This does not mean, however, that capacity of milling is equally distributed.

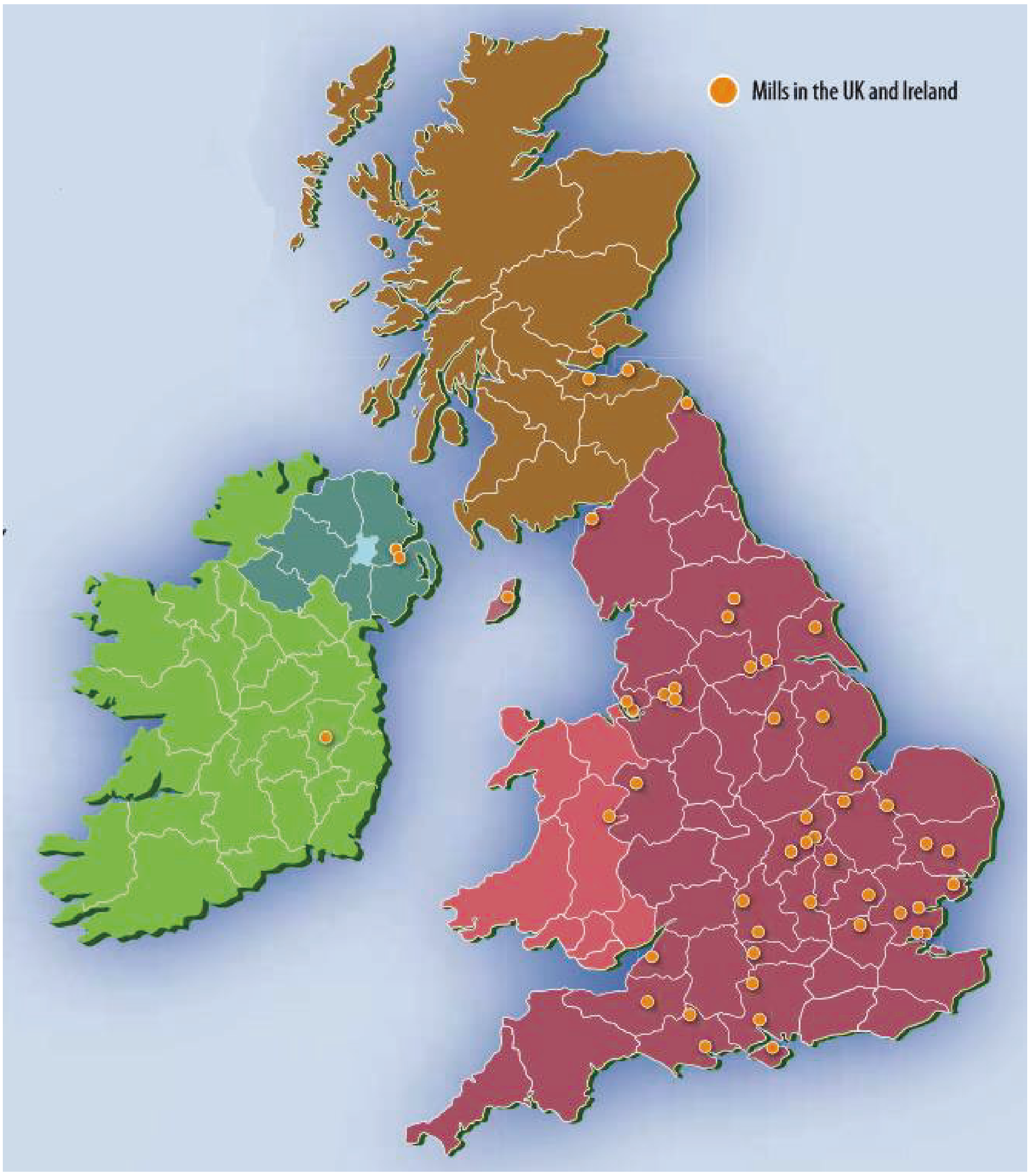



**Figure 3.8** Locations of mills in the UK (nabim, 2018b).

The mills affiliated with nabim process approximately 5 million tonnes of wheat a year (of which 4.3 million sourced in the UK) and have an annual (2019) turnover of £1,25 billion. Approximately 2/3 of flour production in the UK is done by just four companies, and the other third is provided mostly by another 10 firms. The other mills are attached to niche markets. Table 3.4 shows the distribution of flour uses in the UK (nabim, 2018a).

**Table 3.4** Percentage of the different types of flour milled.

| | 2016/2017 | 2017/2018 | 2018/2019 |
|---|---|---|---|
| **White breadmaking** | 44.1% | 45.6% | 48.9% |
| **Brown breadmaking** | 0.9% | 0.9% | 1.0% |

| | | | |
|---|---|---|---|
| **Wholemeal breadmaking** | 4.7% | 4.8% | 5.2% |
| **Biscuit** | 7.1% | 7.9% | 9.5% |
| **Cake** | 2.1% | 2.3% | 1.9% |
| **Pre-packed household** | 2.9% | 3.1% | 3.4% |
| **Food ingredients** | 5.1% | 5.6% | 8.0% |
| **Starch manufacture and other** | 33.2% | 30.0% | 22.1% |

Source: (nabim, 2019, p.2).

Wheat flour milling also produces bran for human food and animal feed. Table 3.5 shows the main destinations of the UK flour (2019). The cereal is the most significant cost for mills, with prices being defined in the international market and dependent on world stocks, production around the world, weather conditions, etc. (nabim, 2018a).

**Table 3.5** UK flour destinations.

| | |
|---|---|
| **Bakeries** | 66% |
| **Cake making** | 2% |
| **Household flour** | 4% |
| **Exported** | 7% |
| **Other foods** | 10% |
| **Biscuit making** | 11% |

Source: (nabim, 2019, p.3)

According to nabim (2018a), most mills operate over 360 days a year, and technological development has led to machinery being almost exclusively powered by electricity. These companies evaluate both quality and safety standards of wheat grain from direct suppliers (grain merchants and cooperatives) and farmers, with independent inspections, also carried out.

Most of the bakery production in the UK is represented by the Federation of Bakers (FOB), comprising of 9 companies (33 bakeries) plus 20 associate members. This sector provides more than 21,000 direct jobs and has an annual revenue of £3.5 billion (FOB, 2018a), producing approximately 4 billion units of bread a year.

There are roughly three types of bakeries in the UK market (FOB, 2018a):

a) **Plant bakeries**: large companies that produce around 85% of bread in the UK (by volume) with 75% of production value. These organisations produce mainly wrapped bread (large scale), and this account for ¾ of bread consumption in the country[16]. Three companies (Allied Bakeries, Hovis and Warburtons) produce around 75% of bread value in this category. They sell their product both in their own brands as well under retailers' labels.

b) **In-Store Bakeries**: bakeries mostly present in supermarkets. They produce about 12% of the volume of bread in the UK, but 20% of the value. All large retailers (e.g., Tesco, Sainsbury's, ASDA, etc.) have this kind of bakeries in their stores, producing bread from scratch and/or from frozen bread / pre-prepared dough.

c) **Craft/high street bakeries**: Account for 3% of bread production (volume) and 5% of its value. UK craft bakeries are diversifying into catering, takeaway food and supplying supermarkets. This is because of the increase in sales and production of in-store and plant bakeries. In the rest of Europe, these firms dominate the market but are under financial pressure in the UK. Craft bakeries formed their own association, the CBA (Craft Bakery Association) that identifies 4,500 small bakeries, 350 medium size (25-100 people) and 150 large plant bakeries in the UK (CBA, 2018). Around 40% of employees of the industry work in production.

The average UK household spends £54.41 a year on bread loaves (around 80 loaves per household, per year), a product that is consumed in 99% of UK houses (FOB, 2018b). The value spent per household includes yellow sticker offers (e.g., reduced price at the end of the day to clear stock) and both 400 and 800g loaves.

Another significant part of wheat industrialisation is linked to biscuits and pasta. Biscuits' market gross revenue was estimated to reach £1.9 billion, with a demand of 86% of all UK´s households consuming such products. Most biscuits consumed are sweet, but the overall market is reducing its sales in favour of more healthy snacks (Biscuit People, 2014; Daneshkhu, 2017).

The pasta industry in the UK is smaller than the other discussed so far, considering the pre-Brexit participation. The biggest producer and exporter of pasta in the European Union is Italy, almost 100 times larger than the UK´s. The UK produced 35,000 tonnes of pasta in 2015 (last data available) with a 3.5 kg of pasta consumed per capita (2015) (UN.A.F.P.A., 2016a; UN.A.F.P.A., 2016b).

[16] According to FOB, this is because of convenience, quality maintenance and value for money (FOB, 2018).

Most of these products are sold in grocery stores, with a small percentage in high street craft bakeries. As stated before, around 12% of the overall bakery products in the UK is made by in-store bakeries. Grocery stores account for almost half of the retail stores market value (£366 billion overall retail sales in 2017 with £190.3 billion from grocery stores) (Retail Economic, 2018; Crisp, 2018). These companies can be classified into six categories (Crisp, 2018):

a) Hypermarkets – accounts for 8.62% of the market (£16.4 billion).
b) Supermarkets – biggest share of the market, with 46,8% (£89.1 billion).
c) Convenience – second largest share of the market value at 21.1% (£40.1 billions).
d) Discounters – includes Aldi, Lidl and Wilko. Currently going through an expansion, account for 12.1% of the market (£23.1 billion).
e) Online – fastest growing category, it represents 6% of the market (£11.4 billion).
f) Other retailers – this category is formed by food and drink retailers; confectionery, tobacco and news; and food sales from mainly non-food retailers and street markets. Accounts for 5.3% of the market (£10.2 billion).

Four companies account for over 68% of the market (Tesco, Sainsbury, Asda and Morrison's) (Statista, 2018). According to data from the Office of National Statistics (2017), the average UK household spends £10 a week on wheat and other cereal-based foods[17], and this accounts for £14,3 billion a year. These types of foods represent 19.3% of total expending on food a week. Large supermarket chains, as expressed above, sell 78.6% of the sales from such products while other outlets account for 13.6% and online shopping 7.8% (ONS, 2017).

<u>Section summary</u>: Section 3.2 presented an overview of the UK's wheat agro-industrial complex: wheat production characteristics (including geographical distribution), general statistics of the crop and industry structure. Furthermore, the section also included data of the following actors in the wheat supply chains, considering main production and consumption patterns. Most UK's wheat is used for feed, but a significant part is focused on the internal (national) consumption. The UK's WAIC has a small group of players in each link of the industry dominating the market. Considering the sectoral information for wheat and wheat-base products both in Brazil and the UK as the overall economic-setting

[17] Bread, rice and cereals; Pasta products; Buns, cakes, biscuits; Pastry (savoury).

that the supply chains investigated in this thesis, the next section discusses the framework for the research, constructed based on the information provided.

## 3.3 ACADEMIC RESEARCH GAP AND RESEARCH QUESTIONS

Chapter 1 identified the background, research motivation and justifications for the present thesis. Considering the literature review presented in Chapter 2 and the WAIC of both Brazil and the UK (Chapter 3), it is relevant to reiterate how the research problem and questions were formulated and their development flow.

Wheat is one of the most important staple foods worldwide. Its production is distributed throughout the world, it is the most traded cereal in the international market, and it represents an essential percentage of the daily kcal consumption of humans (Mori and Ignaczak, 2012; Smith and Barling, 2014). Wheat food supply chains are long supply chains that connect wheat farmers to different types of organisations and transform the material until it reaches various retails (Smith and Barling, 2014; nabim, 2018b). The sustainability of such a product is, therefore, an important issue to be tackled by policy, organisational practices and, in the present case, academic research. The Brazilian WAIC and the UK´s WAIC present differences that can influence the supply chain, from structure to consumption patterns and include a divergent perspective regarding wheat and food production overall: while Brazil is a net exporter of food, it is a net importer of wheat, while the UK is a net importer of food but a net exporter of wheat. Therefore, the WAIC from Brazil and the UK are fertile cases to be investigated.

With such a backdrop, the study addresses different sustainability perspectives in supply chains, identifying CE (and, consequently, CSC) as one of the more prominent frameworks currently. Some gaps in the literature were identified, including the understudying of works discussing wheat food supply chains and CE, the lack of description on CE practices in such contexts and no prior comparison between the Brazilian and the UK´s wheat food supply chains (as highlighted in section 2.2.2). With CE being a practical framework, it has clear operations connected to it. Similarly, it is important to map the material flow in order to identify the circularity of the materials, in this case, wheat food, its by-products and waste. Both of these elements (CE practices identification and mapping of the material flow) form the first two research questions when associated with the countries in question (Brazil and the UK). Alongside the analyses of each case, it is relevant to compare both cases as local characteristics influence these practices. By comparing the different cases, it is possible to identify commonalities or differences between them, thus deepening the understanding of wheat food supply chains and CE. Considering such factors, the first three research questions were formulated as follows:

Q.1 - What are the main Circular Economy practices in wheat food supply chains in Brazil and the UK?
Q.2 - What are the material flows, including wastes and by-products, in a wheat food supply chain in Brazil and the UK?
Q.3 - What are the similarities and differences of the Circular Economy practices between the wheat food supply chain in Brazil and the UK?

While the first three questions emerged from wheat sustainability concerns with the inclusion of CE as the sustainability perspective to tackle the topic – including bridging the academic research gap presented - the following two research questions emerged from the literature on supply chain management and the relationship between actors. Even though TCE is one of the more prominent perspectives on the topic, it was a gap in CE and CE diffusion influencers (as highlighted in section 2.4). Therefore, TCE was included in the research as an auxiliary theory, influencing the formulation of the research problem itself. The fourth and fifth research questions were:

Q.4 - What are the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated?
Q.5 - How the characteristics of the transactions between the organisations of the supply chains studied interact with the Circular Economy diffusion influencers?

By answering the five research questions, it is possible to address the research problem: to understand the role that transaction dimensions have in the diffusion of CE practices in wheat food supply chains. Figure 3.9 below summarises the flow of development of the research questions, marking the origins of the academic research gaps that this thesis tackled. It also serves as the basis for the development of the research framework (Chapter 4).

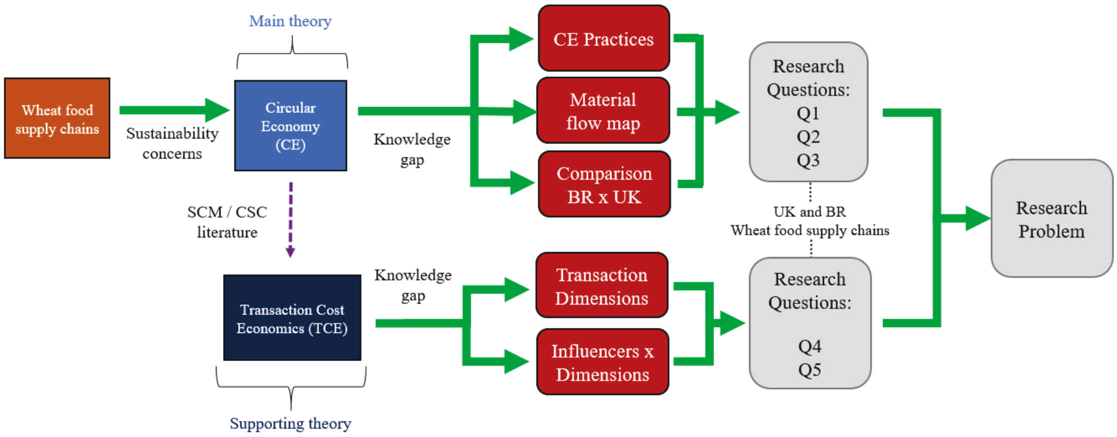



**Figure 3.9** Flow of development of the academic research gap

As Figure 3.9 shows, the gaps that the research aims at fulfilling emanated primarily from concerns relating to the sustainability of wheat food supply chains. As the research progressed, it became clear that CE was the primary theory to address such concerns, as Chapter 2 demonstrated. It is first necessary to identify if there is CE in wheat, thus, Questions 1 to 3. Similarly, by addressing SCM literature (including CSC), TCE emerged as the supporting theory to shape the investigation given the academic research gaps identified, thus requiring Questions 4 and 5 and the research itself at the end.

# 4. RESEARCH FRAMEWORK

Having presented the research questions and objectives (Chapters 1 and 3) and the overall field (theoretical and practical) where the research takes place, it is crucial to clarify how the different theoretical elements presented so far are linked with each other. This forms the framework that guided the research, aiming thus at addressing the research problem and achieving its objectives.

Models and frameworks can be seen as simplifications of reality and research (Grix, 2010) that help to outline its essential elements. Saunders *et al.* (2016) proposed a broader perspective, arguing that there are four types of frameworks: a) analytical schemes; b) simplifications of reality for discussion, analyse or research; c) simplifications of reality with certain phenomena/variables and suggestions of individual relationships between them; or d) judged for utility, not correctness. In this research, the use of the framework is the second one (b), therefore a simplification to allow more accessible understanding of the pieces of the study, but that also allows a clearer picture of the relationship between elements and thus having aspects of the third type (c).

The first element of the model is the CE representation and the connection with CE practices and diffusion (Figure 4.1). From the CE theory, it originates two of the three major Operational Concepts (OC) of the research that are also linked together as they originate from the same source:

- CE practices - including those connected with CSC material flow (e.g., repurpose, redistribution, etc.) as it directly relates to the first two research questions and is needed for the third one.
- CE diffusion - influencing factors in the adoption of CE operations by organisations in the cases researched. Includes the barriers, drivers, and enablers to CE diffusion in the supply chain.

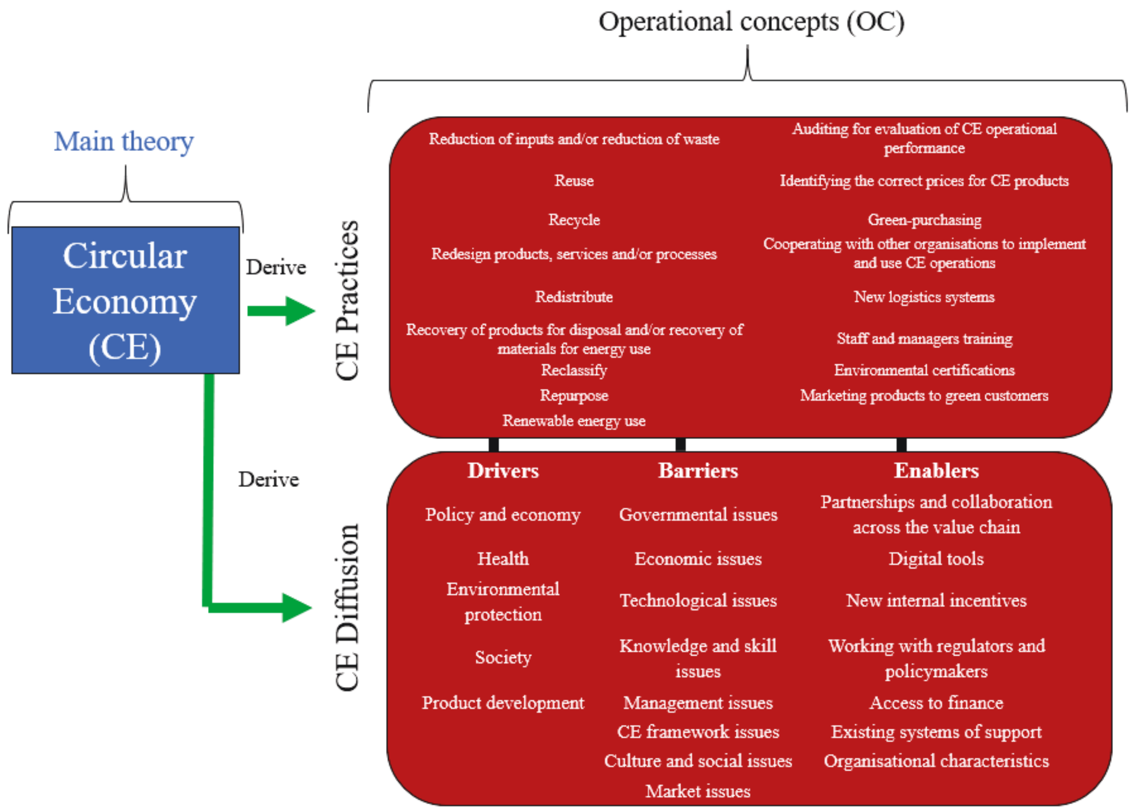



**Figure 4.1** Operational concepts deriving from CE theory.

As Sections 2.2.2 to 2.24 showed, there is a large number of CE practices and diffusion influencing factors in the literature. To account for that, the CE practices used in the framework are those shown in Table 2.7 with the addition of the practices identified by Govindan and Hasanagic (2018) and Masi *et al.* (2018) that are not 'R practices' (Section 2.2.2). These operations were selected considering their application in the agri-food supply chain setting, how common they are in CE literature and the differences between the practices.

Figure 4.1 also presents the complete set of barriers, drivers, and enablers of the framework. As expressed previously, the clusters (categories) of Barriers and Drivers identified in Govindan and Hasanagic (2018)'s systematic review were chosen as the categories for this investigation. The two main reasons for that are the sizeable scope of the work undertaken by these authors in their review and the applicability of these categories in the agri-food supply chain setting studied here. Initially, the work of Kirchherr *et al.* (2018) was going to be used for the barriers. However, after some considerations, it was identified that the categories were too focused on industrial (technical) products.

For the drivers, Govindan and Hasanagic (2018)'s work was selected once more as the primary reference Considering the significant overlap between different works that addressed drivers for CE adoption, having a coherent framework facilitates data collection and analysis (Cooper and Schindler, 2014). Therefore, it was logical to keep the same document for both barriers and drivers.

The categories suggested by Mishra *et al.* (2018) (Table 2.6) were selected for the enablers. Most of the literature on influences of CE adoption/diffusion centres on drivers and barriers, with comparable fewer documents addressing the conditions to overcome such challenges (Mishra *et al.*, 2018). Furthermore, the application of such categories is viable in multiple types of supply chains, including those of the cases investigated.

CE is not the only theory that supports the present research, as Section 2 showed. TCE function as a supporting theory for the understanding of the roles that transactions between buyers and suppliers (dyads) have in the diffusion of CE practices. However, not all of the theory regarding TCE is used here, only its three main dimensions (asset specificity, frequency, and uncertainty) plus types of contracts.

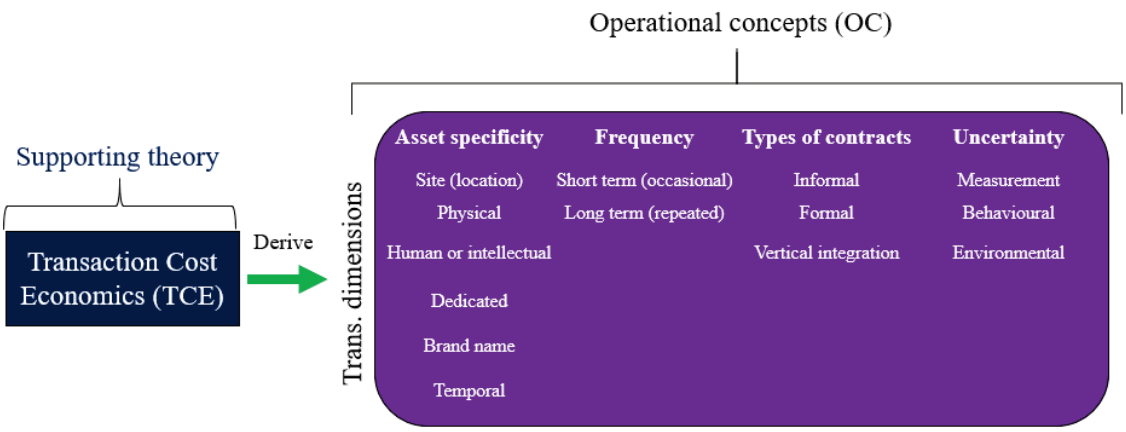



**Figure 4.2** Operational concepts deriving from TCE theory

The dimensions chosen to be part of the study are the three main dimensions in transactions (Williamson, 1998), their subcategories according to the literature, plus the dimension types of contracts. The last dimension was selected given Williamson's works on governance and the criticisms of TCE in the debate with Zipkin (2012) in relation to supply chains.

The categories shown above are applied in the circular agri-food supply chain (CAFSC), more specifically, in wheat food supply chains in Brazil and the UK.  shows the complete research framework. The dotted arrows represent the connection that needed to be identified in order to answer the research questions. The top arrow (initiating at CE practices) is linked with the first three research questions (CE practices identification, material flow and comparison of cases).

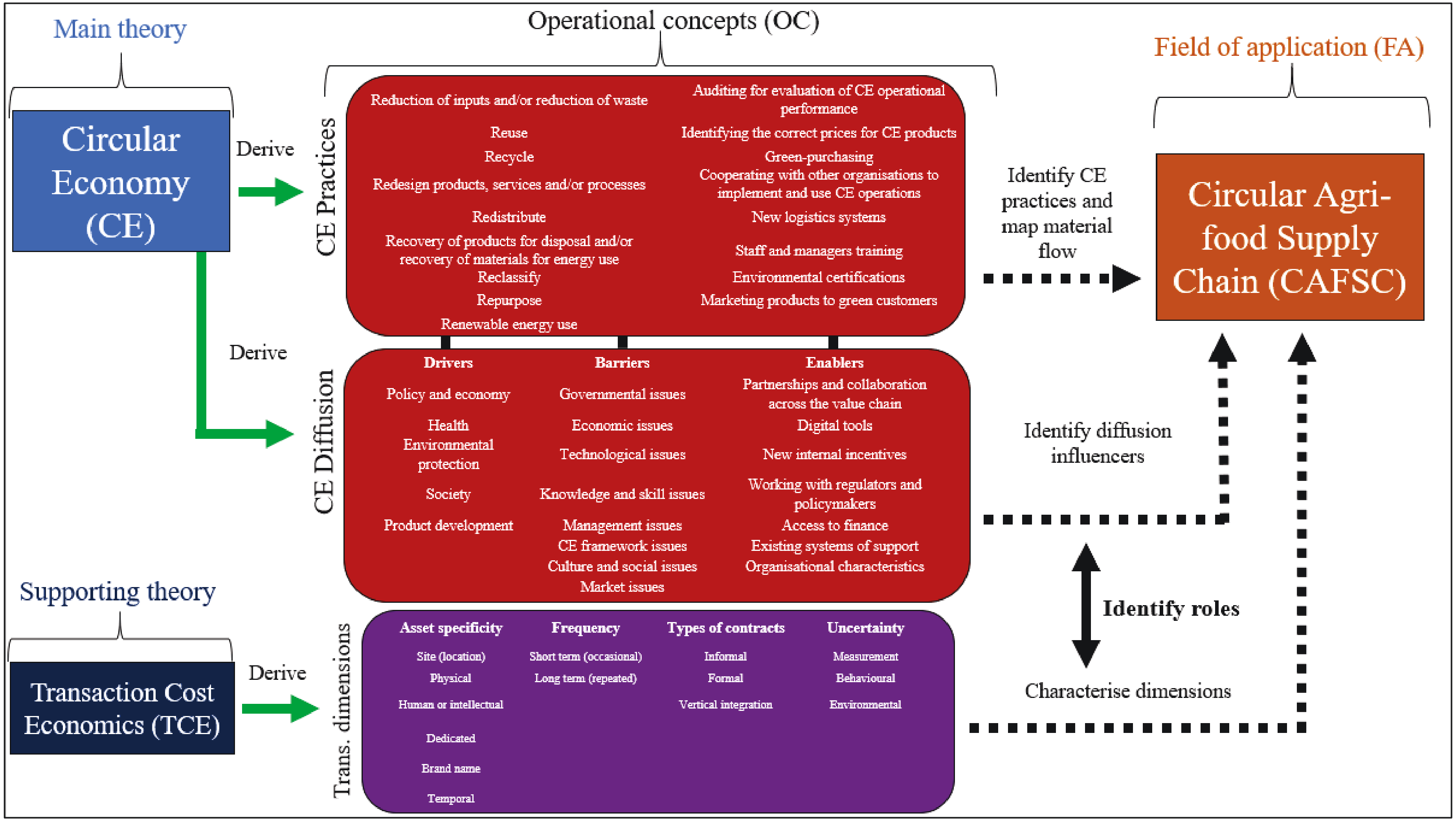



**Figure 4.3** Research framework.

The arrow from the TCE section is required for the fourth research question (identification of TCE dimensions). The information identified there is connected with the characteristics of the dimensions (double-headed arrow) to answer the final research question (interaction between influencers and dimensions) and subsequently, addressing the research problem.

In the next section, further details of the model is explained, and how they are linked with the thesis and were operationalised in this research. The following section also aims to serve as a translation of the abstract theoretical information, into applicable factors for the research, thus forming a bridge between theory and methodology.

## 4.1 CONCEPTUAL DEFINITIONS AND OPERATIONAL DEFINITIONS OF VARIABLES

Conceptual Definitions (CD) are theoretical definitions that describe a variable or category of analysis based on the existing theory (Angot and Milano, 2001; Bryman and Bell, 2015). Although the concepts described in this thesis do not attempt to be definitive, they present the underlying assumptions under each element studied here.

Operational Definitions (OD) are elements used to translate the CD into practical aspects for the research, reducing the chance of misapplication of the theoretical framework (McBurney, 1994). Some authors such as Bryman and Bell (2015) consider OD more closely linked with measurement and quantitative research than to qualitative research (although they do not prohibit its use in the latter). Others, such as Angot and Milano (2001), view this translation as a way to bring the theoretical to the empirical reality, not making distinctions between qualitative and quantitative research. This second approach is used in this thesis

- Circular Economy (CE) Practices

CD: CE practices are the set of operational and business model applications of the organisations in the food supply chains, within the scope of Circular Economy theory. Examples of such practices can be found in section 2.2.4.

OD: Operationalised with the information from questions 1 and 2 that looked into understanding the practices informed by the interviewee that fit into the sustainability practices informed and/or CE practices listed and selected by the participant (Appendix C), as well as from secondary data from reports (e.g., sustainability reports), websites and documents provided by the participants.

- Diffusion of Circular Economy (CE) Practices

CD: CE Practices Diffusion is the dissemination of CE practices throughout the organisations part of the supply chain being studied. It derives from the literature on operational practices, innovation and technology diffusion and transference, and has barriers, drivers and enablers. For a single organisation, the term adoption was used, for more than one, diffusion.

OD: Operationalised with the information from questions 3, 4 and 5 and that aim at understanding the enablers, drivers and barriers of CE practices dispersion within the organisation (adoption) and the overall supply chain (diffusion), presented in the semi-structured interview script, in Appendix C.

- Transactions

CD: Transactions occur when a product or a service is provided to a consumer (Davies and Lam, 2001). Based on the work of Wever *et al.* (2012), it is defined here as the form in which supply chain participants manage their exposure to risks (both supply and demand), accounting for their interactions with the participants of the supply chain, especially their suppliers and buyers.

OD: Operationalised with the information from question 15-21 of the interview script, focused into understanding the ways that the researched/selected organisation interacts with their suppliers and/or buyers regarding uncertainty, investments, formalisation and frequency. This is presented in the semi-structured interview script in Appendix C.

- Material flow in circular supply chains

CD: Deriving from the works of The Ellen MacArthur Foundation (2014), De Angelis *et al.* (2018), Batista *et al.* (2018a) and Vlajic *et al.* (2018), is defined here as ‘supply chains with restorative forward and reverse flows (of funds, goods, wastes, etc.) both within itself – **closed loops** – and outside of it, cascading across supply chains – **open loops**.

OD: Operationalised with the information from the overall analysis of the semi-structured interviews, aiming at understanding the circularity of the supply chain. It focuses on the buyer-supplier dyads and the 'R practices' connected to material flow (e.g., repurpose, redistribution, reuse, etc.). In the interview script (Appendix C), questions 6-14 were focused on supplementing the picture in terms of waste flows.

- Circular Agri-food supply chain (CAFSC)

CD: CAFSC is circular supply chains that function in an agri-food setting. In the present research, they are comprised of wheat food supply chains, part of a larger wheat agro-industrial complex (WAIC). Since wheat can be used as not only food but also feed for animals or chemical feedstock (industry), 'food' was clearly defined within the scope of the supply chain. The wheat food supply chain is composed of the organisations that produce, trade, industrialise, and store wheat and wheat-based food products, from farm to market.

OD: Operationalised with the information from the secondary data and semi-structured interviews, especially question 13-14 (Appendix C), that looks into understanding the relationships of the participant. The mapping of the material flow is also part of the operational definition of the CAFSC.

# 5. METHODOLOGY

This chapter considers the procedures used to answer the research questions, as well as the epistemological foundations that guided the research. It is subdivided as follows: research specification; ontological and epistemological considerations; categories of analysis; research design and delimitation; research limitations.

## 5.1 RESEARCH SPECIFICATION

The introductory chapter of this thesis already identified the research problem and aim, questions and objectives. However, to facilitate the understanding of the methodological choices taken, it is relevant to restate both research questions and objectives. The research problem was stated as follows:

| |
|---|
| Problem statement: CE literature has shown that there are many influencers – driver, barriers and enablers – in the adoption/diffusion of CE practices within a supply chain, including the relationships between actors. However, the ways in which transaction dimensions in buyer-supplier dyads affect the diffusion influencers in wheat food supply chains is a phenomenon still requiring further study and understanding. |

To address the research problem, five research questions needed to be answered and are linked with the aims and objectives below:

- What are the main Circular Economy practices in wheat food supply chains in Brazil and the UK?
- What are the material flows, including wastes and by-products, in a wheat food supply chain in Brazil and the UK?
- What are the similarities and differences of the Circular Economy practices between the wheat food supply chain in Brazil and the UK?
- What are the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated?
- How the characteristics of the transactions between the organisations of the supply chains studied interact with the Circular Economy diffusion influencers?

Research Aim:

The aim of this research is to investigate the role that the transactions between organisations in the UK's and Brazilian wheat food supply chains can have in the diffusion of Circular Economy practices.

Research Objectives:

- To identify the Circular Economy practices in a wheat food supply chain in Brazil and the UK.
- To map the material flows, including wastes and by-product outputs, in the wheat food supply chain in Brazil and the UK.
- To compare the similarities and differences of Circular Economy practices between the wheat food supply chain of Brazil and the UK.
- To identify the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated.
- To verify how the characteristics of the transactions between the organisations of the supply chains studied interact with the Circular Economy diffusion influencers.

The next section discusses the philosophical approach to science (epistemology) that this thesis follows.

## 5.2 ONTOLOGICAL AND EPISTEMOLOGICAL CONSIDERATIONS

It is essential to clarify the philosophical basis of the research and how it is constrained since research must be well-grounded. There are four layers to be considered (Easterby-Smith *et al.*, 2015) regarding this:

a) Ontology: the considerations of the nature of reality.
b) Epistemology: the theory/philosophy of knowledge.
c) Methodology: the procedures of scientific investigation (Babbie, 2018).
d) Methods and techniques: the elements or tools used for data collection, organisation and analysis.

### 5.2.1 Ontological positions of the research

Ontological assumptions or the worldviews that are formed by the philosophical orientations regarding reality and what is to be known (Grix, 2010; Creswell, 2013; Saunders *et al.*, 2016) tend to be classified in a continuum. In one pole, there is Subjectivism (also called relativism, or in the extreme, nominalism) and in the other, Realism (also known as foundationalism or objectivism ) (Grix, 2010; Braun and Clarke, 2013; Saunders *et al.*, 2016). Subjectivism is an ontological position that asserts that social actors are continually producing social phenomena and its meanings, or in other words, reality depends on the interpretation of people (Grix, 2010; Braun and Clarke, 2013). On the other hand, Realism can be defined as reality (i.e., social phenomena and its meanings) existing independently of perceptions of social actors (Grix, 2010; Saunders *et al.*, 2016).

This thesis is positioned on the subjectivist perspective, consequently, with the understanding that there are many 'truths' and that the viewpoint of the observer can influence the facts (Easterby-Smith *et al.*, 2015). The subjectivist typology is made clear since the thesis considered the different views of different participants and their organisations regarding the overall phenomenon of CE practices diffusion and its relationship with transactions between organisations. In other words, there is no single true perspective for the participants of this research, nor the researcher, but to the inquiry on such elements facilitated improving the understanding of CE and transactions, given the different perspectives included in the study.

Another element that must be highlighted is that this thesis is not in the extremes of the poles regarding reality (Easterby-Smith *et al.*, 2015). With the continuum view of reality, the perspective taken in the thesis is closer to the middle ground between realism and subjectivism. With this positioning, although the thesis falls within subjectivism, elements of realism are also possible. The implications of this are more clearly perceived in the epistemological and methodological choices taken in the thesis and discussed below.

### 5.2.2 Epistemological position of the research

As stated before, the ontological views of reality are linked with the epistemological perspectives regarding what is possible to know and the matter in which knowledge is created. In other words, epistemology is the branch of philosophy that deals with assumptions about knowledge (definition, validity and legitimacy), how to acquire it and communicate it to others (Braun and Clarke, 2013; Saunders *et al.*, 2016). The epistemological assumption more closely linked with Realism is Positivism (sometimes called objectivism). Said epistemological position has profound influence from the natural sciences (where it is the predominant epistemology) and searches typically for statistical generalisations for topics researched. In this stance, researchers look into social phenomena with a perception of a direct link between reality and our perception of it, and that it is possible to reach one objective truth (Grix, 2010; Braun and Clarke, 2013; Saunders *et al.*, 2016).

On the other side of the epistemological spectrum is Interpretivism (also called constructionism or social constructionism) (Grix, 2010; Braun and Clarke, 2013; Saunders *et al.*, 2016). This position is linked with Subjectivism and has greater adherence in the arts and humanities. It identifies individual and context-specific knowledge through the collection and analysis of social interactions such as opinions, narratives and attributed meanings (Saunders *et al.*, 2016) and this means that there is no one truth to be identified. Although these two are the dominant positions within social sciences, other stances also exist, such as postmodernism, contextualism and pragmatism (Braun and Clarke, 2013; Saunders *et al.*, 2016).

This research was characterised within the interpretivism perspective. Both the research aim and the research objectives were worded to show this. Interpretivist epistemology orients to the need to identify new understandings and worldviews. It also adheres to varying narratives and interpretations depending on the person, the organisations part of the wheat food supply chain and the researcher, thus bringing a more comprehensive perspective on a subject (Saunders *et al.*, 2016). The interpretivist philosophy for this thesis is evident when considered:

a) The diversity of assorted participants and organisations, and therefore perspectives, present in the WAIC;
b) CE practices in supply chains vary considerably according to existing theory, as well as the reasons to implement them both on the organisation and the supply chain;
c) The decision to adopt a practice is dependent on many different factors (enablers, drivers, barriers), also influenced by the perspective of the actor;

d) Transactions can vary depending on several elements as TCE points out, and to include the perspectives of the different participants increases the understanding of these phenomena.

From a different standpoint, the research problem suggests an interpretivist position since it requires a wide range of perspectives to answer it, with potentially different understandings of the same issue (CE diffusion and transactions) depending on the respondent. It must be pointed out, however, that this thesis does not have an extremist epistemological perspective (Collis and Hussey, 2014; Saunders *et al.*, 2016), coming closer to a middle ground on the positivist-interpretivism spectrum. Therefore, some elements of the thesis are not purely in the interpretivist field. One of such factors is the mapping of processes relating to the material flow used in the CSC. Another regards the approach to theory and knowledge used in the thesis and is discussed in the next section.

### 5.2.3 Approach to theory and knowledge

Knowledge development tends to be classified into two categories: deductive and inductive (Fisher, 2007; Grix, 2010). The first identifies generalisations from general to specific and is used mostly for theory testing. A theory is, therefore, pre-existing in the context of the research. On the other hand, induction generalises knowledge from specific to general, thus aiming at theory generation/building (Saunders *et al.*, 2016). These positions are not necessarily unique and self-excluding. It is possible to join them in deductive-inductive research (Grix, 2010) or abductive research (Saunders *et al.*, 2016).

Abduction is a form of middle-ground between induction and deduction, given that it creates generalisations from the interactions between general and specific and aims at theory generation or modification through the analysis of reality, allowing for theory improvement based on that analysis (Saunders *et al.*, 2016). While traditional (purely) interpretivist epistemology is closely linked with inductive research, this thesis does not adhere to this and is more accurately classified as abductive research.

According to Grix (2010), it is highly unlikely that research is 100% inductive or 100% deductive. Most studies will have some overlap between both perspectives, thus allowing greater reflexivity between theory and reality description. This research is based on the perspective of mixed form of knowledge creation and theory-reality relationship as per Saunders's *et al.* (2016) definition of abductive research. The reason for this is that it used the existing theory as a starting point to understand reality, but also aimed at improving the theory based on the research results, therefore being classified as abductive. More plainly, existing theories (CE and TCE) were used, but they still required adaptation to this field of practice (namely wheat food circular supply chain), and better development given the lack of information regarding transactions and CE diffusion.

Section summary: Section 5.2 presented the ontological, epistemological and the approach to knowledge creation used in this thesis. Ontologically the research is classified as Subjectivist; epistemologically, the investigation falls in the Interpretivism category. Both of these positions are not in the extreme of the spectrum. The approach is Abductive, with the use of pre-existing theory and further development of those theories from the data.

## 5.3 CATEGORIES OF ANALYSIS

It is appropriate to define the elements of analysis that were used in this thesis in order to frame what was investigated and the entities studied. Different authors have different definitions for these constructs. For instance, Yin (2018, p.286) argues that the unit of analysis is the case per se, or in other words, the "*main focus of inquiry in a case study*". A similar position was presented by both Sekaran (2003) and Easterby-Smith et al. (2015) when they defined the unit of analysis as the main "level of aggregation" of the researched data analysed. For Yin (2018), it is also important to differentiate 'unit of analysis' from 'unit of data', and Easterby-Smith *et al.* (2015) reinforced the position by calling the second element subsidiary unit of analysis or 'embedded case' (the term used in this thesis) therefore "*a case within a larger case*" (Easterby-Smith *et al.*, 2015, p.334).

It is useful to reiterate that a case study approach was chosen given the lack of previous studies on both the topic and the setting, its capacity to gather in-depth information considering the interpretation of the participants on a given subject (Eisenhardt, 1989; Babbie, 2018), and this is further explored in section 5.4.1.1. Both Grix (2010) and Bryman and Bell (2015) argue that it is possible to have more than one level of analysis in a study, but this needs to be made explicit and distinguish between them. It is also possible to argue that more than one unit of analysis in a single investigation is viable (Easterby-Smith *et al.*, 2015).

Considering that the supply chains are formed by the organisations that are part of it, Figure 5.1 illustrates the elements that formed the units of analysis, as well as the comparisons between the elements (the dotted arrows) performed in the present investigation.

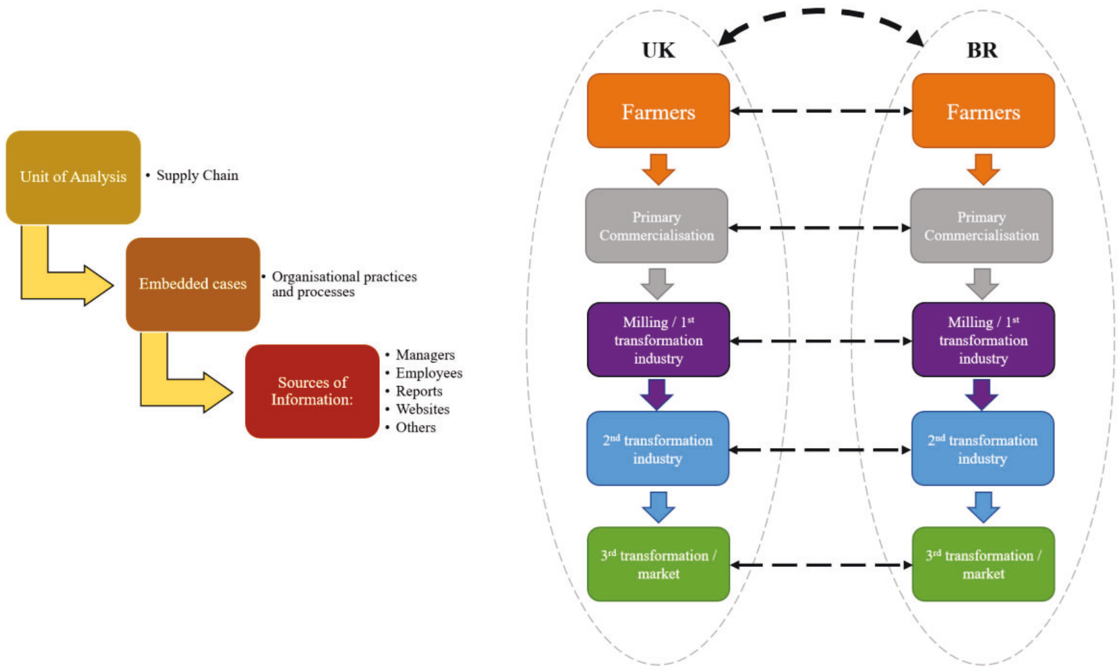



**Figure 5.1** Units of analysis and comparative design

Each wheat food supply chain formed a case that was compared to its counterpart in another country, thus making this a comparative dual case study (Collis and Hussey, 2014) of supply chains. However, it is also possible to say that each embedded case - the organisational practices and processes executed by the actors' part of the supply chain – were likewise compared with their counterpart in the other supply chain. Although transactions are an essential part of this thesis, they are not embedded cases. This is further explored in the limitations and future works of this research.

<u>Section summary</u>: Section 5.3 discussed the categories of analysis of the research. The unit of analysis is the supply chain. The embedded cases are the organisational practices and processes identified in cases. The investigation uses multiple comparative case studies comparison, or dual comparative case study comparison, comparing both the supply chain and the processes performed by the organisations that are part of them.

## 5.4 RESEARCH DESIGN AND DELIMITATION

While the methodology is the framework that constrains and guides the research, methods are the applications of these guidelines and tools used for the investigation (Braun and Clarke, 2013). The research design is the blueprint used in the thesis. The following section outlines the principles that supported this thesis, describing the operational decisions taken and how the literature supports them.

### 5.4.1 Research design

This current section is divided into two parts: the first is the identification of the research, that is, the different forms (taxonomies) that this research is classified with; and the second part are the concepts and elements used to guarantee its quality.

#### 5.4.1.1 Identification of the research

Collis and Hussey (2014) classify the types of research based on the processes related to it, that is, how data is collected and analysed, as well as the nature of said data. Considering this, methodologically this research is Qualitative. Qualitative studies are those that prioritise information in the form of words, meanings, perceptions inherent traits, characteristics and qualities, rather than quantities, numbers or statistical analysis aiming the understanding of human and social activities - “what” instead of “how much” (Grix, 2010; Braun and Clarke, 2013; Collis and Hussey, 2014; Cooper and Schindler, 2014; Bryman and Bell, 2015). Qualitative research is also employed for theory creation and/or improvement (Braun and Clarke, 2013; Collis and Hussey, 2014; Saunders *et al.*, 2016) as is the case for the present investigation in terms of filling the identified knowledge gaps.

Qualitative research is often employed in practices (and accounts of practices) identification as well as theory creation and improvement (Braun and Clarke, 2013; Saunders *et al.*, 2016), all of which were overall goals of this thesis, and linked with the abductive strategy discussed previously. This is reinforced by Stake (1995) when he described that among the differences between qualitative and quantitative research is the type of knowledge aimed at: qualitative research is linked to understanding complex interrelationships of the case studied instead of explanation and control (quantitative).

There are several types of qualitative research strategies, such as ethnography, action research, focus groups, etc. (Neuman, 2014; Babbie, 2018). The present research is a case study. Considering the interpretivist orientation of this study, the definition used here is the one provided by Stake (1995):

> *"Case study is the study of the particularity and complexity of a single case, coming to understand its activity within importance circumstances"* (Stake, 1995, p.xi).

Considering that this thesis investigated two cases (one Brazilian and one UK's wheat food supply chains), the investigation is more accurately classified as a comparative dual case study (Stake, 1995; Braun and Clarke, 2013; Gerring, 2017; Yin, 2018).

The choice for case study research was made given the capacity for this kind of strategy to bring robust information regarding the phenomenon in question (Stake, 1995; Collis and Hussey, 2014; Yin, 2018). Not only that, case study allowed an in-depth perspective of a supply chain, being able to cross information from more than one theoretical framework (circular economy and transaction cost economics in this context) looking at different settings (Bryman and Bell, 2015).

The analysis of supply chains from different countries that have different economic perspectives regarding wheat (UK net exporter versus Brazil net importer) was planned to give a more comprehensive view of the subject in question. Considering that the context influences the perspective of the organisations, and therefore their operational choices, the diverse viewpoints on the subject enriched the investigation.

Regarding objectives, research can be classified as exploratory, descriptive or explanatory, but these possibilities are not mutually-exclusive, and a research can be more than one of these at the same time (Neuman, 2014; Collis and Hussey, 2014; Yin, 2018; Babbie, 2018). This thesis is characterised as exploratory-descriptive. Exploratory researches are those that aim at finding patterns, ideas or hypothesis, where the end goal is the gain of familiarity with the topic, generally in areas scarcely explored or developed, thus allowing more rigorous studies in the future. Considering that during the literature review no studies were identified comparing wheat food supply chains in Brazil and the UK with a CE perspective or transaction dimensions and diffusion of CE in agri-food supply chains, this research is classified as exploratory. At the same time, it is descriptive because it aims to describe phenomena in a real-world context diffusion (Gerring, 2017; Yin, 2018), CE practices and processes, material flow and the interactions between dimensions and influencers of CE diffusion.

Collis and Hussey (2014) and Yin (2018) consider that case studies are particularly useful for exploratory and descriptive research. This research was not explanatory because explanatory research aims at explaining the why things are the way they are and/or to identify causalities between variables of a fact or a phenomenon (Neuman, 2014; Yin, 2018).

Another form to classify the present study is based on Stake's (1995) categories of case study. Stake (1995) argues that a case study can be intrinsic – the primary interest is the case itself – or instrumental – the investigation aims at understanding something else. Considering these definitions, this research can be classified as instrumental, since it aimed at understanding something else besides the cases per se.

Regarding time horizon (Babbie, 2018), this research fits into the cross-sectional classification, that is, based on a particular time (Saunders *et al.*, 2016). Data collection was limited to a specific period, therefore creating a snapshot of the objects studied in that fixed moment (Neuman, 2014). After data collection and analysis of each case (Brazil and UK), a comparison was made between the cases in terms of CE practices performed in each supply chain at the moment of collection.

<u>Section summary</u>: Section 5.4.1.1 presented some of the several forms the research can be identified. Methodologically, the research is a Qualitative investigation, performed using a comparative dual case study. The objectives of the research are both exploratory and descriptive. The type of case study is Instrumental, and the time-horizon is cross-sectional. The next section of this thesis details both the understanding of research quality used in this thesis (since this can vary based on authors and epistemological positions) as well as the steps taken to ensure the criteria.

#### 5.4.1.2 Research Quality

Validity (the conclusions of the research derived from the research) and reliability (ability to replicate a study and to achieve the same results) are the criteria for evaluating quality in research traditionally (Braun and Clarke, 2013; Bryman and Bell, 2015; Saunders *et al.*, 2016; Welch and Piekkari, 2017). However, these elements are more aligned with positivist-quantitative investigations (Collis and Hussey, 2014; Welch and Piekkari, 2017; Korstjens and Moser, 2018).

Qualitative-Positivist authors such as Gerring (2017) and Yin (2018) argue that qualitative research can also be evaluated using those standards (internal, external and construct validity, reliability and replicability) and in this are supported (at least partially) by some constructivist-interpretivist authors such as Robert E. Stake (Stake, 1995) or Remenyi *et al.* (1998).

Nevertheless, this thesis takes the position discussed by Welch and Piekkari (2017) and Korstjens and Moser (2018), who consider that the quality of interpretative-qualitative research should be evaluated in other terms, notably trustworthiness.

Trustworthiness is the capacity of research to have findings that can be trusted (Korstjens and Moser, 2018). Four elements comprise this concept:

a) *Credibility*: it is the counterpart to internal validity in positivist studies (Korstjens and Moser, 2018). It is related to truth-value, that is, if the findings of the research are believable, with information that is plausible and derived from the original data with an accurate interpretation of the original view (Lincoln and Guba, 1985; Collis and Hussey, 2014; Welch and Piekkari, 2017; Korstjens and Moser, 2018).
b) *Transferability*: it is related to external validity in positivist inquiries (Lincoln and Guba, 1985), and consequently, it is connected to generalisation (Collis and Hussey, 2014). Transferability conveys the quality of research (findings) to hold in other settings or with other respondents (Lincoln and Guba, 1985; Collis and Hussey, 2014; Welch and Piekkari, 2017; Korstjens and Moser, 2018).
c) *Dependability:* equivalent to reliability for positivist investigations (Lincoln and Guba, 1985). Consistency in interpretivist works is difficult to achieve considering the changes in respondents and context, but a higher level of stability can be attained by documenting and explaining these changes over time, thus increasing the dependability quality of the research (Lincoln and Guba, 1985; Welch and Piekkari, 2017).
d) *Confirmability:* related to objectivity in positivist researches (Lincoln and Guba, 1985). Since interpretivist consider that full-objectivity (akin to neutrality) is not attainable, the findings and conclusions must be consistent and sustained by the data (Welch and Piekkari, 2017). Therefore, the emphasis of the researcher shifts in favour of a focus on the data (Lincoln and Guba, 1985; Collis and Hussey, 2014).

To achieve the quality criteria mentioned above, a series of strategies were required, such as prolonged engagement and inquiry audit. Lengthy interviews (average 1 hour), repeated contacts when needed, data triangulation – both within the supply chain and with secondary data, thick description, a grace period of 30 days for participants were also executed in this research in accordance to quality criteria described above. Table 5.1 presents the strategies and steps taken in relation to said criteria and the research methodology literature it was based.

**Table 5.1** Quality evaluation criteria and strategies implemented

| Criteria | Strategy | Description |
|---|---|---|
| **Credibility** | Prolonged Engagement | Long interviews and repeated engagement with participants. Semi-structured interviews. |
| | Persistent Observation | Identifying, characterising and focusing on the most relevant elements to the problem. In loco observations whenever authorised by participants. |
| | Triangulation (data and method) | Using multiple data sources, specifically different interviewees regarding the same topic. Also evaluating secondary data (reports and websites) whenever available. |
| | Member check | Feedback to participants the transcription of the interview for evaluation and correction. |
| **Transferability** | Thick description | Description of opinion, context and operational practices in detail. |
| **Dependability** | Inquiry audit | Transparency with data available to evaluation and future use, as well as steps that were taken in the research. Operational and conceptual definitions to support this. |
| **Confirmability** | Triangulation | Using multiple data sources, specifically different interviewees regarding the same topic, also evaluating secondary data (reports and websites) whenever available. |
| | Inquiry audit | Transparency with data available to evaluation and future use, as well as steps that were taken in the research. Operational and conceptual definitions to support this. |

Sources: (Lincoln and Guba, 1985; Welch and Piekkari, 2017; Korstjens and Moser, 2018)

Section summary: Section 5.4.1.2 presented the research quality criteria for the investigation. The study followed trustworthiness criteria (Lincoln and Guba, 1985), and the main strategies to ensure are long, *in loco* interviews; data triangulation and transparency; in-depth transcripts and its verification. The operations performed and presented in the right-side column of Table 5.4 are further described in Section 5.4.3. The next section presents more details regarding the field of study, case selection and sampling methods used in the study.

### 5.4.2 Population, sampling and case selection

This section of the thesis discusses the population, the sampling strategies and the criteria used on the research. According to Cooper and Schindler (2014), a population is the sum total of the elements in which inferences are attempted. In this thesis, it represents all the wheat food supply chains in both countries. Interpretivist research generally does not explicate the populations linked with the case since it is mostly interested in the case per se and not the numerical context where it is contained (Lincoln and Guba, 1985; Stake, 1995; Braun and Clarke, 2013). However, the instrumental aspect of the thesis, as discussed by Stake (1995), must also be taken into consideration. For that reason, such information provides a clearer understanding of the setting of the research and the context in which the cases originated.

Since the configuration of a supply chain can vary considerably based on different parameters such as time of year (e.g., raw material availability), types of products produced (e.g., flour for bread, for biscuits, for pasta, etc.) and types of suppliers (e.g., foreign, local, mixed), it is impossible to describe the population of wheat food supply chains fully. However, it is possible to identify the population of the central actors' part of the supply chain, as previously discussed. Considering the work of Mori (2011) and Smith and Barling (2014), both the UK's and the Brazilian wheat food supply chain network have five major nodes:

a) Farms.
b) Primary commercialisation industry: grain merchants, traders, and farmers cooperatives.
c) First transformation industry: mills are the primary example.
d) Second transformation industry: industrial bakeries (biggest user of flour), pasta and biscuit industries.
e) Third transformation industry, wholesalers, and retail trade, comprising mostly from supermarkets (both retail and in-house bakeries), craft bakeries, pizzas, ready to eat dishes, among others.

Considering such actors, it was possible to estimate the population of each of the nodes at least partially:

a) There were approximately 33,000 wheat farms in the UK (DEFRA, 2018b) and 35,000 in Brazil (IBGE, 2017).
b) According to Smith and Barling (2014) and Williamson (AHDB Cereals & Oilseeds, 2019) there were around 25 wheat merchants in the UK. Regarding agricultural cooperatives, while the UK had 420 farmer co-ops (COOP, 2018),

Brazil had 1,555 of such organisations (OCB, 2018) but approximately 190 are more relevant considering regional wheat production (OCEPAR, 2017; OCERGS, 2017).

c) There were 30 milling companies in the UK operating 51 flour mills (nabim, 2018a). Brazil had 203 mills operating in the country (ABITRIGO, 2017b; ABITRIGO, 2018d).
d) The UK had nine large-scale industrial bakeries (33 plants) (FOB, 2018a) selling to retail stores and 22 pasta-producing companies (IBIS World, 2018). Brazil had at least 94 industries producing bread, pasta and biscuits (ABIMAPI, 2018b).
e) In the UK, there were approximately 5,000 craft bakeries (CBA, 2018) and 86,332 grocery retail stores. Brazil had around 70,000 craft bakeries (ABIP, 2019). The top 10 supermarket chains in Brazil owned 3,532 stores out of over 38,000 total in the sector (Fonseca and Berk, 2016).

Considering these populations, it was possible to outline the sample for the research. In case study research, the sample is the case itself (Gerring, 2017). The process of choosing what is the case to be studied (therefore, the sampling) can be implemented with several strategies (Easterby-Smith *et al.*, 2015; Saunders *et al.*, 2016). To that end, two elements are considered: i) what were the cases; and ii) in what number:

a) Regarding 'what cases', non-probabilistic choices for case selection were made. According to Eisenhardt (1989), Gerring (2017) and Yin (2018) when case studies are executed to construct or improve a theory, the choice of objects to be researched may not be random, nor it is preferable that they are, making the choice of cases possible by just how they add to the theory. In this thesis, the comparison of cases in different contexts were factors considered when selecting the cases. Such decisions are called selection by judgment (Cooper and Schindler, 2014) or purposive sampling (Braun and Clarke, 2013): a type of intentional sampling in which the research arbitrarily selects elements to fit some criteria.

The capacity to access the data and information is essential to the choice of the actors to be studied. Convenience sampling, also called logistic or *ad hoc* sampling, depending on the author (Braun and Clarke, 2013; Easterby-Smith *et al.*, 2015; Gerring, 2017), is defined as a type of non-probabilistic sampling where participants' selection is considered based on easiness of access by the researcher.

Although this type of sampling strategy has some criticism (Braun and Clarke, 2013; Cooper and Schindler, 2014) the importance of data accessibility, as well as the capacity of the cases selected at fulfilling the research objectives and answering the research questions outweighs the shortcomings making it a viable choice (Stake, 1995).

Another sampling operation was used to identify the remaining organisations of the supply chain: snowball sampling. Snowball sampling can be defined as a form of non-random sampling method of identifying participants for research by the suggestion of other participants, thus identifying other cases (Neuman, 2014; Easterby-Smith *et al.*, 2015; Saunders *et al.*, 2016). Snowball sampling is prominently used when looking at interconnected networks, such as a supply chain (Neuman, 2014; Cooper and Schindler, 2014). The referred participants have characteristics, experiences and attitudes different from those of the referring part (Cooper and Schindler, 2014) given that they have different roles within the supply chain, and therefore were vital to this investigation.

b) Regarding the number of cases, according to McBurney (1994) and Stake (1995), a case study tends to have small sample sizes. Both positivist (Gerring, 2017; Yin, 2018) and interpretivist (Stake, 1995; Braun and Clarke, 2013) methodologists argue that the number of cases depends on the discretionary choices of the researcher as well as the objective of the research. Additionally, it is also essential to consider the concept of saturation, that although deriving from grounded theory, it is also valid for other forms of research (Braun and Clarke, 2013). Saturation relates to the amount of data for a qualitative study and the point where additional data fails to generate new information (Braun and Clarke, 2013).

The cases and the embedded cases are typical cases within the WAICs of each country, especially considering sustainability issues. Gerring (2017) argues that typical cases are used to identify common characteristics in a given setting. Typical case sampling considers the selection of participants that are conventional within their setting, thus representing characteristics that are common within a population (Stake, 1995; Gerring, 2017). This criterion was used to exclude other organisations that were potential actors to be accessed. In light of the objectives of this thesis, typical case selection was deemed a more suitable approach than unusual cases, especially given the need to compare practices between the countries.

Two steps were taken to increase the capacity of identifying typicality, besides following the literature on wheat food supply chains (De Mori, 2011; Smith and Barling, 2014):

a) Questions 1, 5 and 12 of the interview script were designed to ascertain potential differences of practices in the overall sector, therefore allowing the identification of different perspectives to add to the research if needed.
b) Supra-organisational bodies were interviewed (e.g., associations or boards of farmers, mills, and certification schemes cooperatives) thus gaining a bigger picture of the practices and identifying potential discrepancies worthy of further investigation.

Geissdoerfer *et al.* (2017) argued that CE focuses on policymakers and business practitioners. Similarly, this thesis investigated the supply-side of the supply chain, thus focusing on the organisations rather than the consumers. In other words, end-clients were not part of the study since the research investigated the industrial domain of wheat food value chain, from farm to the market.

Two cases were investigated considering these steps and criteria: one in each country. Table 5.2 summarises the organisations participating in the Brazilian supply chain while Table 5.3 summarises the UK's organisations. The tables are coloured to facilitate the differentiation between the cases and the information refers to the year of data collection (2019).

**Table 5.2** Summary of participating organisations in the Brazilian case

| Organisation | Org. focus | Size | Quantity of wheat |
|---|---|---|---|
| BR Farmer 1 | Grain production | 190 hectares | 575 t/year [a] |
| BR Farmer 2 | Grain production and cattle raising | 50 hectares | 120 t/year [a] |
| BR Farmer 3 | Grain production | 60 hectares | 160 t/year [a] |
| BR Grain-merchant | Agri-products trade | 2 silo sites | N/A[18] |
| BR Cooperative 1 | Agri-products trade, marketing support, farm support | 14,500 members | ~ 80,000 t/year [a] |
| BR Mill 1 | Wheat processing + pasta | 1 mill + 1 factory | ~90 to 100,000 t/year [b]. |
| BR Mill 2 | Wheat processing | 1 mill + 1 grain silo site | ~80,000 t/year [c] |

[18] Wheat trades are irregular in terms of quantity for this trader, and participant did not want to give specific numbers. Soya beans, the main product, around 8,600 tonnes a year.

| | | | |
|---|---|---|---|
| BR Mill 3 | Wheat processing | 7 mills | 2,000,000 t/year [a] |
| BR Cooperative 2 – Mill 4 | Agri-products trade, marketing support, farm support | 1 mill | 57,000 t/year [b] |
| Agrifood industry | Food manufacturer | 31 industrial plants | ~ 40,000 t/year [d] |
| BR Industrial bakery | Bread and toasts | 1 factory | Not willing to comment |
| Supermarket chain 1 | Groceries | 62 stores | 170,000 t/year [e] |
| BR Cooperative 2 - supermarket 2 | Agri-products trade, marketing support, farm support | 12 stores + 1 DC | >420 t/year [d, e] |
| BR Supermarket chain 3 - in-store bakery | Groceries | 3 stores | 72 t/year [f] |
| BR Craft bakery | Craft bakery & food services | 1 store | 36 t/year [f] |
| BR Mill association | Trade association | 18 mills (64 in the state) | 3,400,000 t/year [c] |
| BR Extensionist | Farmers' technical support and technology transfer | >13,000 farmers | N/A |

[a] Grain produced.
[b] Flour produced.
[C] Grain used.
[D] Various goods produced.
[E] Various goods sold.
[F] Flour used.

**Table 5.3** Summary of participating organisations in the UK's case

| Organisation | Org. focus | Size | Quantity of wheat |
|---|---|---|---|
| UK Farmer 1 | Wheat production and storage | 280 hectares | 2,000 - 2,400 t/year [a] |
| UK Farmer 2 | Wheat production and storage | 255 hectares | 2,000 - 2,400 t/year [a] |
| UK Farmer Cooperative | Wheat storage and marketing support | 600 members | 150,000 t/year (grain stored) |
| UK Grain-merchant 1 - private | Agri-products trade and marketing support | 40 sites | 1,7 million t/year traded (grain traded) |
| UK Grain-merchant 2 - cooperative | Agri-products trade and marketing support | ~4000 members | ~ 4 million t/year (grain traded) [g] |
| UK Mill 1 | Wheat processing | 10 mills | > 1,300,000 t/year [c] |
| UK Mill 2 | Wheat processing and flour industrialisation | 4 mills | > 500,000 t/year [c] |
| UK Industrial bakery | Industrial bakery and food manufacturer | 12 bakeries + 14 depots | 2 million units/day [d] |
| UK Craft bakery | Craft bakery & food services[19] | 3 stores | 242,000 loaves/year [d] |

[19] The UK Craft bakery is also a community-interest company. However, the bakery is managed as a regular bakery according to the participant. Therefore, the organisation was treated as a bakery, not a social enterprise.

| | | | |
|---|---|---|---|
| UK Supermarket chain 1 | Groceries, services, other retail products | >3700 (UK and Ireland) | Not identified |
| UK Supermarket chain 5 | Groceries, services, other retail products | 634 | Not identified |
| UK Food distribution charity | Food surplus redistribution charity | 25 warehouses | 11 million meals/year (did not knew wheat-based). |
| UK Beer making charity | Social enterprise | 1 brewery | 656,000 pints/year (produced) |
| UK Mill association | Trade association | 31 members in 50 sites | ~ 5 million t/year [c] |
| UK Assurance scheme | Certification of farmers' operations | Almost all UK wheat food farmers | ~ 5 million t/year [c] |
| UK Extensionist | Farmers' technical support and technology transfer | 2,000 farmers in the region | N/A |

[a] Grain produced.
[b] Flour produced.
[C] Grain used.
[D] Various goods produced.
[E] Various goods sold.
[F] Flour used.
[G] includes animal feed

There were 31 separate interviews with 30 different organisations. BR Cooperative 2 had 2 participants interviewed, one from the mill and one from supermarket chain owned by the cooperative, as they have different perspectives relating to internal transactions within a hierarchical organisation. The organisations had an average age of 48 years[20] working with wheat and a median of 36 years [21]. On the other hand, the participants had an average of 18 years working with wheat and a median of 14 years. The research centred in three different areas within organisations: commercial (mostly purchases), sustainability and operations as these areas deal directly with the research topic (transactions and pro-sustainability practices). Table 5.4 displays the participants and their role (position) in the organisation at the time of the interview.

Table 5.4 Research interviewees' role in their organisations

| **BR Participant** | **Interviewees' role** | **UK Participant** | **Interviewees' role** |
|---|---|---|---|
| BR Farmer 1 | Owner / manager | UK Farmer 1 | Owner / manager |
| BR Farmer 2 | Owner / manager | UK Farmer 2 | Owner / manager |
| BR Farmer 3 | Owner / manager | UK Farmer cooperative | Operations Director |
| BR Grain-merchant | Owner / manager | UK Grain-merchant 1 - private | Farm Trader |
| BR Cooperative 1 | Technical manager | UK Grain-merchant 2 - cooperative | Member Services Director |

[20] 44 average for BR orgs. and 52 for the UK / 23 average for BR participants and 13 for UK.
[21] 44.5 median for BR orgs. and 30.5 for the UK / 17 median for BR participants and 4.5 for UK.

| | | | |
|---|---|---|---|
| BR Mill 1 | Commercial Director | UK Mill 1 | Health, Safety & Environmental Manager |
| BR Mill 2 | Commercial Director | UK Mill 2 | Purchasing oficer |
| BR Mill 3 | Commercial Director | UK Industrial bakery | Corporate Sustainability Manager |
| BR Cooperative 2 – Mill 4 | Technical manager | UK Craft bakery | Owner / Managing director |
| Agrifood industry | Agriculture manager | UK Food distribution charity | Food Coordination Assistant |
| BR Industrial bakery | Purchasing officer | UK Beer making charity | Customer Needs Manager |
| Supermarket chain 1 | Commercial Director | UK Mill association | Policy and Research Officer |
| BR Cooperative 2 - supermarket 2 | Commercial manager | UK Assurance scheme | Technical Manager |
| BR Supermarket chain 3 - in-store bakery | Bakery supervisor | UK Extensionist | Knowledge Exchange Manage |
| BR Craft bakery | Owner / manager | | |
| BR Mill association | Executive manager | | |
| BR Extensionist | Wheat program coordinator | | |

Two UK supermarket chains were included in the research through the use of secondary data only. The eight biggest supermarket chains were approached multiple times (~60) through various channels including in-person, social media, email and intermediated by colleagues and other participants. Five potential participants of four different organisations expressed willingness to participate, but once the topic of CE and wheat-based products was mentioned, they stopped replying. The data for the two UK's supermarkets came from reports, policies, websites, news articles and bakeries' association conference proceedings, in addition to the mentions in the other interviews.

The role that mills have in the supply chain and the position as the central node of the chain (De Mori, 2011; Smith and Barling, 2014), made these actors the first element approached and investigated. For the second step (the identification of the other actors of the chain), the interviewees of the mills suggested both upstream and downstream organisations: wheat suppliers and flour customers. From there, the other actors also recommended upstream or downstream organisations, as depicted in Figure 5.2. Organisations with different divisions part of the supply chain (e.g., flour production and bakery goods) were also approached since their colleagues recommended them. However, only BR Cooperative 2 was willing to participate in that fashion.

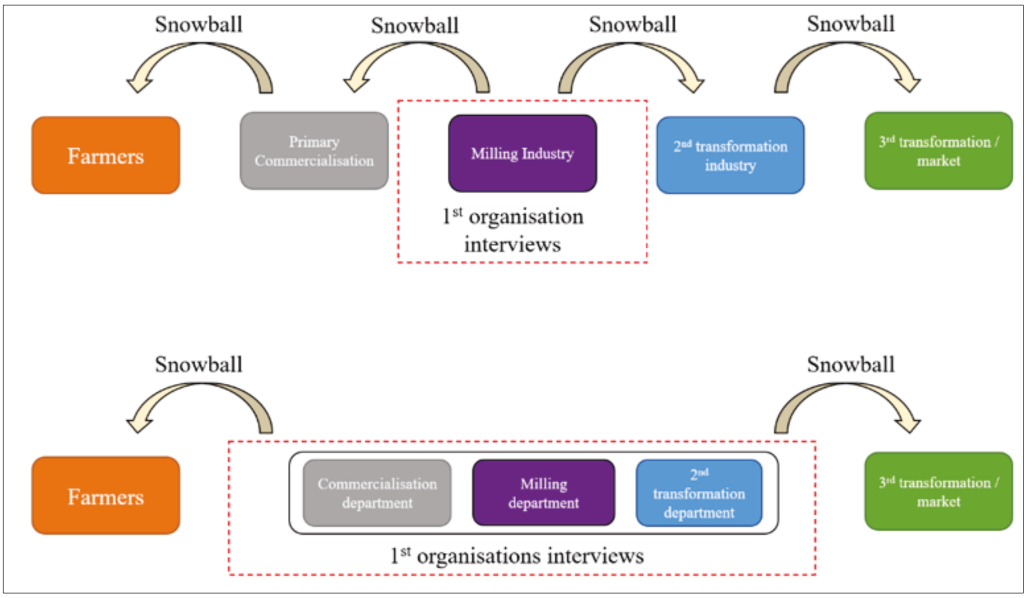



**Figure 5.2** Sampling strategy for the thesis

Given the differences between the Brazilian and UK's WAIC, adaptations were made when needed. For instance, cooperatives in Brazil have multiple roles, including traders, mills and supermarkets, while in the UK the roles are less broad. On the other hand, the UK has established charities that participate in the CSC, while Brazil does not. These types of changes were deemed acceptable since the local context is critical for the trustworthiness of the research.

For transparency, it must be highlighted that the researcher currently works within the Brazilian WAIC, as an analyst of the Brazilian Agricultural Research Corporation (Embrapa). Two risk factors regarding biases to the thesis were linked to this: the researcher own bias, and the bias that Embrapa might bring. Considering the first point, it is not possible to completely eliminate bias since human beings, especially if they have a personal interest or position in the research have biases (Bell, 2005). Three steps were taken to account for that:

a) Constant self-monitoring and questioning of biases, especially in the data collection and analysis, since this reduces the chances of problems arising if they left without attention (Sekaran, 2003; Bell, 2005; Bryman and Bell, 2015).
b) Constant discussion with the supervisors regarding the research, considering that experienced professionals might visualise issues more explicitly (Bell, 2005).
c) A structured process of approval for the research was carried out, namely the ethics committee from the University of Northampton and the examiners for both

the transfer and the seminar, since they improve on the proposed research, especially concerning the data collection instrument.

For the second point, that is, the role of Embrapa, the company is a research organisation, not a regulatory body, and deals mostly with technicians in private (such as cooperative technical advisors) and governmental extension agencies (Acosta *et al.*, 2018) and has scarce contact with the links in the chain downstream of the mills. No conflict of interest was experienced, considering that Embrapa does not participate in the research directly (only through the researcher per se), and the University of Northampton funded this research, not Embrapa. For the benefit of the participants, these considerations were made clear in both the contact with the organisations, as well as in the participation information sheet (Appendix D). The consent form signed by the participants is in Appendix E.

<u>Section summary</u>: Section 5.4.2 presented the information for population, sampling and case selection. Data on the population of the organisations part of cases were presented considering the five main links in a wheat food supply chain. For case selection, that is, selecting the organisations investigated, multiple steps were taken: selection by judgment (mills), snowball (recommendations) and convenience sampling (access). Both supply chains and the organisations and processes within it are typical organisations, not unusual cases. Multiple examples of organisations that form wheat supply chains took part in the research. Farmers, cooperatives, grain-merchants, mills, industries and retail comprise the bulk of the participants. Other organisations in a CSC perspective were also included, such as charities, support organisations and trade associations. Thirty-two organisations are part of the research, with thirty-one interviews conducted. A summary of the organisations was presented, as well as the interviewees. Finally, the steps executed to reduce detrimental biases were provided.

### 5.4.3 Data: source, collection and analysis

To Collis and Hussey (2014, p.341), data is defined as "facts or things used as a basis for inference or reckoning". Similarly, Cooper and Schindler (2014) and Saunders *et al.* (2016) argue that data can also consist of opinions, observations, behaviour, attitudes, motivations and statistics and others, gattered and recorded for reference and/or analysis.

It can be classified as primary - original research where collected data is obtained aiming to addressing the research problem; alternatively secondary - collected by third parties with different objectives than those in which the data were reviewed (Cooper and Schindler, 2014). Secondary data can also consist of information that already exists within databases or publications (Easterby-Smith *et al.*, 2015). Neuman (2014) and Saunders *et al.* (2016) classify data as quantitative (numerical type collected data) or qualitative (data collected in the form of words or images). The data for this study was overwhelmingly qualitative.

Is also important to understand sources of data. Yin (2018) points to the existence of six different sources of evidence: documentation, archival records, interviews, direct observations, participant observation and physical artefacts, with the added possibility of combining several of these forms into another model.

To collect primary data, the present research primarily used interviews, a type of guided conversation (Yin, 2018) that is more flexible than questionnaires (standard in surveys). Braun and Clarke (2013) point out that interviews are traditionally done in person, but virtual interviews are also possible, such as by email, telephone or video-chat (e.g., Skype). In the present research, almost all the interviews were in person, with the exception of <u>BR Extensionist</u> who was interviewed via Skype. <u>UK Food distribution charity</u> requested that the researcher volunteered for at least three days in one of its sites before giving the interview. The researcher agreed[22] as this is an example of prolonged and persistent engagement and the experience was beneficial to the research since it allowed a greater understanding of their operations.

In situations where further information was needed, email exchanges, in-person and phone conversations were also conducted (repeated interactions), although without structure and for better understanding of a point already made during the interview.

Another way to classify interviews is regarding its structure: structured, semi-structured or unstructured, depending on the degree of rigidity in terms of pre-prepared questions, as well as questions order and the possibility of on-the-spot questions (Cooper and Schindler, 2014; Bryman and Bell, 2015). Regarding this, the research followed a semi-structured interview process, as discussed by Gillham (2005), since it considers:

a) The same set of questions to the participants.

---

[22] The researcher volunteered in one of the warehouses of the charity in Buckinghamshire. The interviewee was not present during those three days.

b) The questions had a common focus – divided here by the study's aims and framework.
c) Interviewees were prompted by supplementary questions (if not brought up spontaneously).
d) Questions had open answers (not pre-scheduled)[23];
e) Probes were used when the interviewer considered that more could be extracted from an answer or a point.

The selection of semi-structured interviews allowed flexibility and structure (Gillham, 2005), facilitating the analysis later. Despite the information used in the construction of the interview script being based on the literature reviewed and presented in Chapter 2, the semi-structured nature allowed non-anticipated questions that evolved from the participant information during the interview, thus enriching the data. Therefore, the interview script (Appendix C) included the questions asked, but by the end of the research, other information came from questions generated *in loco*.

Data collection protocol had four sections: i) interviewee and organisational context; ii) CE practices with the CE practices of Section 2.2.4 guiding the discussion plus diffusion influencers; iii) material flow including auxiliary materials and waste; iv) transactions, relationships, and material flow.

The construction of the interview script followed two premises:

a) The need to address the research problem and questions. Each of the three sections of the script was connected with the first, second and fourth research questions. With the data collected and analysed to answer those, it was then possible to answer the remaining two research questions (third and fifth). The interviews accompanied supporting information, as recommended by both Gillham (2005) and Yin (2018). In this sense, a glossary of terms and subsequent explanations by the researcher were also used when needed.
b) The theoretical background of the research and the need to return to it, as expected of an abductive research. This meant that all the questions of the script had a theoretical underpinning presented and discussed in the literature review, and were envisioned to translate them into practical questions, and later (in the analysis and discussion) back into abstract/theoretical elements.

[23] The exception to this in the present research is question 2, that allows at the same time, open-ended questions and a set of options that serve as prompts.

The researcher was born and raised in Brazil and therefore is a native Portuguese speaker, facilitating communication in the country. The interviews in Brazil were conducted in Portuguese, with transcription first in Portuguese and then translated by the researcher to English. An example of this can be found in Appendix F. Such operation allows greater transparency with the participants (as most Brazilians do not speak English), thus following research trustworthiness criteria as described in Section 5.4.1.2 (Table 5.1) since the interviews were returned to them for verification as recommended by Yin (2018).

All interviews were recorded with the mobile phone recording app (direct recording), except for two: BR Farmer 3 and UK Farmer Cooperative. These participants were not comfortable with being recorded, even with anonymity being guaranteed, but allowed taking notes. Additionally, field notes were made by the interviewer during the interviews. Of the returned transcripts, only one, from UK Mill 2, asked to revise some sections as the participant felt that their suppliers could perceive them negatively.

Anonymity at all stages of the research was assured to all the participants, not only to the interviewees but also to the organisations mentioned. This characteristic of the study was guaranteed to the participants both in the initial contact, as well as in the research information sheet (Appendix D).

Regarding data storage, there are two types of data: physical and digital. Physical data, such as field notations and physical reports and documents, were digitalised. Those physical documents where anonymity was not possible to secure (e.g., too many identifiable symbols or marks) were not used in the research. The digitalisation was done with two purposes: safety and easiness of movement (since the researcher travelled for the data collection). All digital data are stored in the researcher's personal computer and other approved systems by the University of Northampton.

Regarding strategies to analyse the data, Yin (2018) identifies four possibilities: relying on theoretical propositions; identifying patterns non-specified by the literature (akin to grounded theory); systematic case description; and examination of plausible rival explanations. Of those and linking to the epistemological position previously identified for the thesis (interpretivism), this research followed the first strategy. It is essential to point out that unforeseen patterns emerged from the analysis and were not discarded; rather, it was expressed in the data analysis and discussion.

Content analysis was used to analyse the data, following the definition of Cooper and Schindler (2014) – content analysis is a flexible method used to interpret semantic content of a communication. The researcher examined pre-determined themes and thematic patterns in the interviews according to the literature on CE practices, CE diffusion and adoption and TCE dimensions and listed/organised in the research framework. This is in line with Easterby-Smith's *et al.* (2015) description of content analysis and Cooper and Schindler's (2014) definition of thematic analysis. The analysis of each case originated unique information of each organisation, dyad and practices, thus leading to pattern identification for generalisations among cases (Eisenhardt, 1989). Data saturation was clear when no new information was identified in the data, with several repetitions of the same points by the different interviewees.

Data analysis was done with the support of software Nvivo 12. Coding procedures were executed following Braun and Clarke (2013) direction and included the secondary data gathered:

- Codes followed the categories and subcategories of the framework (Chapter 4), and represented in Figure 5.3 with a snapshot of the coding nodes from the research framework´s OC.

**Nodes**

| Name | Files | References | Created On | Created By | Modified On | Modified By |
|---|---|---|---|---|---|---|
| CE Practices and Diffusion | 115 | 2210 | 07/01/2020 15:21 | AAD | 01/04/2020 18:14 | AAD |
| List of practices | 98 | 951 | 07/01/2020 15:21 | AAD | 01/04/2020 18:14 | AAD |
| CE drivers | 84 | 517 | 07/01/2020 15:22 | AAD | 01/04/2020 18:14 | AAD |
| Society | 44 | 142 | 07/01/2020 19:43 | AAD | 20/05/2020 08:13 | AAD |
| Consumer demands | 43 | 126 | 07/01/2020 19:44 | AAD | 20/09/2020 21:30 | AAD |
| Organisations expansion | 9 | 10 | 07/01/2020 19:44 | AAD | 20/09/2020 21:30 | AAD |
| Urbanisation and its influences | 6 | 6 | 07/01/2020 19:43 | AAD | 02/12/2020 19:11 | AAD |
| Environmental protection | 56 | 131 | 07/01/2020 19:41 | AAD | 01/04/2020 18:14 | AAD |
| Reduce environmental impact | 30 | 44 | 07/01/2020 19:42 | AAD | 20/09/2020 21:30 | AAD |
| Adapt agriculture | 24 | 42 | 07/01/2020 19:42 | AAD | 20/09/2020 21:30 | AAD |
| Concern with sustainable development | 17 | 27 | 07/01/2020 19:42 | AAD | 02/12/2020 13:43 | AAD |
| Fight climate change | 13 | 18 | 07/01/2020 19:41 | AAD | 20/09/2020 21:30 | AAD |
| Product development | 39 | 104 | 07/01/2020 19:53 | AAD | 02/04/2020 20:41 | AAD |
| Increase product efficiency | 29 | 59 | 07/01/2020 19:53 | AAD | 20/09/2020 21:30 | AAD |
| Increase in product value | 28 | 45 | 07/01/2020 19:54 | AAD | 01/12/2020 08:30 | AAD |
| Health | 38 | 73 | 07/01/2020 19:39 | AAD | 02/04/2020 21:53 | AAD |
| Policy and economy | 31 | 67 | 07/01/2020 16:02 | AAD | 01/04/2020 18:14 | AAD |
| CE barriers | 48 | 405 | 07/01/2020 15:22 | AAD | 01/04/2020 18:14 | AAD |
| CE enablers | 69 | 337 | 07/01/2020 15:22 | AAD | 01/04/2020 18:14 | AAD |
| Transactions | 79 | 1305 | 07/01/2020 15:23 | AAD | 01/04/2020 18:14 | AAD |
| Formalisation | 68 | 470 | 07/01/2020 15:32 | AAD | 24/08/2020 19:09 | AAD |
| Uncertainty | 52 | 330 | 07/01/2020 15:33 | AAD | 19/08/2020 18:40 | AAD |
| Environmental Uncertainty | 40 | 143 | 28/04/2020 16:25 | AAD | 20/09/2020 21:30 | AAD |

**Figure 5.3** Nvivo 12 framework / nodes of coding

- The first stage of coding centred on mapping the flow of the material, allowing the CSCs to be diagrammed using the software Bizagi (v. 3.2).

- CE practices and diffusion influencers were coded after the CSCs mapping. An example of such coding is shown in Figure 5.4.

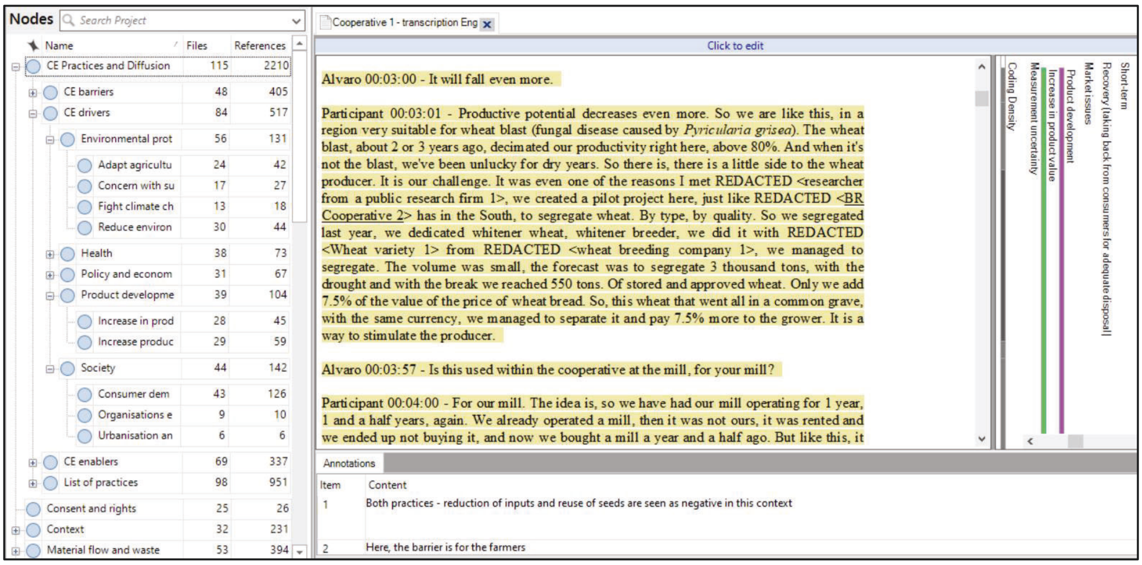



**Figure 5.4** Example of coding and annotations within Nvivo

- The final cycle of coding focused on the transaction's dimensions and the interactions between dimensions and diffusion influencers. Figure 5.5 shows a set of the coded interactions between the two OC (transaction dimensions and CE diffusion influencers). Each relationship coded emerged from the data as it was being analysed. For example, when the participant from the UK Craft Bakery mentioned the formal ties with partners in the value chain and how this helps them with the social sustainability practices that they operate, a relationship between the transaction dimension *´formal contracts´* and the diffusion enabler *´partnerships and collaboration across the value chain´* was created.

Relationships

Search Project

| From Name | From F | Type | To Name | To Fold | Direction | Files | Refer | Created On | Created | Modified O | Modifie |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Transactions\Formalisation\Formal | Nodes | Associa | CE Practices and Diffusion\CE enablers\Partnerships and collaborati | Nodes | | 22 | 29 | 15/03/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Formalisation\Formal | Nodes | Associa | CE Practices and Diffusion\CE drivers\Society\Consumer demands | Nodes | | 15 | 28 | 13/03/2020 | AAD | 17/09/2020 | AAD |
| Transactions\Formalisation\Requirements | Nodes | Associa | CE Practices and Diffusion\CE drivers\Society\Consumer demands | Nodes | | 16 | 28 | 16/03/2020 | AAD | 17/09/2020 | AAD |
| Transactions\Frequency\Long-term | Nodes | Associa | CE Practices and Diffusion\CE enablers\Partnerships and collaborati | Nodes | | 22 | 28 | 18/03/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Uncertainty\Environmental U | Nodes | Associa | CE Practices and Diffusion\CE barriers\Market issues | Nodes | | 10 | 14 | 12/05/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Asset specificity\Physical ass | Nodes | Associa | CE Practices and Diffusion\CE drivers\Society\Consumer demands | Nodes | | 7 | 14 | 18/05/2020 | AAD | 14/09/2020 | AAD |
| Transactions\Formalisation\Informal | Nodes | Associa | CE Practices and Diffusion\CE enablers\Partnerships and collaborati | Nodes | | 8 | 13 | 29/03/2020 | AAD | 01/09/2020 | AAD |
| Transactions\Uncertainty\Behavioural unc | Nodes | Associa | CE Practices and Diffusion\CE barriers\Market issues | Nodes | | 9 | 13 | 29/04/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Uncertainty\Environmental U | Nodes | Associa | CE Practices and Diffusion\List of practices\Reduction of inputs | Nodes | | 5 | 11 | 13/05/2020 | AAD | 12/07/2020 | AAD |
| Transactions\Uncertainty\Behavioural unc | Nodes | Associa | CE Practices and Diffusion\CE drivers\Society\Consumer demands | Nodes | | 7 | 8 | 13/05/2020 | AAD | 17/09/2020 | AAD |
| Transactions\Asset specificity\Site specifici | Nodes | Associa | CE Practices and Diffusion\CE enablers\Organisational characteristic | Nodes | | 6 | 8 | 13/05/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Formalisation\Formal | Nodes | Associa | CE Practices and Diffusion\CE drivers\Health\Concern to public heal | Nodes | | 6 | 7 | 20/03/2020 | AAD | 15/08/2020 | AAD |
| Transactions\Uncertainty\Environmental U | Nodes | Associa | CE Practices and Diffusion\List of practices\Reclassify (identify as lo | Nodes | | 7 | 7 | 13/05/2020 | AAD | 14/09/2020 | AAD |
| Transactions\Formalisation\Verticalisation | Nodes | Associa | CE Practices and Diffusion\CE enablers\Organisational characteristic | Nodes | | 5 | 6 | 11/03/2020 | AAD | 31/08/2020 | AAD |
| Transactions\Formalisation\Formal | Nodes | Associa | CE Practices and Diffusion\List of practices\Reduction of waste | Nodes | | 5 | 6 | 16/03/2020 | AAD | 21/07/2020 | AAD |
| Transactions\Uncertainty\Behavioural unc | Nodes | Associa | CE Practices and Diffusion\List of practices\Reduction of inputs | Nodes | | 6 | 6 | 13/05/2020 | AAD | 12/07/2020 | AAD |
| Transactions\Asset specificity\Dedicated s | Nodes | Associa | CE Practices and Diffusion\CE drivers\Society\Consumer demands | Nodes | | 6 | 6 | 18/05/2020 | AAD | 06/06/2020 | AAD |
| Transactions\Formalisation\Formal | Nodes | Associa | CE Practices and Diffusion\CE barriers\Market issues | Nodes | | 6 | 6 | 18/05/2020 | AAD | 17/09/2020 | AAD |
| Transactions\Asset specificity\Temporal sp | Nodes | Associa | CE Practices and Diffusion\CE barriers\Market issues | Nodes | | 3 | 5 | 26/07/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Formalisation\Verticalisation | Nodes | Associa | CE Practices and Diffusion\CE drivers\Society\Organisations expansi | Nodes | | 4 | 5 | 11/03/2020 | AAD | 17/09/2020 | AAD |
| Transactions\Formalisation\Verticalisation | Nodes | Associa | CE Practices and Diffusion\CE barriers\Management issues | Nodes | | 4 | 5 | 23/03/2020 | AAD | 08/06/2020 | AAD |
| Transactions\Formalisation\Formal | Nodes | Associa | CE Practices and Diffusion\CE enablers\Existing systems of support | Nodes | | 3 | 5 | 29/03/2020 | AAD | 23/08/2020 | AAD |
| Transactions\Uncertainty\Behavioural unc | Nodes | Associa | CE Practices and Diffusion\CE enablers\Partnerships and collaborati | Nodes | | 5 | 5 | 12/05/2020 | AAD | 20/09/2020 | AAD |
| Transactions\Uncertainty\Environmental U | Nodes | Associa | CE Practices and Diffusion\CE drivers\Policy and economy\Complia | Nodes | | 3 | 5 | 12/05/2020 | AAD | 10/06/2020 | AAD |
| Transactions\Uncertainty\Behavioural unc | Nodes | Associa | CE Practices and Diffusion\CE barriers\Culture and social issues | Nodes | | 5 | 5 | 12/05/2020 | AAD | 17/09/2020 | AAD |
| Transactions\Uncertainty\Environmental U | Nodes | Associa | CE Practices and Diffusion\List of practices\Repurpose (change the | Nodes | | 5 | 5 | 16/05/2020 | AAD | 12/07/2020 | AAD |

**Figure 5.5** Examples of relationships coded - transaction dimensions and CE diffusion influencers

The comparison between cases was the next step, looking first for similarities and then differences of the CE practices of the organisations. The relationships between the transaction dimensions and the different diffusion influencers were mapped as a network using the free tool Flourish. With the interactions coded (Figure 5.5), it was possible to create and export the data to a spreadsheet file and uploaded it to Flourish (Figure 5.6). It was also necessary to create the groups within the website, thus differentiating the transaction dimensions and the influencers (Figure 5.7). With such information added and organised in the website, the web of interactions between influencers and dimensions was created.

Copy of Enablers with 1

by Alvaro Augusto Dossa · Publicly visible

Create a story · Export & publish

Preview · Data

Links · Points

| | A | B | C |
|---|---|---|---|
| 1 | source | target | value |
| 2 | Formal | Partnerships and collaboration across the value chain | 29 |
| 3 | Long-term | Partnerships and collaboration across the value chain | 28 |
| 4 | Informal | Partnerships and collaboration across the value chain | 13 |
| 5 | Site specificity | Organisational characteristics | 8 |
| 6 | Verticalization | Organisational characteristics | 6 |
| 7 | Formal | Existing systems of support | 5 |
| 8 | Behavioural uncertainty | Partnerships and collaboration across the value chain | 5 |
| 9 | Behavioural uncertainty | Organisational characteristics | 4 |
| 10 | Behavioural uncertainty | Existing systems of support | 3 |
| 11 | Dedicated specificity | Organisational characteristics | 3 |
| 12 | Measurement uncertainty | Partnerships and collaboration across the value chain | 3 |
| 13 | Requirements | Partnerships and collaboration across the value chain | 3 |
| 14 | Environmental Uncertainty | Partnerships and collaboration across the value chain | 3 |
| 15 | Formal | Digital tools | 2 |
| 16 | Informal | Existing systems of support | 2 |
| 17 | Site specificity | Existing systems of support | 2 |

Upload data

Links

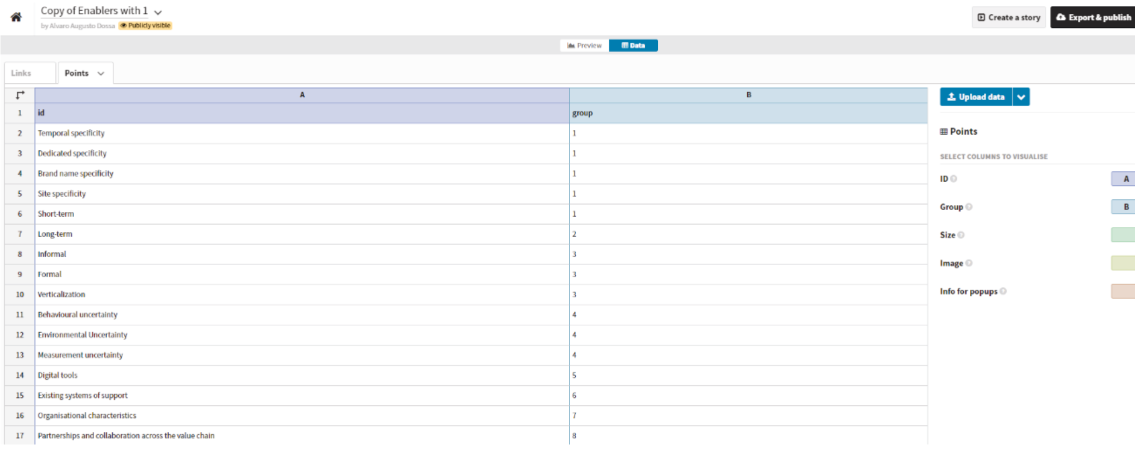
SELECT COLUMNS TO VISUALISE

Source point: A

Target point: B

Value of link: C

**Figure 5.6** Example of links in Flourish – enablers and transactions




| | A | B |
|---|---|---|
| 1 | id | group |
| 2 | Temporal specificity | 1 |
| 3 | Dedicated specificity | 1 |
| 4 | Brand name specificity | 1 |
| 5 | Site specificity | 1 |
| 6 | Short-term | 1 |
| 7 | Long-term | 2 |
| 8 | Informal | 3 |
| 9 | Formal | 3 |
| 10 | Verticalization | 3 |
| 11 | Behavioural uncertainty | 4 |
| 12 | Environmental Uncertainty | 4 |
| 13 | Measurement uncertainty | 4 |
| 14 | Digital tools | 5 |
| 15 | Existing systems of support | 6 |
| 16 | Organisational characteristics | 7 |
| 17 | Partnerships and collaboration across the value chain | 8 |

**Figure 5.7** Example of groups in Flourish – enablers and transactions

Organisational sustainability reports, institutional leaflets, websites and publications were used in the data triangulation. Such a documental analysis can be classified as record analysis. As already pointed out, the use of multiple sources of evidence brings greater reliability in the investigation (Eisenhardt, 1989; Cooper and Schindler, 2014; Collis and Hussey, 2014). However, not all organisations had information available to collect, especially the farmers and the craft bakeries, as the size and nature of their activities do not require sharing much information. For the UK's supermarket chains, secondary data was the primary source of information, using only freely available data from the internet.

Section summary: Section 5.4.3 discussed the sources, collection and analysis of the data used in this thesis. The data collected and analysed in this thesis was qualitative. The primary form of data collection was semi-structured interviews of around 1 hour. All interviews were recorded, except for two. Only one interviewee requested change in the interview script to avoid misunderstandings. Primary and secondary data were analysed using content analysis and searching for pre-defined themes (categories) from the framework. Coding was done using Nvivo 12; material flow map used Bizagi; the network of interactions used Flourish. Secondary data, when available, were also used, both for triangulation and as the data source for the UK's supermarket chains.

After presenting the research's methodology, including its epistemological bases, operational procedures and the participants that took part in it, the next chapter presents the research findings and analysis.

# 6. RESEARCH FINDINGS AND ANALYSIS

The current chapter has five sections, based on the research framework (Chapter 4):

- Brazilian case - containing CE practices and material flows in the supply chain.
- UK's case - containing CE practices and material flows in the supply chain.
- Comparison between the cases: similarities and differences CE practices.
- Characterisation of the CE diffusion influencers and transactions dimensions.
- Map of the interactions and influences of transaction dimensions in CE diffusion.

Throughout the work, the participants are differentiated with an underline in their organisation's name (e.g., <u>BR Farmer 1</u>) and the categories of the framework (CE practices, diffusion influencers and transaction dimensions) are in bold (e.g., **measurement uncertainty**).

## 6.1 BRAZILIAN SUPPLY CHAIN CASE

Section 6.1 was organised considering the first two research objectives: to identify the Circular Economy practices in a wheat food supply chain in Brazil; and to map the material flow, including wastes and by-product outputs, in the wheat food supply chain in Brazil. It must be noted that none of the Brazilian participants knew about CE before the interview. Some of the participants were pro-active in asking about it, and the others were asked by the researcher before the start of the interview if they knew about CE, answering in the negative.

### 6.1.1 CE Practices - Brazil

Based on the research framework discussed in Chapter 4, the structure of this section is presented in Figure 6.1. The current section discusses the **CE Practices** as described in Chapter 2 - section 2.2.4, with the objective of answering the first research question (i.e., 'what are the main Circular Economy practices in wheat food supply chains in Brazil and the UK?') in relation to Brazil.


**Figure 6.1** Research framework section related to Section 6.1.1.

The **CE practices** in the Brazilian wheat agri-food supply chain identified by each participant are in Appendix G. It is possible to note that there is considerable variation between the selected operations. The themes that emerged through the discussion of CE operations in the interviews are presented below.

*a) Reduction – of waste and inputs:*

Before describing the operations related to the reduction of waste, it is essential to clarify that the interviewees' have different definitions of what waste is. Authors such as Korhonen *et al.* (2018a) have anticipated this issue, and consider that this reduces the capacity of organisations to implement CE. Some of the participants (e.g., BR Farmer 1, BR Craft Bakery) classify waste as the loss of inputs in the production process (including time) that can influence their finances; others (e.g., BR Farmer 2 & 3, BR Extensionist, BR Mill 2) consider the loss of value as waste (i.e., turning wheat for food into feed); another possibility identified by the participants (e.g., Agrifood Industry, BR Industrial Bakery, Supermarket chain 3 - in-store bakery), classified waste as the loss of grain, flour or bakery goods during production, storage or transport; finally, the other participants (e.g., BR Mill 1 & 3, Supermarket chain 1) consider that there is no waste of wheat or wheat products because everything is useful in some capacity (e.g., repurpose as animal feed, glue or energy) or because their operations do not have any waste given its efficiency.

Figure 6.2 below summarises the views of the different interviewees regarding the issue. The commonality between the different views identified is the low-profit margin of wheat and its by-products, demanding the utmost use of every bit of the product. An expression of this was provided by BR Mill 1: *"I think bran is waste because it is a lot of volume for little added value"*.


**Figure 6.2** Summary of the participant's different interpretations regarding wheat waste.

Concerning the operations of **reduction of waste**, several strategies were cited throughout the supply chain. Examples include: filters in the mills that collect material used later in animal feed; reception of grain post-harvest well distributed geographically (closer to farmers); supply chain integration to reduce the chance of oversupply - especially for the cooperatives; and tight inventory and production control at the retailers, as exemplified by the following quote relating to waste:

> *"It is a problem. It is more a problem, a problem of, a waste often, often a production problem. If you do a follow-up, if you do a follow-up, of sales, right, you will start to manufacture a little less, you know. I'm already doing this. We didn't do that, right. We didn't do that, and there was money left over at the register. Not today. Today you do, you do everything, wow, this crisis there, which settled there, wow, it has already made such a big difference, you know, in our knowledge, you know."* BR Craft Bakery.

Two of the organisations (BR Industrial Bakery, Supermarket chain 1) have structured programs connected to a national-level project called Mesa Brasil[24] to avoid food waste through donation. However, most of the other participants pointed to the existing waste being used in different industries - notably animal feed. BR Industrial Bakery also uses

[24] Mesa Brasil is a project managed by SESC, a non-profit organisation managed by different businesses in the retail, services and tourism industry. They were contacted to be included in the research but did not respond to the emails and calls.

an additive in its bread packaging to reduce the plastic lifespan, thus reducing overall waste production:

> *"Today, we already use the… an additive, that D2W for bread packaging, in those plastic packages that he has there, you apply it to the packaging." (...) "Biodegradable, which then you, in two years there, if it goes, it deteriorates".* BR Industrial Bakery.

The practice of '**reduction of inputs'** was argued on two levels in the supply chain: one directly related to wheat food production, and the other to soya bean production, Brazil's main crop. For BR Farmer 1 & 3, BR Cooperatives 1 & 2, BR Grain-merchant and BR Extensionist, soya bean is the most important crop of their organisation. Most of their operations are connected to it, including allocation of storage in the silos and strategic planning around it.

The interviewed farms use no-tillage production in their operations, and crop rotation is an integral part of no-tillage systems. BR Extensionist and BR Cooperative 1 recommend no-tillage systems to the growers in the researched regions. Such systems are preferred because the practice is viewed as necessary for soil protection, greater fertility and higher organic matter content, also allowing reduced use of agrichemicals, especially herbicide and fungicide. This means that planting wheat reduces costs, risk and environmental issues in the soya bean production. Wheat also helps farmers and cooperatives financial liquidity:

> *"Today, the profitability of wheat is small, if you take, for example, the income of inputs that the cooperative sells, wheat is a small slice. It doesn't reach 10%. So, we make a lot of effort with wheat with the farmer (...) if the wheat ties in the winter is already profitable, for the benefit in makes in the production system. So we work with wheat as not only, if you are going to take to the producer that wheat is a profitable crop, he does not plant. He has a history of losses. So, you have to think about the system, that the focus of REDACTED <BR Cooperative 1> is both sides. Wheat is important for the company's turnover, 80 thousand tons give an important turnover, that is, the mill's fixed costs are paid, for example, fixed costs, generation of jobs in the chain, but wheat is of great agronomic importance."* BR Cooperative 1.

> *"Yeah, and he leaves a clean crop. When you harvest it, you don't have these glyphosate resistant pests, they don't, they don't do very well in the wheat, you know. It leaves one plant or another, that does not, does not need sometimes to apply a specific product to kill it. The sourgrass (Digitaria insularis), for example, it's*

*REDACTED <agrochemical 2>, it's expensive per alqueire*[25]*. And one application, sometimes it is not enough, it has to be two. (...) Also, if you have a lot of horseweed, what we do, we apply in the wheat and then once, then, and then we pick it by hand. I gathered everyone, the girls also hoe and 'let's pick sourgrass', the little plants. Pick those little sprouts and such, so as not to have many pests in the farm."* BR Farmer 1.

Figure 6.3 shows the soya bean straw covering the field of BR Farmer 1's no-tillage system, with wheat already sowed but not germinated, showcasing the rotation mostly used by the interviewed farmers.

**Figure 6.3** Example of no-tillage wheat farm waiting for emergence.

The reduction of input directly related to the wheat food production (grain, flour, bread, etc.) includes the decrease in agrichemicals in wheat production at farm level by sowing more resistant varieties. Both cooperatives, mills 1 & 2 and Agrifood Industry, have special programs of grain purchase of specific varieties for their needs and the need for other inputs like added gluten is reduced with such programs. Similarly, some of the interviewed bread-making organisations avoid preservers in their products by better controlling the flour purchased. Some elements must be noted regarding the reduction of inputs:

- According to BR Extensionist, it is possible that agrichemical application is better suited than some operations in the soil for weed control, considering the amount of carbon released in removing the soil.
- The use of broad-spectrum agrichemicals (as preferred by BR Farmer 3, for instance) can reduce the number of times that farmers have to spray their crop.

[25] Alqueire is a form of area measurement commonly used in the region of the interviewed farm. It represents 2.42 hectares.

However, this is not necessarily the best option, since more specific pesticides can be better suited in terms of reduced toxicity.

- There is considerable pressure from agrichemical retailers to sell inputs to farmers in the form of "technological packages". These packages include pre-defined fertilisers, pesticides and seed varieties to be used in a scheduled format and not necessarily needed by farmers or fit for their production system. Several of the participants (BR Farmer 1 & 3, BR Extensionist and BR Cooperative 1) argued that this is detrimental to sustainability. Still, many farmers are willing to go along with it because it facilitates operations and reduce crop loss risk (i.e., better safe than sorry).

BR Farmer 2 also has integrated crop-livestock systems in his farm. According to him, the use of dual-purpose wheat (both for grain and pasture), along with beef production and the other crops, produce synergy in which one element improves the other:

> *"One fosters the other, and another complements the other and I would say, maize is one of the pillars, soya bean today is almost like for rotation within the property, dual-purpose wheat is one of the pillars as well. Cattle, integration is one of the pillars, because of biological fertilisation, right. If you think about urine, fertiliser and what's going on with our soil, then as I was telling you, reducing input use, we are 14 years agricultural limestone-free, and the other plot is getting up to 9 years without use of agricultural limestone. And we still did system fertilisation this year and we harvested over 70 sacks of soya bean per hectare."* BR Farmer 2.

Figure 6.4 and Table 6.1 summarise the views of the participants regarding the 'reduction of waste and inputs in the wheat food supply chain. Current CE literature does not discuss the use of one crop to reduce input use in a different crop.

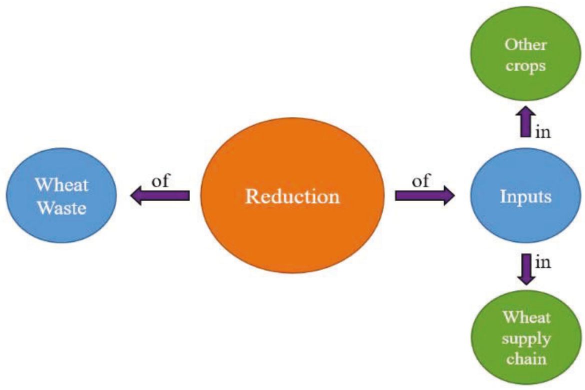



**Figure 6.4** Summary of the Participants different view regarding 'reduction'.

**Table 6.1** Summary of CE practice Reduction of waste and inputs.

| Reduction of waste | Reduction of inputs | |
|---|---|---|
| | In wheat supply chain | In other crops by planting wheat |
| Filters in the mills that collect material used later in animal feed | No-tillage production - soil protection, greater fertility and higher organic matter content | No-tillage production - soil protection, greater fertility and higher organic matter content. |
| Distributed reception post-harvest for the grain (closer to farmers) | Crop rotation | Crop rotation that includes wheat. |
| Supply chain integration to reduce the chance of oversupply - especially for the cooperatives | More resistant varieties | |
| Tight inventory and production control at the retailers | Purchasing programs with seed variety control | |
| Structured programs connected to a national-level project called Mesa Brasil[1] to avoid food waste through donation. | Agrichemical application can be a better option in terms of CO2 emissions (trade-offs): broad-spectrum vs specific; application vs scarification. | |
| Waste being used in different industries - notably animal feed. | Integrated crop-livestock systems (Dual-purpose wheat) | |
| Use of additives in its bread packaging to reduce the plastic lifespan, thus reducing overall waste impact. | Technological packages pushed by agri-retailers damage the practice. | |

*b) Reuse*

**Reuse** as a practice connected to wheat had different interpretations by the participants, summarised in Figure 6.5. Three themes emerged in the interviews: reuse of auxiliary materials such as water and packages; the reuse of food, including flour; reuse of seeds (saving seed and replanting), but this is a conflicting issue, as discussed below.

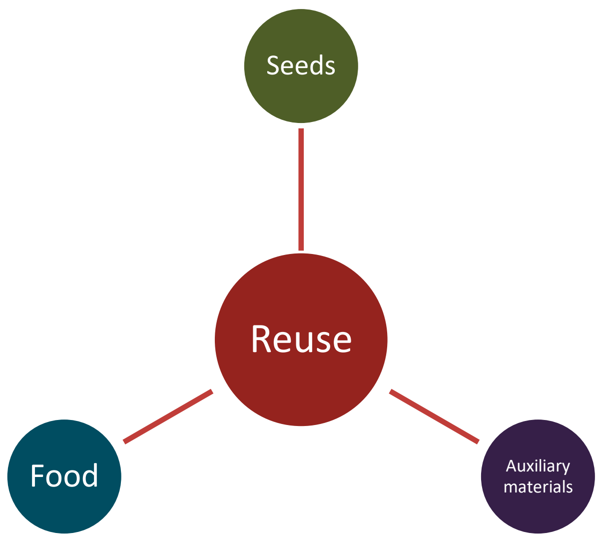



**Figure 6.5** Different perspectives regarding reuse in wheat.

Although BR Farmer 1 & 3 reuse seeds, this can be problematic according to BR Cooperative 1, BR Extensionist, Agrifood industry, BR Mill 1 & 2. The reasons cited include loss of control in the receiving of wheat grain (i.e., unknown variety) and lower productivity potential. The reuse of flour (BR Cooperative 2 - mill 4) was cited as possible while it is still in the production process because food safety practices and regulations do not allow the reuse of material after the production line. BR Craft Bakery and BR Cooperative 2 - supermarket interpreted the reuse[26] of food, as the reuse of bread turned into breadcrumbs flour. Finally, the reuse of auxiliary materials, most commonly packages (e.g., seed bags, flour packages) was cited by the other organisations (e.g., Big-bags by Agrifood Industry). Additionally, BR Industrial Bakery was also capable of reusing water of the water stream in the plant to cool the building.

*c) Recycling*

**Recycling** was also divided into two elements: recycling of food and recycling of auxiliary materials. While the recycling of material – most notably plastic, cardboard and office supplies – was common throughout the interviews, the recycling of foodstuff was identified in few occasions. While BR Cooperative 1 mentioned biodigesters, the bread-making retailers (Supermarket chain 3 - in-store bakery, BR Cooperative 2 - supermarket and BR Craft Bakery) use the recycling of food in a different sense: unsold bread is toasted and grated, becoming breadcrumb flour that will be used as inputs for other types of food:

> "*Yeah, actually bread, bread today, I, I got one, I got a buyer. A pastry industry there, then, what I have left of bread, before I donated. Even the last time we talked, I donated, I donated to a guy who has fish tanks there, I donated to him, so as not to throw it away, you know. Today, I, for example, it has been about 15 days since I gave him anything. As I reduced the number… we, like I told you, as I reduced the number of products, so I already got one, I already got one, this reduction has already managed to give one, give a better destination for things, that is to sell, right, that my idea is to sell everything I produce." (...) "The bread, in the production process, goes to the pastry industry. I, I, sometimes I send whole toasted bread, which goes to make meat dumplings, which goes into the recipe, right, and, and there are, there are times when, when the industry has, they have a lot of bread, he asks me to I grate it. Then I send it as breadcrumbs.*" BR Craft Bakery 1

[26] Their interpretation of reuse is different from the one used in this thesis. Considering the need to transform the product into small particles, breadcrumb flour is better classified as recycle, not reuse.

*d) Redesign – of products, services and processes:*

**Redesign** was not easily understood by the interviewees, requiring an explanation of the concept, especially for those participants not connected to the industrialisation of goods. This means that although redesign is discussed by several authors in the CE literature, it is still a concept that might require rewording, at least for some contexts. All redesign types (product, processes, services) were connected to increase efficiency or value-added for customers. For Supermarket chain 1, redesign of products was only seen possible in their own brand. At the same time, BR Farmer 2, BR Cooperative 1 pointed out that they participate in the selection processes of seed breeding organisations. The BR Industrial Bakery is developing a bread that has a higher shelf life.

*e) Redistribution*

Two of the organisations commented on their **redistribution** practices, both of them the intermediaries between farmers and mills (BR Grain-merchant and BR Cooperative 1). The cooperative highlighted the sales team in the topic of redistribution, especially in the case of oversupply of grain (super harvest), and the grain-merchant argued that redistribution: "*is the nature of the business*". In other words, the need to move the grain for their clients (farmers) to a buyer, or to acquire the desired grain (for a mill) forces the intermediaries to redistribute the products, thus, avoiding waste. This means that the redistribution is directly connected to the intermediary's role and operation, acting therefore, as facilitators of the redistribution process as it connects different suppliers to different buyers considering specification, availability, cost, etc.

*f) Recovery – for adequate disposal and for energy generation/use*

The use of **recovery for incineration** was only cited for contaminated cargo, but the participants argued that this is only in extreme cases, and it is very rare. This is also not done for energy production, but to avoid contaminating the supply chain. On the other hand, the **recovery for adequate disposal** has different perspectives. The retailers consider **recovery** a common practice in cases where there is a compromised product, e.g., mouldy bread within a viable date or a ripped package in the store. They receive the product back from consumers and return to the suppliers. However, after the purchase of the product, the responsibility for the material belongs to the buyer, and only through proof of blame would a supplier recover the product for adequate disposal:

> "*I recover something, but just exchange it, right. But not like that, validity, no. This is because, in Brazil, we understand that the product's responsibility, after entering the store, it belongs to the customer, that is, he, consequently, has to know how to deal with this expiration date. Yes, if we don't, it's difficult in Brazil.*" BR Mill 1

Broadening the discussion from wheat food products, recovery is a common practice in Brazil concerning the **recovery** of pesticides packages and containers from farmers[27].

*g) Reclassification*

Regarding **reclassification** of products, the participants explained that they aim at the highest stability of the product possible; thus, it is not surprising that clients (especially the clients of flour) work with different standards. However, several factors can influence the quality of the grain (and therefore the flour made from it), including varietal type, rain during the harvest and overall season's weather. Because of this, the participants saw wheat and wheat-based products' **reclassification** to lower-value grades of the product' as part of the nature of wheat itself. According to the participants, after it reaches a certain threshold, the grain will be allocated to a feed mill or even a glue factory. In this sense, **reclassification** and **repurpose** (discussed next) were identified as synonymous by some of the participants (Figure 6.6), as the following quotes illustrate:

> "*Reclassify, reposition, change usage, example food for feed. Yes, this one we do. So, for example, if the wheat, we have a wheat that did not reach a standard, we have a feed factory and we even industrialise it*". BR Cooperative 1

> "*Reclassify, identify with a lower standard, sell cheaper. Yes, we end up doing that. Of course, it's just like I told you, if we know that the standard will, it will serve another company, which in São Paulo we don't sell, but in Paraná it will sell, we sell for the same price. But like the glue issue, we end up lowering the price, lowering the price much more because of relocation (...) changing the use, example: food for feed. Yes, we change precisely that*". BR Cooperative 2 – mill 4

[27] The recovery of such products falls outside the scope of the present research. For more information on the topic view the Brazilian National Solid Waste Policy and the non-profit organisation inpEV.

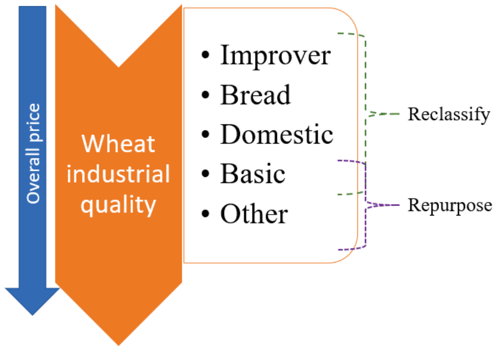



**Figure 6.6** CE practices reclassify and repurpose in Brazilian wheat grain.

The participants regarding reclassification brought two other points: i) farmers do not control the classification regarding the grain that they want to sell, nor the price that they want (except in future transactions); ii) reclassification is part of the strategy of bakeries and supermarkets to avoid food waste:

> "*Good products. Good products, just like I told you: 'Is this sweet bread from today?', 'Not this one is from yesterday and such', 'So no thanks.'. 'Is this sweet bread from today?', 'No, it is from yesterday, but it is 50% off, the product is great and such', 'So I'll take one'*". BR Craft Bakery

*h) Repurpose*

The **repurposing** of products was also discussed by several of the participants. It included the use of by-products (e.g., bran) from the milling process, potential production problems relating to standards in bread-making and unsold bread being reverted to animal feed, including beef, pork and fish production. Section 6.1.2 shows the analysis of the flow of the materials in open loops of the CSC.

*i) Renewable energy use*

The bigger organisations of the research identified the use of **renewable energy** in their operations. However, several of the other interviewees expressed interest in the practice, especially solar and wind power. BR Farmer 1, BR Mill 1, Supermarket chain 1, said that they are not only interested but also researched how to implement it.

The next CE operations are not 'R' practices (Table 2.7) but were identified in the literature review (Section 2.2.2) and also found in the research.

*j) Measure sustainable practices*

Regarding **audits of performance relating to adopted CE operations**, some organisations (e.g., BR Industrial Bakery, Agrifood industry, Supermarket chain 1, BR

Mill 3) have designated sustainability departments that conduct such measurements, although not expressed as 'Circular Economy'. The others do it as a form of management control related to cost and legislation. The exception are the farmers' extension programs that uses the information as a form of technology transfer tool in certain model farms to multiply knowledge of sustainable practices.

*k) Maintaining prices of new pro-sustainability products*

The practise of **setting the right price for the product**, had two differentiating perspectives throughout the supply chain, based on their position within it. Upstream organisations - farmers and the intermediaries - cannot determine the price of grain since it is sold as a commodity. This means that although some organisations can pay more for specific grain (premium), overall, most of the prices are determined internationally. On the other hand, downstream organisations do not differentiate their prices because they consider that the market is not willing to pay more for something more sustainable. The following quotes illustrate:

> "*There is only one price, so to speak. We focus on the chain as a whole, that is, we work to make the chain as sustainable as possible in the face of our scenario. For this, there is no differentiation of this producer. Let's suppose that there is a very capricious producer in our region, that he has high productivity with low use of pesticides. This guy doesn't have a plus for this product. The price of his product is the same as that of the other producer.*" BR Cooperative 1.

> "*It ties in because, you don't know, wheat is a commodity, the major wheat price maker in the world is Chicago. So, it fluctuates a lot, on the stock exchange, in everything. The price of wheat varies according to the production in the world, according to the world stocks of wheat, which sometimes, in general, in recent years has been high, but sometimes for some contingency, it reduces a lot, a drought in Russia, or something in China or something in the United States or Canada. This influences the price a lot, so it is very difficult not to negotiate contract by contract*". BR Mill Association.

*l) Purchases of cleaner inputs and services*

Regarding **cleaner purchases from the suppliers**, almost all the participants said that it is a policy of their organisation. Exceptions include the extension agency not being able to force farmers to purchase more sustainable products and the interviewee from Supermarket chain 3 - in-store bakery not knowing the company's policy on the topic.

Supermarket chain 1 is still implementing these decisions for their brand name products, namely their eggs and meat products. However, there are no wheat-based own-brand products for said company. It must also be highlighted that none of the participants expressed a willingness to pay more for more sustainable options in the short run.

*m) Cooperation with other organisations to use CE practices*

**Cooperation with other organisations for sustainability** is one of the most common practices (only one participant did not select that option). Several different forms of this exist, such as knowledge sharing practices (e.g., agricultural fairs), pro-sustainability research partnerships and donation of food for social causes (e.g., churches and non-profit organisations). The work of the cooperatives and their relationship with its farmers are also connected to reduction of waste post-harvest through their capacity to store the grain, something almost non-existent in most of Brazilian wheat farmers. This is similar to what previous findings in this area (Despoudi *et al.*, 2018).

*n) New pathways of logistics systems*

For the use of **new logistical options that are more sustainable,** there are sizeable differences in logistical options because of Brazilian infrastructure. Some of the interviewees argued that they aim at being more efficient in their logistics, like Agrifood Industry (e.g., 100% capacity for transport by lorries & use of ethanol fuel) and Supermarket chain 1 (Distribution Centres and stores storage). However, most of the participants argued that they do not have options relating to logistics and are constrained to road transport using lorries and storage of grains and flour in big silos distributed throughout the targeted market region (Figure 6.7). Flour from the mills interviewed is transported for large clients (industries and supermarket chains) using Big-Bags and small packages for craft bakeries using lorries (Figure 6.8). According to BR Craft Bakery: *"... you today, you buy only what you will need. Today, nobody works with stock, nothing more*." This quote is also supported by the picture of the storage of flours in the bakery (Figure 6.9)

Logistic cost and time-constraints play an essential role in the wheat food supply chain. An example of this can be seen by the decision of the farmers on where to sell their grain - none had storage capacity for the grain in the farms. This means that they need to use their lorries to deliver the harvested grain as fast as possible and return to continue the harvest. According to Baldez (2020), logistics costs in Brazil account for 26% of products' cost, although for farmers in Parana and Rio Grande do Sul, transport and storage account for around 5.6% of total production costs and for cooperative it represents around 5,1% of storage costs (CONAB, 2020; OCEPAR, 2020). BR Mill 2 argued that logistics is their highest costs after the raw material. Similarly, BR Mill 3, that imports its grain from Argentina, have four of its seven milling plants stationed directly in ports, thus reducing logistics cost.

**Figure 6.7** Grain silos.

**Figure 6.8** Flour transport from the mill to industries and retail.

**Figure 6.9** Flour storage at BR Craft Bakery.

*o) Education and training to staff and managers*

The last of the more selected CE practices, **education and training of staff and managers for sustainability practices**, was argued as being very important by the participants that commented on it. However, CE was not cited among the types of courses. Some of the training mentioned includes food safety, staff safety, biological control (bacteria) for farm pests and sustainable on-farm operation.

*p) Environmental certifications*

**Environmental certifications** were sparsely discussed by the participants. Although both BR Mill 1 & 2 cited the FSSC 22000 (food safety legislation), they argued that they are operating within ISO requirements but don't have the certification yet. Of the bigger organisations in the supply chain studied, only the Supermarket chain 1 did not select environmental certification but mentioned that they are working on it. Some of the participants (e.g., Cooperative 2 - supermarket & Supermarket chain 3 - in-store bakery) considered the applicable legislation as their certification. BR Farmer 2 and Supermarket chain 1 consider that in the future, environmental certifications will be an obligatory requirement for those in the wheat food supply chain.

*q) Targeting the market of "green customers"*

Of the list of the given CE practices, **targeting the market of "green customers"** was selected by some of the organisations, most notably all the supermarkets. They talked about new strategies to reach this 'new' type of consumer, although some barriers still exist (barriers are presented in section 6.4.1.1).

*r) Other practices*

'Other' CE practice was not marked by any of the participants, even after being explained the general principles of CE. However, one kind of CE practice was discussed several times: **services over ownership**. The use of services could be identified prominently in relation to the storage of grain. The investment in sheds, silos or warehouses for farmers is too significant, and to maintain such structures would also prove to be too expensive for small/medium farmers. This meant that the use of cooperatives and grain-merchants is also attached to the storage capacity provided by those services.

Another type of services over ownership discussed by some of the farmers is connected to agricultural machinery and lorries for grain transport. Most farmers prefer to buy their own lorries and machinery because of the risk associated with not having the service available to them at the needed time. The demand for such services creates difficulties in tight windows of time open for certain operations such as spraying agrichemicals or harvesting wheat and planting soya beans. This is exemplified by BR Farmer 1:

> "*No, machinery, we have it all. We already, by the analysis, would not compensate, right. It's worth it to rent a machine, it's worth it to you to rent a lorry, right? But then, when the time comes, you can't get the service on time*." BR Farmer 1

Finally, Supermarket chain 3 - in-store bakery also provided an example of service over ownership in the wheat-food supply chain. According to the participant, bread-making industries lend the machinery needed to store and heat frozen bread in exchange for the continuous purchase of the company's product:

> "Yeah, today, all these companies, for example, it supplies, it is a bread factory, it supplies many people here in Curitiba and region. So, it offers, in addition to the product, it still supplies me the equipment, for us to be working, right. It's a partnership that we made, makes with the company. So, we have, most of the equipment we have, is theirs. It is borrowed." Supermarket chain 3 - in-store bakery.

### 6.1.2 Wheat material flow - Brazil

The second research objective of this thesis was 'to map the material flows, including wastes and by-product outputs, in the wheat food supply chain in Brazil and the UK'. The present section focuses on the Brazilian case. None of the Brazilian research participants provided accurate quantities or percentages of their wheat food waste. The reasons given include:

- Their definition of waste does not allow any measurement since all raw material that enters the organisation has some form of value.
- The amount of waste (e.g., less than 0.5%) is so tiny that the organisation does not care about accurate measures.
- The participant did not know of any value regarding food waste.
- They never thought about measuring wheat waste,

However, it was possible to map the flow of the wheat in the supply chain, both within the closed loops and the open loops, thus including wheat-food products, by-products, co-products, waste and wastage.

6.1.2.1 Linear wheat food supply chain

Figure 6.10 summarises the Brazilian wheat food supply chain with the participating organisations of this thesis. It provides a base-line for the discussion regarding the CSC, or in other words, it represents the linear version of the wheat food supply chain, before the ‘circular economy lenses’ are applied.

The supply chain design shown in Figure 6.10 differentiates the cooperative’s divisions that relate to wheat food as this facilitates the understanding of the role of such organisations for the Brazilian wheat industry. Another element that needs to be highlighted is the possible direct connection between farmers and mills, a practice that is still not standard in the industry, according to the participants. Most wheat is purchased either from grain-merchants/traders or cooperatives. Therefore, the number of links between wheat production and end-consumer can be three (e.g., farmer –> mill –> craft-bakery) to five (e.g., farmer -> grain-merchant -> mill -> industrial bakery -> supermarket).

Finally, it was also identified that mills, agri-food industries, and supermarket chains (especially large ones) function as hubs, receiving supplies from a range of different organisations. Large corporations acting in such capacity have considerable leverage of negotiating power and play a significant role in the supply chain as both buyers and sellers.

The trade of wheat shown in Figure 6.10 aligns with the WAIC discussed by Mori and Ignaczak (2012). It does not have any differentiating characteristic of note from the current literature on the Brazilian wheat supply chain (Brum and Muller, 2008). The focus of the discussion, therefore, must be in the circular perspective.

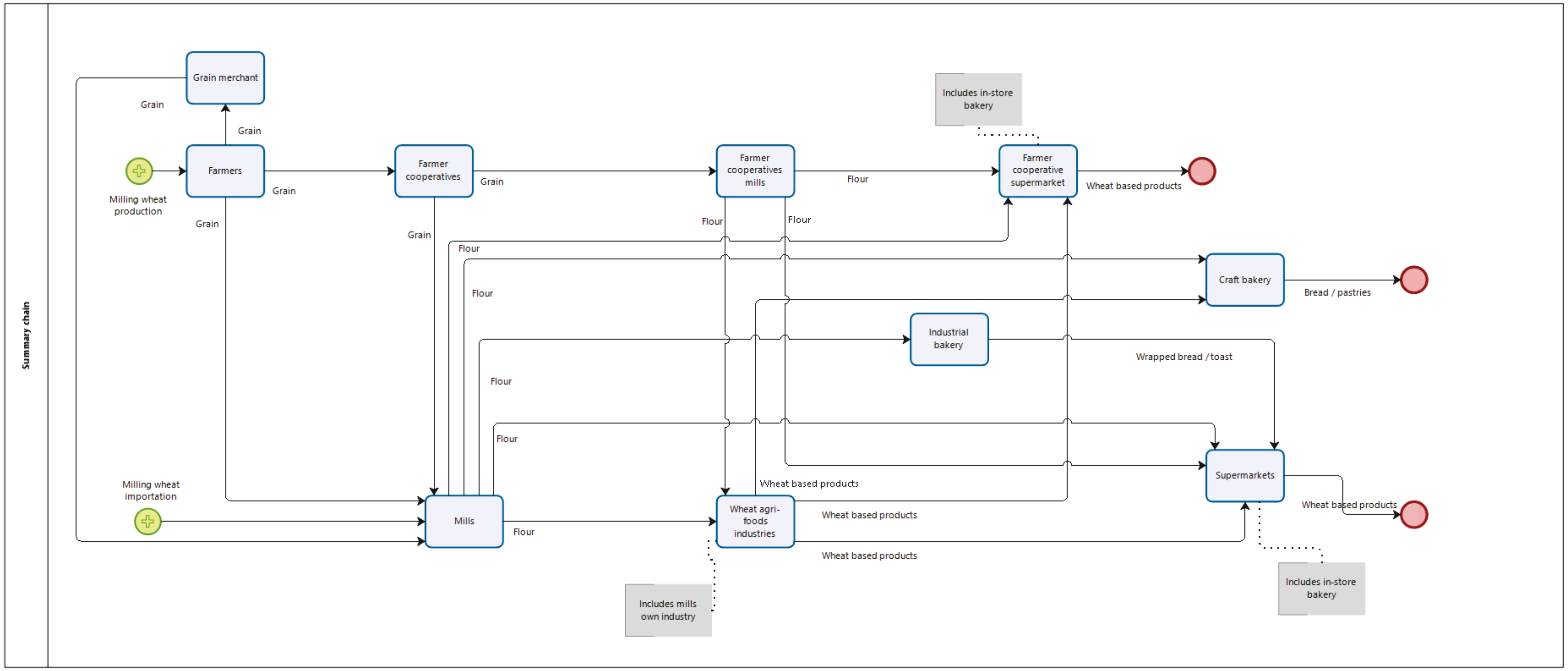



**Figure 6.10** Brazilian wheat food supply chain.

#### 6.1.2.2 Circular wheat food supply chain

With the application of the CSC framework (Batista *et al.,* 2018c) to the design of the supply chain, it is possible to visualise a more comprehensive picture of the flow of the material. Figure 6.11 shows the CSC of the Brazilian case, based on the interviews conducted. The orange arrows represent the circularity aspect of the flow (both closed and open loops), such as **recovery** of wheat waste, **repurpose** of wheat to animal feed or **recycling** of bread into breadcrumb flours. The purple boxes represent organisations connected to the wheat industry, but not linked directly with food (i.e., open loops). Even though these organisations are part of the overall wheat industry (Mori and Ignaczak, 2012), to connect them as a circular perspective of food is a new approach from this thesis.

Wheat exports (i.e., ‘**redistribution**’ as per Table 2.7 definition) is possible within the Brazilian wheat supply chain - especially by cooperatives from the state of Rio Grande do Sul. However, they are not indicated in Figure 6.10 nor Figure 6.11 for two reasons: i) it is not possible to identify if it is used in wheat food; ii) none of the interviewed organisations mentioned executing the practice directly. Both the linear and the circular perspectives show an interlinked supply chain, but the circular view shows a more complex network of organisations and material flows.

To facilitate the analysis of the different material flows in the CSC, six different ‘snapshots’ are displayed below. These perspectives consider the type of organisation central to the ‘loop’ discussed and the different forms of wheat flow in the supply chain.

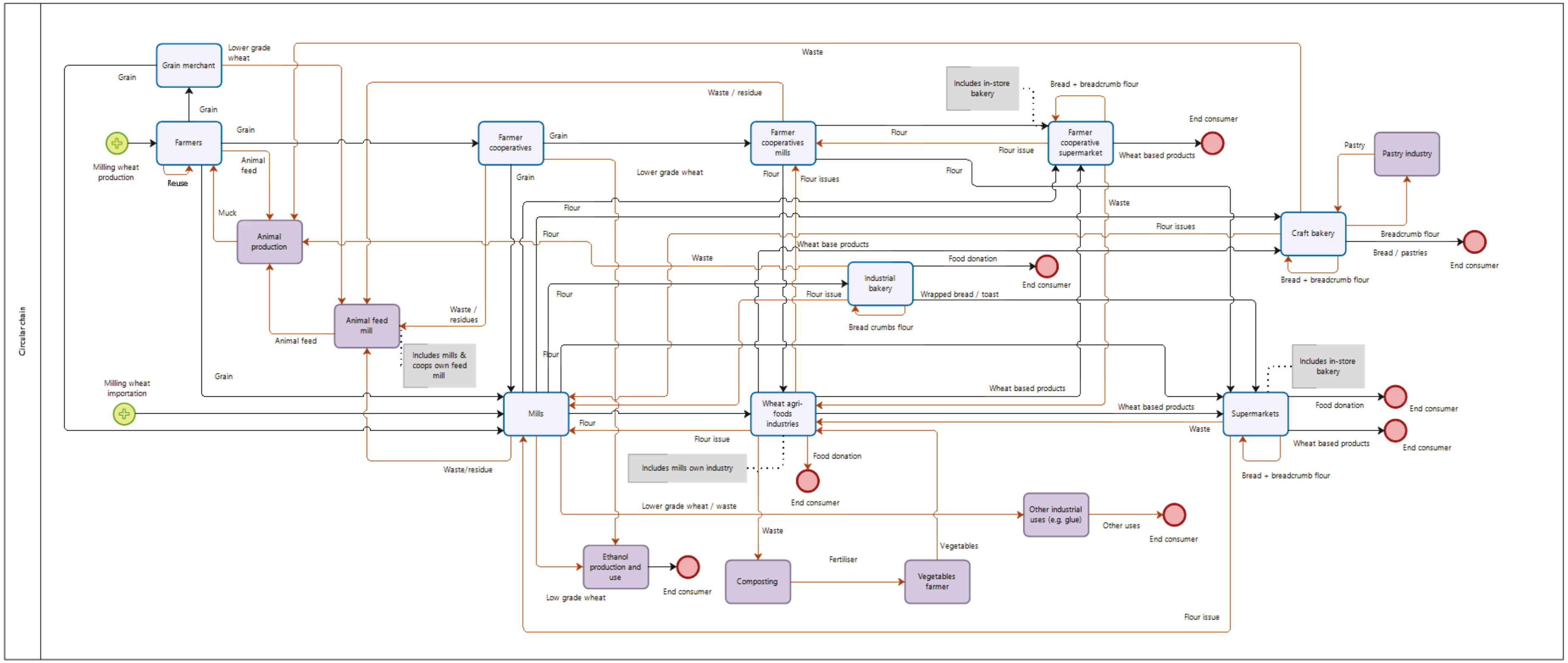



**Figure 6.11** Brazilian circular wheat food supply chain.

*a) Farmers*

The first segment of the wheat circular flow is connected to farmers, as shown in Figure 6.12.

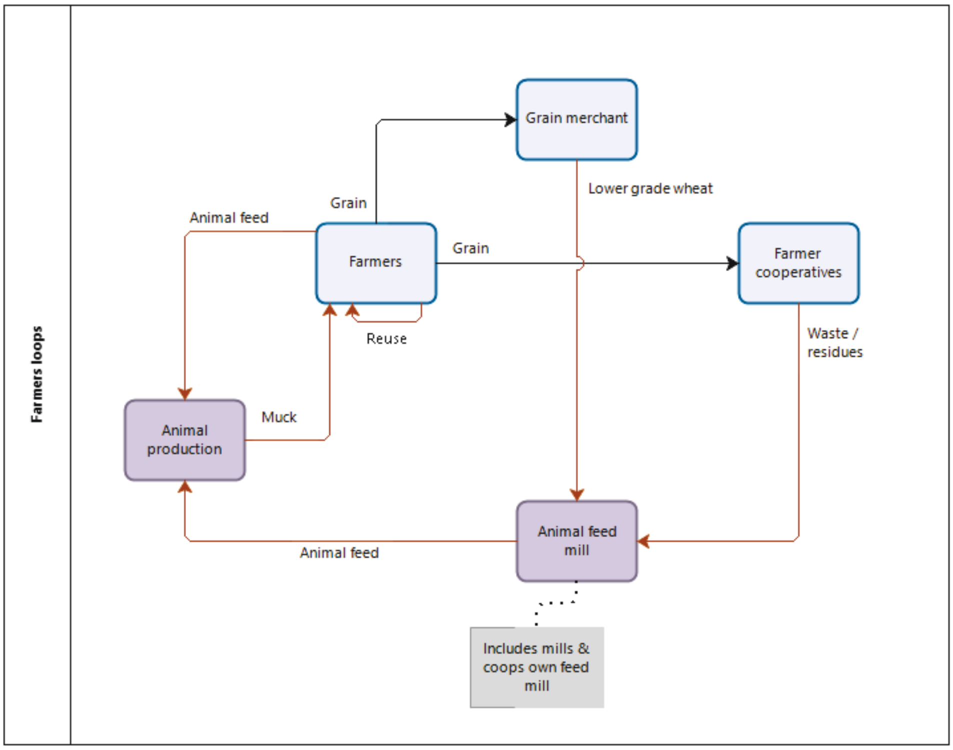



**Figure 6.12** BR Farmer circular wheat flows.

Figure 6.12 indicates how animal production can be part of the circularity of wheat food. Directly linked to the farmer (e.g., dual-purpose wheat at Farmer 2), animal waste has a synergic relationship with grain production through the increase in organics matter and fertility. Additionally, it connects through the feed preparation at feed mills, using waste and residues coming from cooperatives and grain-merchant silos (**reduction of waste**). It is also common to use lower industrial quality of wheat (**reclassification**) as raw material for animal feed. Finally, **reuse** of seeds, although disputed by some participants[28], is a practice being operated in wheat farms, including some of those interviewed. The direct selling of wheat to mills was not included in Figure 6.13 because such practice is more representative of the mills' practices than of the farmers, as it is not a common option for farmers and not likely to represent 100% of wheat grain sales even to those that do sell to mills (e.g., BR Farmer 3) if they have other options.

[28] Reuse of seeds can increase risk of pests and reduce both productivity of seeds and wheat industrial quality (Sa and Azevedo, 2012; Sa *et al.*, 2013)

*b) Mills*

The following perspective is the one executed by the mills and pictured in Figure 6.13 below.

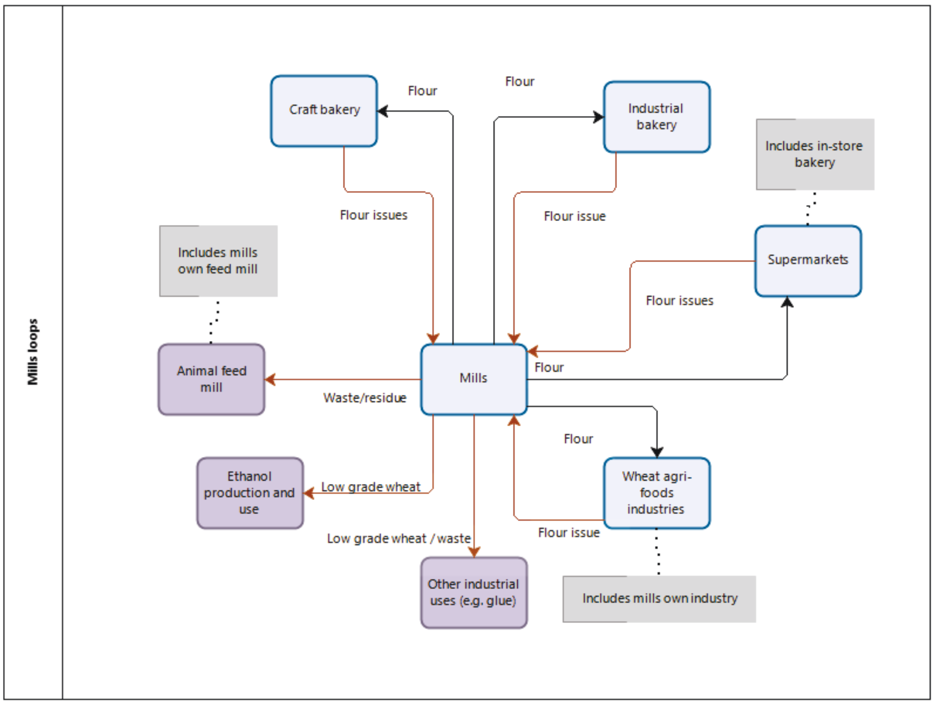



**Figure 6.13** BR Mill circular wheat flows.

The graphic representation of the mills circular wheat flow shows <u>open</u> and <u>closed loops</u>. The closed loops are connected to **recovery** of flour from clients that could not use the product for reasons mostly related to food safety (e.g., mould) or quality (e.g., too much humidity in the flour package). This requires that the client send the flour to the supplier that will investigate the cause of the issue.

The **recovery** of products is not intended on **reducing waste**, however, and the **recovery** expressed here is more representative of supplier responsibility of ensuring a quality product, and it is not the mills responsibility to take care of the potential unused flour from its clients. It is also connected at ensuring the food safety of the supply chain: removing potential contaminants that would jeopardise other goods such as bread or pasta.

The <u>open loops</u> on the other hand, are connected to different forms of CE practice (Section 2.2.4): **reduction of waste**, **reclassification,** and **repurposing of materials**. The feed mills play a significant role in such activities, since the use of lower grade grain (e.g., low gluten), by-products (e.g., bran) and residues (e.g., residues in air filters) are all integral parts of feed mills' feedstock. Another form of **repurposing** material is by submitting the unwanted flour for production of glue or through ethanol production using unwanted wheat grain. This is not common in Brazil since most ethanol produced in the country is from sugarcane, but the use of wheat as an alternative to sugarcane is stronger in the state of Rio Grande do Sul where government incentivise it. The **repurpose** of wheat initially intended for food to other industrial uses is normally avoided by the mills since the profit margin for such sales tend not to be as interesting as the other alternatives discussed.

*c) Industries*

Figure 6.14 shows the identified material loops of two types of participating organisations: industrial bakery and agrifood industry. There are three commonalities in their operations: both sell to supermarket chains; both donate their surplus production to charitable organisations (**reduction of waste**); and both resubmit their unwanted flour to the mills. There are, however, more differentiating practices on how to deal with waste.

The BR Industrial Bakery also **recycles** the surplus of bread into breadcrumb flour (as discussed in Section 6.1.1) and donates waste and residue to neighbouring farms that use it to feed their animals (**repurpose**). This kind of donation is, however, an occasional practice and not a systemic one. The Agrifood industry, besides donating its overproduction to NGOs, also composts its waste through a partner organisation (**recycle of food**). The fertiliser produced is used by vegetable farmers near the factory and re-enters the production system as fresh vegetables. Supermarkets also resubmit their potential waste to the suppliers, but this is mostly connected to problems in the product and not to avoid waste.

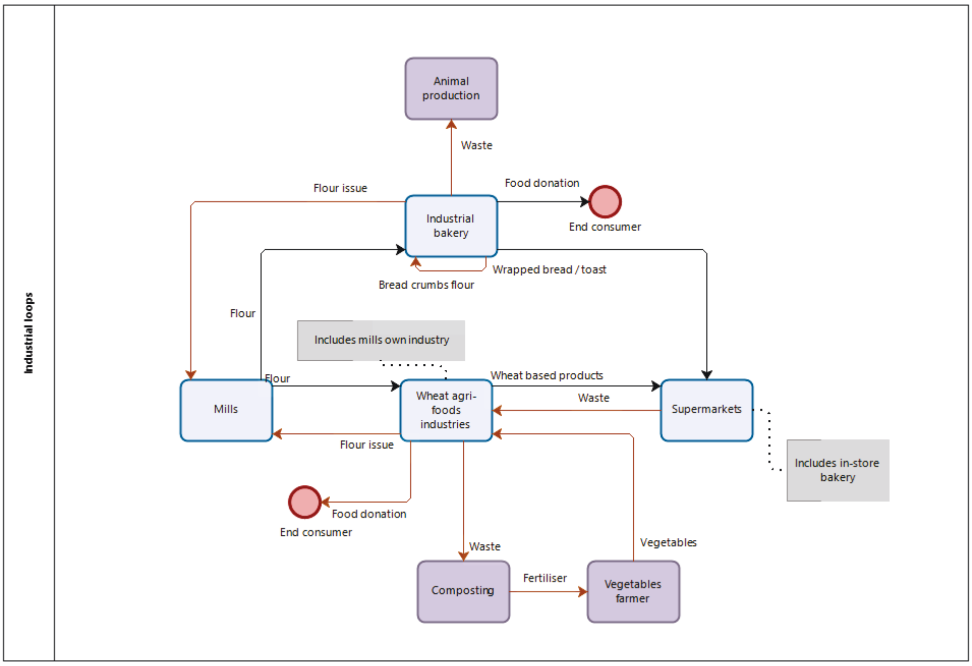



**Figure 6.14** BR Industry circular wheat flows.

### *d) Supermarket*

The supermarket chains interviewed apply three sets of circular practices besides the return (**recovery**) of wheat-based products to suppliers that influence the flow of material: food donation, **reuse** and **recycling** of bread in their in-store bakeries. Food donation varied from regular occurrence as part of a program connected to Mesa Brasil (<u>Supermarket chain 1</u>) to sporadic donations to NGOs, churches and other social outreach entities. Not necessarily linked with the reduction of waste, these practices are connected to social responsibility and helping local communities.

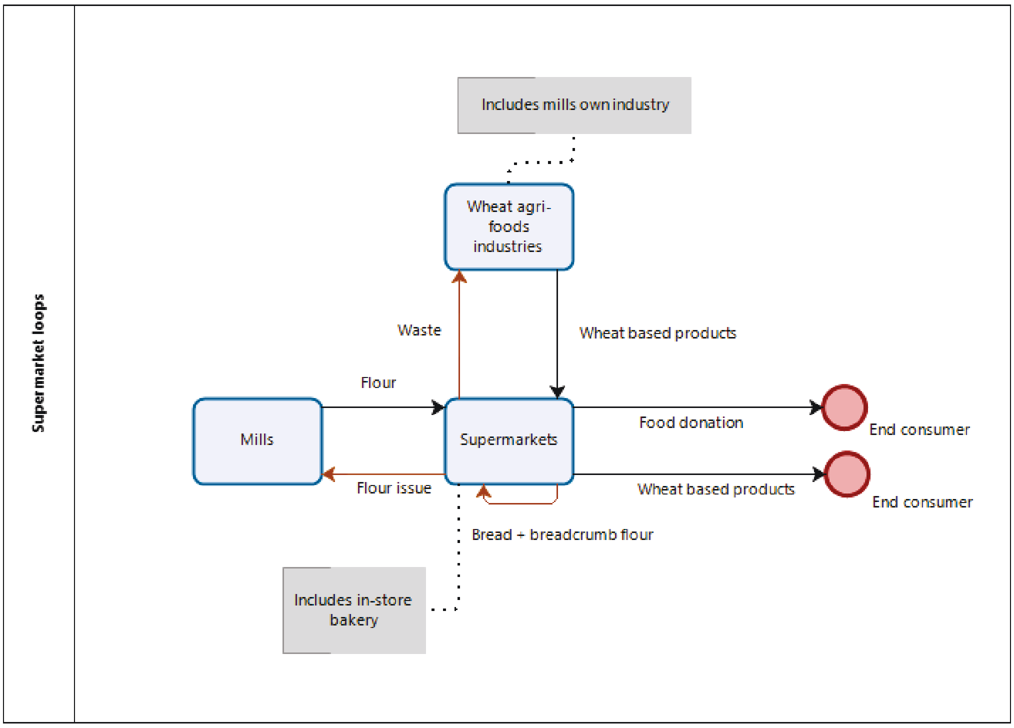



**Figure 6.15** BR Supermarkets circular wheat flows.

Figure 6.15 also shows the possibility of **reusing** the bread made in the stores as different products, reducing prices (**reclassification**) or producing breadcrumb flour for own use or sales. Such operations, however, require governmental licences for producing and handling food that some supermarket chains (e.g., Supermarket chain 1) do not want to concern themselves. Such a decision makes the supermarkets dependent on ready-made frozen bread and pastries heated in the store. It does not allow the handling of those products after they are made available to customers, thus increasing the dependency of bread loaves (e.g., sliced bread) over rolls (e.g., French bread).

*e) Craft bakery*

The interviewed craft bakery has one different circular operation in comparison to the other bread-producing organisations of the research. Although **reduction of waste** via the donation of by-products and potentially wasted bread for animal production (i.e., fish production) had recently stopped, surplus production still had two destinations: **reuse/recycling** inside the store and trade with a partner industry. Figure 6.16 shows all of those cycles.

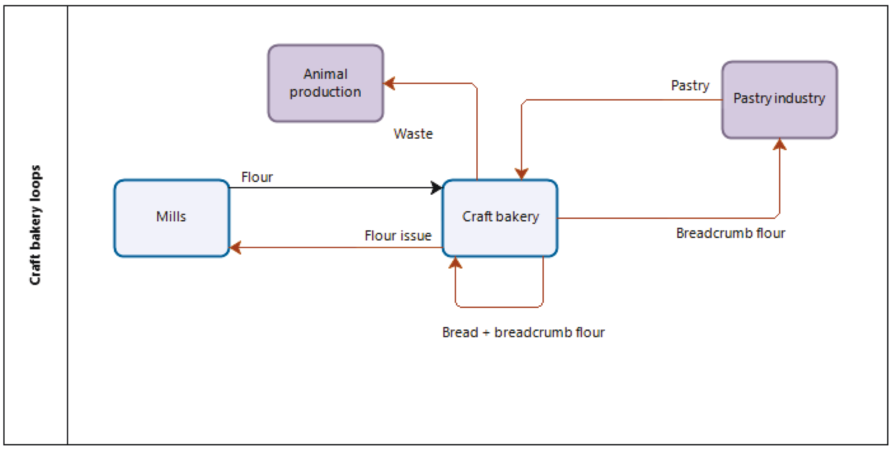



**Figure 6.16** BR Craft bakery circular wheat flows.

The in-store production of certain pastries (Figure 6.17 as an example) and the **reuse** of toasted bread as a side for the soup buffet served at the bakery, reduced costs and increased value of products and services for the organisation. Additionally, the bakery formed a partnership with a local pastry industry, providing high-quality breadcrumb flour (**recycled** bread) in exchange for credits in the industry products. The pastries supplied by the industry contain the flour from the bread of the bakery, thus closing the loop.

**Figure 6.17** Brazilian '*coxinhas*' produced in the BR Craft Bakery.

*f) Cooperatives*

Figure 6.18 shows the representation of the different divisions of the researched cooperatives. Although cooperatives supply mills with grain and industries with flour, some of them recently developed the capacity to add value to wheat. These include not only their own flour mill, but also animal feed mills, food industries and supermarkets.

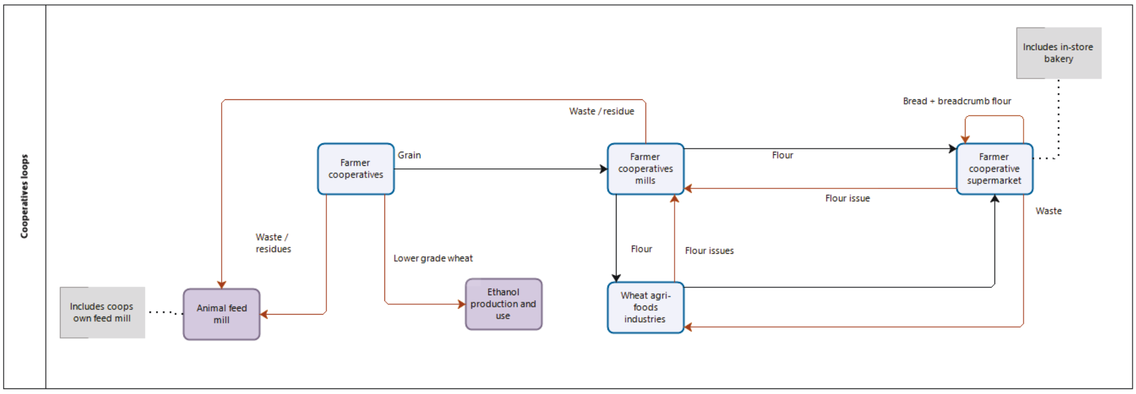


**Figure 6.18** BR Cooperatives circular wheat flows.

The cooperatives also use animal feed mills as an essential component of wheat waste or residue usage (**repurpose**). Cereal for ethanol production also became a new alternative for using the grain (**repurpose**). Partnerships with industries that provide pasta or biscuits for the cooperatives supermarkets using cooperative flour were also mentioned. These partnerships required greater control of overall wheat production of the associated farmers, thus reducing the need for imports or correcting additives (**reduction of inputs**). The supermarkets of BR Cooperative 2 also produce breadcrumb flour and other uses for unsold bread (**recycling** and **reuse**). The connection of the cooperative's supermarket and mill, as well as its location (around 200 meters from each other), also reduces challenges of problematic input (e.g., glyphosate as a desiccant for wheat). The mills also can influence the grain fomented by the cooperative to its associated farmers in programs designed to differentiate its flour from others in the market (i.e., whitening flour).

## 6.2 UK SUPPLY CHAIN CASE

The UK's wheat industry, overall, has fewer players participating, with the exception of the number of farmers which both countries have around 35,000 (Chapter 3). In a similar vein, the UK's case studied, also has fewer participating organisations, as pointed out in the discussion below. Section 6.2 follows the same structure as the previous. Preliminary findings of this section were presented in a paper titled '*Diffusion of circular economy practices in the UK wheat food supply chain*' (Dossa *et al.*, 2020).

### 6.2.1 CE Practices - UK

Section 6.2 is also based on the research framework shown in Chapter 4. Section 6.2.1 aims at answering the first research question (i.e., 'what are the Circular Economy practices in a wheat food supply chain in Brazil and the UK?') in relation to the UK case. In the framework (Chapter 4), Section 6.2.1 is likewise represented in Figure 6.1.

The UK's wheat agri-food supply chain **CE practices** selected by each participant interviewed are in Appendix I. There is substantial variation between the practices. UK's supermarkets were not included in the appendix because they were not interviewed. However, with the study of their secondary data, it was possible to identify all of the listed CE practices, with the exception of *redesign services* and *maintaining prices of new pro-sustainability products*.

*a) Reduction – of waste and inputs:*

There is considerable overlap between the participants concerning waste and its definition. The primary view is that all parts of wheat are useful. Waste is, therefore, everything that has no value and needs to be sent to landfills – having originated from surplus production or errors in storage and operation. With such a perspective, the participants can argue that there is little to no waste in the processes.

Two notable deviations need to be highlighted: For the UK Beer-making charity, waste is the bread that is not consumed as human food – similar to the definition proposed by Batista *et al.* (2015b); for the supermarkets, the definition of waste comes from WRAP (2019) as any material that goes to anaerobic digestion, composting, incineration, land application, landfill, sewer or not-harvested. Finally, there is a conflict of information relating to bread waste. The UK industrial bakery considered very little waste in their operation – 5,5% going to animal feed (thus not considered waste by the participant) and about 0.0002% going to the sewer. On the other hand, UK Beer-making charity argued that most bread waste comes from bread production - industry and supermarkets - and consumers. Several reasons can explain such discrepancy, including different definitions of waste and bad data (e.g., data intended for a broader perspective but used in the bakery industry).

In terms of operations to **reduce waste**, three basic strategies could be summarised from the data: a) food safety strategies to minimise contamination and thus wastage (FAO; WHO, 2003; FAO, 2020a); b) reduction of waste from auxiliary materials and by-products (e.g., water, packaging, other foodstuff sold with the wheat-based food, filters in the mills etc.); c) open loops of material (e.g., food to feed and food donation, both to be discussed later in this section). Safety is an integral part of the food industry for both human and animal health (with feed), and safety standards influence the amount of waste generated. In that sense, the waste reduction practices affect all stages of the supply chain and how they produce and deal with safety. Examples include farmers following UK Assurance Scheme guidelines; UK Farmer Cooperative operations for storage; grain requirements, analysis and standards with the grain-merchant and mills; flour transportation (from mills to clients); bread production, inventory and donation by the bakeries and supermarkets; and bread donation and use by the charities. Traceability is also an important factor in that, as the quote from the UK Mill Association shows when discussing sustainability requirements in grain purchase and its connection to grain standards:

> "*Yeah, I suppose there's two bits the, the traceability, the traceability sort of falls under the, in my eyes, the kind of food safety aspect. So in some cases, the wheat is traceable down to the farm level. So you have your flour, and you know what's gone into that flour. And you can trace that wheat back down to the farm level. There, there are instances where the grain is blended at a grain store. (...) And they clean and... clean that wheat to make sure it's free of any kind of bugs or any contaminants, they ensure that it's dry to a moisture level, where there's not going to be any fungal infections or any damages to the actual quality of the grain. And then they will sell that to a mill. And in that case, because they've blended from, from multiple wheat shipments, or loads, because it's all done by lorry... tracing to the individual farm level becomes quite difficult. But because it's, because it's been blended and clean, you kind of have that additional, I wouldn't say its a safety factor, but a kind of quality control step, in that, that store, that grain store knows it is supplying to a mill and so is fully aware that it has to comply with the food safety requirements.*" UK Mill Association.

**Reduction of inputs** was identified in almost all of the interviewed organisations. Practices connected to it are mostly motivated by reduction of cost (thin profit margins) and waste. It includes reduction of inputs (fertilisers and pesticides) in grain production, water and energy usage, packaging, among others. Of the three organisations that did not select such practices (Appendix I), two reasons were discussed: either there is no input use (UK Food distribution charity) or product specification does not allow reduction of inputs (UK Mill 1 and UK Industrial bakery).

Another approach to **reduction of inputs** is the program that UK Industrial bakery created to purchase flour without the use of foliar (liquid) Nitrogen in the wheat grain.

UK Farmer 1 is a part of the program, mediated by UK Grain-merchant 2 – cooperative and UK Mill 1 is one of the UK's mills that produce the flour with the said grain. Traditionally, farmers apply foliar Nitrogen to increase protein (especially gluten) amount in the wheat grain to receive a higher premium for the grain, since it can be milled into greater quality flour. This program has a selected group of farmers who receive a premium for not using such inputs and selling it to the bakery's designated mill via the grain-merchant. By not using such products, the flexibility of farmers to sell the cereal to other grain-merchants/mills is diminished, thus making the premium necessary. Another goal of the program is the reduction of Nitrogen runoffs, thus reducing soil and water contamination.

Both interviewed UK farmers purchase sewage sludge from regional sewage treatment companies and use it as fertiliser and to increase soil organic matter. Additionally, both farmers use cow muck as fertiliser: UK Farmer 1 has a straw for muck deal with a neighbour (further explanation in the cooperation subsection), and UK Farmer 2 uses its farm's cattle-raising operation for that (Figure 6.19). UK Farmer 1 also uses clean water sludge (a different by-product from water/sewage treatment) and is paid for that by the water treatment company. These kinds of operations are connected to the reduction of waste (from the treatment facility) and reduction of inputs (from using chemical fertilisers) as defined in Table 2.7.

**Figure 6.19** Cattle production in UK Farmer 2 – wheat straw/muck.

Some of the farmers' operations are not easily identifiable in the CE literature reviewed (Batista *et al.*, 2017; Weetman, 2017; Jesus and Mendonça, 2018). **Crop**

**rotation** and **soil management** are two forms of operation that can reduce uncertainty (risk), input need/use and waste (of water, agrochemicals, operations and biomatter). Neither is commonly discussed in the CE-literature regarding food supply chains. However, part of the supermarkets' documentation (i.e., website, reports) relating to sustainability mentioned those items.

While tillage and reduced tillage is still the dominating system of soil management/seeding for wheat in the UK, there is a growing number of farmers implementing no-tillage in their fields. This was expressed by UK Extensionist and by both farmers, although UK Farmer 1 expressed some scepticism based on capacity/need to implement in terms of soil and farm location.

*b) Reuse*

In terms of **reuse** of wheat, the same interpretations previously summarised in Figure 6.5 were identified: reuse of food, seeds and auxiliary materials. The most common of the reuse practices identified was the reuse of food[29]. For example, UK Craft bakery will use leftover loaves of bread from the previous day as toasties in the next day and the reuse of dough that has not left the production line and is still safe (UK Industrial bakery).

Reuse (saving) seeds is practised by both of the interviewed farmers, but neither expressed issues relating to the reduction of productivity or increase in diseases. The reuse of auxiliary materials connected mostly to packaging, including reuse of kegs by UK Beer making charity and exploration on new ways to reuse materials by UK Supermarket chain 1. UK Farmer 1 also commented on the reuse of machinery, as he prefers to purchase second-hand machinery since it is cheaper, and he can repair the vehicle if needed.

Classifying the use of surplus bread in beer making either reuse or recycling depends on the definition: by using Weetman's (2017) definition of reuse, modification is not possible. Therefore, it might be more fitting to consider the practice **as recycling** of food (Table 2.7 definition), even though the UK Beer making charity consider it reuse. This is in line with the discussion addressed by Korhonen *et al.* (2018a) where some definitions and concepts of CE can be superficial or conflicting. The practice here also diverges from that of Vlajic *et al.* (2018) as it is more specific and restricted to closed-loop, rather than the possibility of the open-loop (including redistribution) of those authors' work.

[29] The direct reuse of food by using food not consumed by one customer to another one has considerable food safety considerations and is not practiced by the interviewed organisations.

*c) Recycling*

**Recycling** was discussed in two different forms: recycling of food and recycling of auxiliary materials. Recycling of material such as grain bags, plastic and cardboard packaging and office supplies was presented throughout the supply chain as was the recycling of food, primarily through anaerobic digestion or composting. The production of beer using surplus bread, as already discussed, is also a form of food recycling[30].

Anaerobic digestion and composting (Figure 6.20) are common in the supply chain and mostly used for products that are not safe for humans or animals (quote below) (Riding *et al.*, 2015; The Ellen MacArthur Foundation, 2019; WRAP, 2019). However, the use of said products as compost for further use as fertiliser in farms is also possible using by-products of wheat production.

**Figure 6.20** Compost in UK Farmer 2.

*d) Redesign – of products, services and processes:*

**Redesign** was identified in several actors of the supply chain. It included the development of new products like new seeds (in partnership with breeders) that are more productive, require fewer agrichemicals and are better suited for particular products downstream (UK Farmer 1, UK Grain-merchant 2 – cooperative, UK Industrial Bakery), therefore, reducing waste and input use (Pagotto and Halog, 2016; Gallaud and Laperche, 2016). Other examples identified include products with longer life (WRAP, 2019),

[30] Recently an English bakery chain (not part of the present research) has also started to recycle bread into new sourdough bread – called Waste Bread - by mixing processed unsold day-old loaves in the dough.

innovation of internal processes for production and delivery to clients, new services developed to comply to specific clients requirements of waste reduction, new forms of food donation to reduce food waste.

While most of the discussed innovations implemented in the supply chain fall within the CE paradigm (Batista *et al.,* 2018a), other redesigns could be more robust if not for the need to consider trade-offs and boomerang effects (Zink and Geyer, 2017; Korhonen *et al.,* 2018a):

> "*So we've extended life through packaging using different gas mixes so you can get a little bit more life but like I said earlier, the overriding importance to us is the quality of the product, so actually we, we give it less life that, that we could probably get a hold of it, just to make sure that it's the quality when people come to eat it*." UK Industrial bakery.

*e) Redistribution*

Several organisations in the UK's supply chain studied commented on their **redistribution** operations. Redistribution (Weetman, 2017) operations are clear examples of open-loop strategies in CSC (Batista *et al.,* 2018b; Vlajic *et al.*, 2018). Although a small number of the participants in the supply chain donate surplus food (e.g., both bakeries), it is possible to consider that some of the organisations' own nature, enables (or facilitates) the redistribution of materials as they are designed to help the movement of goods from suppliers to clients. The two notable examples are the grain-merchants and the UK Food distribution charity. For the grain-merchants, the need to find buyers for the farmer's contracted grain purchase/sell is fundamental for their business, even when part of the grain is contracted for the grain-merchant parent company (UK Grain-merchant 1 – private). The inability to arrange such deals would lead not only to contract breaks and financial loss but also to increased wheat waste.

The capacity to redistribute donated food before it becoming waste is the whole purpose of UK Food distribution charity that defines itself as "*an environmental charity that tackles a social problem*". By partnering with other charities as well as food producers and retailers, the organisation can arrange distribution, triage, storage and coordination nationwide. Figure 6.21 shows one of their storage/distribution facilities. According to the participant, UK Food distribution charity is the largest of its kind in the UK (donating around 11 million meals a year), but it only redistributes 7% of the UK food waste. Of the wheat-based products, bread represents the largest volume, although they only receive/distribute products with more than two days before the expiration date, thus reducing their capacity to acquire and redistribute such products.


**Figure 6.21** Storage for food redistribution.

*f) Recovery – for adequate disposal and for energy generation/use*

**Recovery for incineration** was cited in the very rare case of contaminated cargo for UK Grain-merchant 1, while UK Industrial bakery mentioned that incineration happens to avoid sending it to landfills. Energy recovery is also used by both supermarket chains according to their websites and reports, although they consider it the last resort. **Recovery for adequate disposal** is similar in the sense that most[31] of the operations relating to it were discussed by the participants as the recovery of substandard or spoiled products. The client must show that the product came with issues before arriving at the buyers. UK law is well established in terms of roles and responsibilities for food sales. When such matters are demonstrated, some the organisations will not recover the product unless it is a substantial cargo. For small quantities, there will be a credit for future purchases for the buyer, and the responsibility of disposing belongs to the buyer. The data reinforced that recovery is one of the practices that is different in CSC depending on the material and need to consider open-loops in discussions of CSC and waste (Gallaud and Laperche, 2016; Vlajic *et al.*, 2018; Batista *et al.*, 2018c).

[31] One British industrial bakery, not part of this study, has implemented recovery of bread bags (plastic packaging) through major retailers' stores.

*g) Reclassification*

For **reclassification**, the bakeries and UK Beer making charity explained that stability of quality is a crucial component in their business model and that can supersede other considerations, including waste reduction. Such a decision reduces its capacity to reclassify products. However, other parts of the supply chain have reclassification as part of their strategies, including the mills that need to keep flour as stable as possible because clients need to make the product fit in the packaging. Reclassification is evident in two stages in the supply chain: with discount to clear products (yellow labels) in supermarkets, especially fresh bread at the end of the day and with grain reclassification expected specifications are not reached (Figure 6.6). Wheat grain specifications are also part of grain-merchant contracts (Figure 6.22), connecting farmers with mills.

1. **Goods sold on *Sample/*Description**: Contractual quality for each individual consignment as under:

| Type/ Variety | Max Moisture % | Min Specific Weight (kg/hl) | Min/Max Nitrogen % (basis dry matter) | Min/Max * Protein % (basis dry matter) | Min Germinative Capacity % | Max Hadberg Capacity % | Max Admixture Impurities (by weight) % | Max Sprouted Grains (by weight) % | Max Screenings (by weight) % (enter sieve size) | Hardness Min/Max* (SKCS Value) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |

11. **Quality:** In addition to obligations arising under the Sale of Goods Act 1979 (as amended) the following conditions shall apply:
    a. All goods to which this contract refers shall be of satisfactory quality, sound, free from mould, heat damage, green grain, infestation or other injurious materials and from objectionable smell of taste.
    b. Feed grain (as specified under Goods sold on Sample/Description above) shall not contain more than 0.001% Ergot by weight. All other goods shall be free from Ergot.
    c. Where the goods have been dried after storage in a sealed silo or container, or where any chemical treatment has been used as a desiccant on the crop from which the goods are produced, these facts shall be declared in writing by the Seller at the time of sale.
    d. Where wheat is sold for flour milling, gluten shall be present and elastic, and of a satisfactory colour; maximum admixture, as stated above under Contractual Quality, shall include all material passing through a 2.0mm slotted aperture sieve and non-wheat tailings retained over a 3.5mm slotted aperture sieve.
    e. In the case of goods purchased on sample, the goods shall in all other respects be as per sample.

**Figure 6.22** Grain contract clauses regarding wheat specifications and classification (AIC, 2019).

*h) Repurpose*

**Repurposing** operations are present throughout the supply chain. Every year, more wheat for feed (animal and industrial) is produced in the UK than for food (tonnes). However, repurposing wheat food as feed is also common. Such repurposing happens not only to wheat grain, but also wheat waste like straw and husks from production and storage (farmers, UK Farmer cooperative, grain-merchants and UK Beer making charity). By-products of wheat milling like bran (both mills) and surplus food from UK Industrial

Bakery and supermarket are also examples of repurposing of wheat for feed. Wheat use for the production of ethanol and glue is also possible, although less common and discussed sparsely, mostly by farmers and grain-merchants. Logistics costs play a significant role in the decision of the organisations regarding where to send the product. Section 6.2.2 presents the flow of the materials in the UK's supply chain.

*i) Renewable energy use*

The use of **renewable energy** is widespread in the supply chain. Most of the organisations focus on solar panels for at least part of their energy production/use. However, wind power (UK supermarket chain 1) was also identified in the supply chain, and UK Mills association described the use of water from rivers and streams next to the mills. According to said participant, that there are mills in the UK that do have solar panels for energy generation, but both mills interviewed do not have this form of power generation and are studying alternatives like biofuel from milling waste/by-products (Venkata Mohan *et al.*, 2016).

> "*At the moment, we're trying to, just trying to reduce the amount of energy that we use. We don't currently have any firm plans for renewable energy. And probably might be considering combined heat and power products, yeah*." UK Mill 1.

> "*So renewable energy is a funny one that we would like to get involved with. So here we are, these... the fields all around here we own, but they're actually on a... floodplain. So we can't really farm them. I would like the idea of having solar power, however, the dust that is produced by the flour mill, means that things around here, we wouldn't really be effective*." UK Mill 2

*j) Measure sustainable practices*

In terms of **audits of performance relating to adopted CE operations**, the application is not homogeneous throughout in the supply chain. Although the farmers selected that they do not measure sustainability, the assurance scheme documentation that they need to prepare at each season has sustainability criteria in it. Examples include the amount of input applied, structured data of recycled material, tractor operations in the farm, including fuel consumption, among others. According to the UK Assurance scheme there were plans to include more explicitly sustainability standards:

> *"(...) And it is something that we will probably include in the standards, we're just starting the standards review process. So I talked about the technical advisory committees earlier. And over the next couple of weeks, we're going to have our first*

*meeting to look at the new standard, we'll discuss it in a couple of weeks time, but we probably will have standards on it. And we can also have recommendations in the standards, so standards which aren't a requirement. And it gets growers thinking about new developments and then in the next standards review become a full standard. So it just, yeah, it gets farmers thinking: "okay, REDACTED <assurance scheme> talking about minimum tillage, maybe I'll give that a try". So we'll probably include it somehow*." UK Assurance scheme.

The supermarkets have detailed control and report of their sustainability performance. Examples of information include the amount of waste and destination, carbon footprint, recycled material, supplier sourcing, among others. Besides bakery waste, data explicitly discussing the sustainability of wheat-based products were not identified. Both grain merchants, both bakeries and both charities also informed that they carry out such measurements, although with varying levels of details and institutional structure (i.e., teams and departments) assigned to it.

*k) Maintaining prices of new pro-sustainability products*

**Setting the right price for the product** was one of the least selected operations in the CE list. According to the farmers and UK Extensionist, wheat prices are not controlled by them as it is priced in international markets with some regional variation depending on grain availability. Therefore, even if they wanted to charge differently, they would not be able to. By considering that one of the criteria that define a commodity is to have standardised contracts (Batalha, 2001), the capacity to alter prices of such products is hindered in comparison to subsequent processing (as flour, pasta, etc.). The exception to this is the program from UK Industrial bakery that pays more for grain/flour with less Nitrogen in it. UK Beer making charity strives to be competitive with regular, non-food waste beer. Therefore, their product is kept at the same price range as others in the retail stores, even though they consider their beer a circular product.

*l) Purchases of cleaner inputs and services*

In terms of **cleaner purchases from the suppliers**, the supermarkets are the organisations that put more emphasis on such operations as per their website and reports. Both organisations have discussed preferring more responsible suppliers and working with them to improve their product' and operations' sustainability. However, no emphasis on wheat was identified in the secondary data, even though UK Industrial bakery has commented that the supermarkets have such requirements in their purchases:

> "*So, outside of our supply chain, and we, we work with WRAP, we work with Food and Drink Federation, we work with some of our customers as well. So, REDACTED <supermarket chains 1, 4 and 5>, we've done activity looking at sustainability with all of those guys. And then also, you know, not just the farming sector, we also do work with some of our other ingredients suppliers. So people that supplies us with things like improvers, and fats and oils*." UK Industrial bakery.

*m) Cooperation with other organisations to use CE practices*

**Cooperation with other organisations for sustainability** alongside the reduction of waste was the most selected practice (only UK Mill 1 did not have said operation). Cooperation was discussed both upstream and downstream of the respondents, meaning widespread collaboration in the industry. It was also identified with peers and organisations adjacent to the supply chain such as unions, boards, different forms of non-profit organisations (social and environmental) and government. The formation of the interviewed cooperatives, especially UK Farmer cooperative, which the central role is grain storage, is another example of cooperating organisations in the supply chain.

Partnerships among farmers and their neighbours are common in the supply chain, e.g., barter of straw for muck deals such as the one used by UK Farmer 1. According to UK Extensionist this kind of deals are common for wheat growers in the UK: wheat growers collect the straw from their fields after grain harvest and exchange with animal producers (mostly cattle) for the animal muck to be used as fertiliser in the wheat farms. The straw is used as feed and bedding for the animals. Barter systems such as these occur mostly among neighbours as the cost for transport long distances would make the partnership less attractive. It is relevant to note that in the UK, there is also a market for straw (including straw prices), but the interviewed participants do not engage in the buying and selling of the material. There is also cooperation with a local water/sewage treatment company to access their clean water sludge and sewage cake. Another possibility is the use of donated materials from other farmers for composting (UK Farmer 2) (Figure 6.20) The local cooperation of these farmers is an example of industrial ecology playing a role in CE using both waste and by-products in circular loops (Batista *et al.,* 2015b; Gallaud and Laperche, 2016).

Both charities cooperate with suppliers to receive the inputs for their organisations (surplus bread and surplus food for donation) and UK Food distribution charity also needs the partnership of other charities to donate food throughout the UK.

*n) New pathways of logistics systems*

In terms of **new logistical options that are more sustainable,** the organisations that selected it in the list argued that it is addressed basically in two forms: management of consumption (i.e., better planning, different routes, incentives for the reduction of fuel consumption and training of drivers) plus purchase, leasing or hiring newer, more efficient vehicles as often as possible.

Both farmers address the issue of more sustainable logistical pathways in terms of farm operations rather than grain transport to clients as they do not own their lorries to transport grain. Their wheat is mostly stored in the farms (Figures 6.23 and 6.24 below) and only transported out when the buyer requires the material. UK Farmer cooperative provides a different option for the associates that do not want or cannot store the grain in their farm (Figure 7.25) and the grain-merchants also have silo for storing grain.

**Figure 6.23** Grain shed in the UK Farmer 2.

**Figure 6.24** Grain storage in the UK Farmer 2.


**Figure 6.25** Example of grain storage in UK Farmer cooperative.

The organisations in the supply chain are highly dependent on road transportation with UK Farmer cooperative and the grain-merchants increasing their demand for transport during harvest season. On the other hand, the mills, UK Industrial bakery, the supermarkets and both charities require a constant supply of flour and bread. Considering the need for freshness, avoidance of waste and high volume/weight of the products, logistics costs are high. As per the Farm Business Research (Rural Business Research, 2019), haulage[32] and storage expenses account for around 9.5% of farmers' cost of production of winter wheat in England.

While UK Craft bakery receives its flour from UK Mill 2 in flour sacks, the UK Industrial bakery receives its flour by pressurised bulk tankers, also having some silo capacity to store the flour before using it. Food safety concerns do not allow for the transport of different materials than flour in the lorries, thus requiring the vehicles to travel empty on return to the mill, as clarified in the quote:

> "*(...) Yeah, so bulk lorries, 28, 28 and a half tonnes at a time. The frustrating thing with bulk lorries is, unlike a feed lorry, where you can take grain back, you can only have flour in a flour lorry. So it's not like I could go and deliver flour over, and pick... and pick up grain and take it back because it's a special tanker... pressurised tanker so that is a huge problem with haulage in this industry is that it's only one way, everything is one way, you can't... you can't reduce the haulage cost part back*." UK Mill 2.

### *o) Education and training to staff and managers*

**Education and training of staff and managers for sustainability practices** was also highly selected, with training involving operational procedures, food safety and legislation, among others. UK Assurance scheme requires control of farmers and staff training as a requirement for the certification (Figure 6.26).

**SC.c STAFF TRAINING RECORDS**

For each staff member, complete a training record and keep it for at least 2 years after they have left.

| | | | | | |
|---|---|---|---|---|---|
| **Name:** | | **Start Date:** | | **Role/ Key tasks** | |
| **Experience:** | | | | | |
| **Training/ Event Date(s)** | **Type of training/ event** | | **Training provider** | | **Other** (e.g. Review dates if applicable) |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

**Figure 6.26** Assurance scheme training control for farmers (UK Assurance scheme documentation for farmers (2017).

[32] Considering 50% of 'other crop costs': £14.50 (haulage) + £2.00 (heating and fuel for grain drying) ÷ £174.00 (cost of production £ per tonne) = 9.5%

*p) Environmental certifications*

Few organisations selected the practice of **Environmental certifications**. Although UK Assurance scheme is not an environmental certification explicitly[33], there is a considerable number of environmental requirements that farmers need to comply. Examples include the identification of the farm's environmental risk, complaints record for environmental issues previously identified, precise control of agrichemical use (pre- and post-harvest), secure storage of potential contaminants, annual audits, among others. According to the participants, the requirements for farmers to have the assurance passport/certification is the de facto license to be a grower in the UK. Over 95% of UK wheat farmers have such certificate, and the need for it is apparent in the grain contracts used by both grain-merchants of the supply chain[34] – Figure 6.27.

**Assurance:**

The Seller should advise the Company if their assurance status changes. The Seller is responsible for ensuring that all possible collection locations are included as 'additional holdings' on their assurance membership and that the assurance details confirmed on the Combinable Crops passport are valid for the loaded goods and movement date. Failure to do this could result in delays or rejections, with additional costs, which will be deducted from the Seller.

**Figure 6.27** UK Gran-merchant 1 – private's contract requirement for assured grain (UK Grain-merchant 1 – private standard contract (2017)).

Additionally, the contracts also require that the haulier transporting the grain also have assurance (TASCC - Trade Assurance Scheme for Combinable Crops), thus affecting UK Farmer cooperative and other organisations involved in storing and transporting grain and flour. The supermarkets' websites also express the requirement for their suppliers to be assured. However, there was no explicit connection to wheat, focusing mostly on riskier products such as coffee and palm oil.

[33] UK Mill association expresses this by arguing that UK Assurance scheme mostly focuses on food safety. The interviewed participant from UK Assurance scheme expressed that environmental standards were being discussed for inclusion. It should be noted that the view of sustainability as pro-environment rather than TBL (Jawahir and Bradley, 2016; Agrawal and Singh, 2019) was also prevalent in the interviews.
[34] Both UK farmers interviewed have the assurance, although only one marked the practice in the list of CE operations.

*q) Targeting the market of "green customers"*

**Targeting the market of "green customers"** is not a key strategy for the actors in the supply chain. For the UK Craft bakery, the focus on local suppliers and the connection to charity has created an influx from big local organisations (e.g., university and regional hospital) to purchase from them. The supermarkets include in their reporting and website that consumers are increasingly concerned with sustainability, thus the need to change their practices and product line to meet such demand.

The nature of UK Beer making charity's products attracts pro-sustainability consumers, although they do not necessarily want only this type of client. UK Grain-merchant 1 – private understand that "green customers" are a niche that needs attention and that will grow in the future. Although said participant considers that UK Farmer cooperative supplies them with organic grain for such markets, the cooperative itself did not select the operation in the list provided, thus showing a disconnection between both organisations on the topic.

*r) Other practices*

None of the participants market 'Other' in the list provided to them. However, **services over ownership** were discussed a few times in the interviews. The service provided by UK Farmer cooperative of storing grain in their silos is a clear example of that. Contracting hauliers instead of having their own fleet was also discussed by UK Food distribution charity and UK Grain-merchant 2 – cooperative, and leasing vehicles instead of owning them (De Angelis *et al.*, 2018) by UK Mill 1. However, UK Food distribution charity was aiming at having their own vehicles for delivery (not contracted), and UK Grain-merchant 2 – cooperative also has a sizeable fleet (34 vehicles), only contracting during harvest times.

According to UK Farmer 2, most UK wheat farmers have their own machinery as there is a tight window of time to do farm operations (especially seeding and harvest) thus creating issues for such contracting. There is also the possibility of importing weeds (especially grass) from other farmers, although the risk is minimal according to the participant.

### 6.2.2 Wheat material flow - UK

Considering the second research objective of this thesis – 'to map the material flows, including wastes and by-product outputs, in the wheat food supply chain in Brazil and the UK' (in this section it is in relation to the UK), only the supermarkets and the UK Industrial bakery had accurate waste estimates to share. The reasons discussed in Section 6.1.2 relating to the lack of information regarding waste in the Brazilian chain are also pertinent in the UK. However, it was possible to map the flow of the wheat in the supply chain, both within the closed loops and the open loops, thus including wheat-food products, by-products, co-products, waste and wastage.

#### 6.2.2.1 Linear wheat food supply chain

Figure 6.28 presents the UK's wheat food supply chain with the participating organisations of this thesis. As a baseline for the discussion of the CSC, it represents the linear perspective of the supply chain, before the 'CE lenses' are used to model the CSC.

The supply chain shown in Figure 6.28 does not include UK Mill 2 bakery division (they refused to participate) even though it would be differentiated because of the verticalisation aspect. The possible direct connection between farmers and mills is a minority in the industry, as only farmers that are close to mills can participate, and not all mills are willing to implement this kind of direct purchase. Most wheat grain for flour production comes from grain-merchants/traders, although they can be stored and supported by central grain storages such as UK Farmer cooperative. Most wheat consumed in the UK goes through 5 links in the supply chain: farmer -> grain-merchant -> mill -> industrial bakery -> supermarket.

Grain-merchants, mills and supermarket chains receive materials from various organisations, having considerable negotiating power. They also act as both buyers and sellers. Supermarkets, however, are the most influential organisations in the chain and decisions made at that point in the chain, tend to have bullwhip effects towards all the organisations (Lee *et al.*, 1997; Wever *et al.*, 2012; Braz *et al.*, 2018).

The description of the UK´s WAIC by Smith and Barling (2014) aligns with the design of the supply chain of the research shown in Figure 6.28. Therefore, the analysis must focus on the circular supply chain.

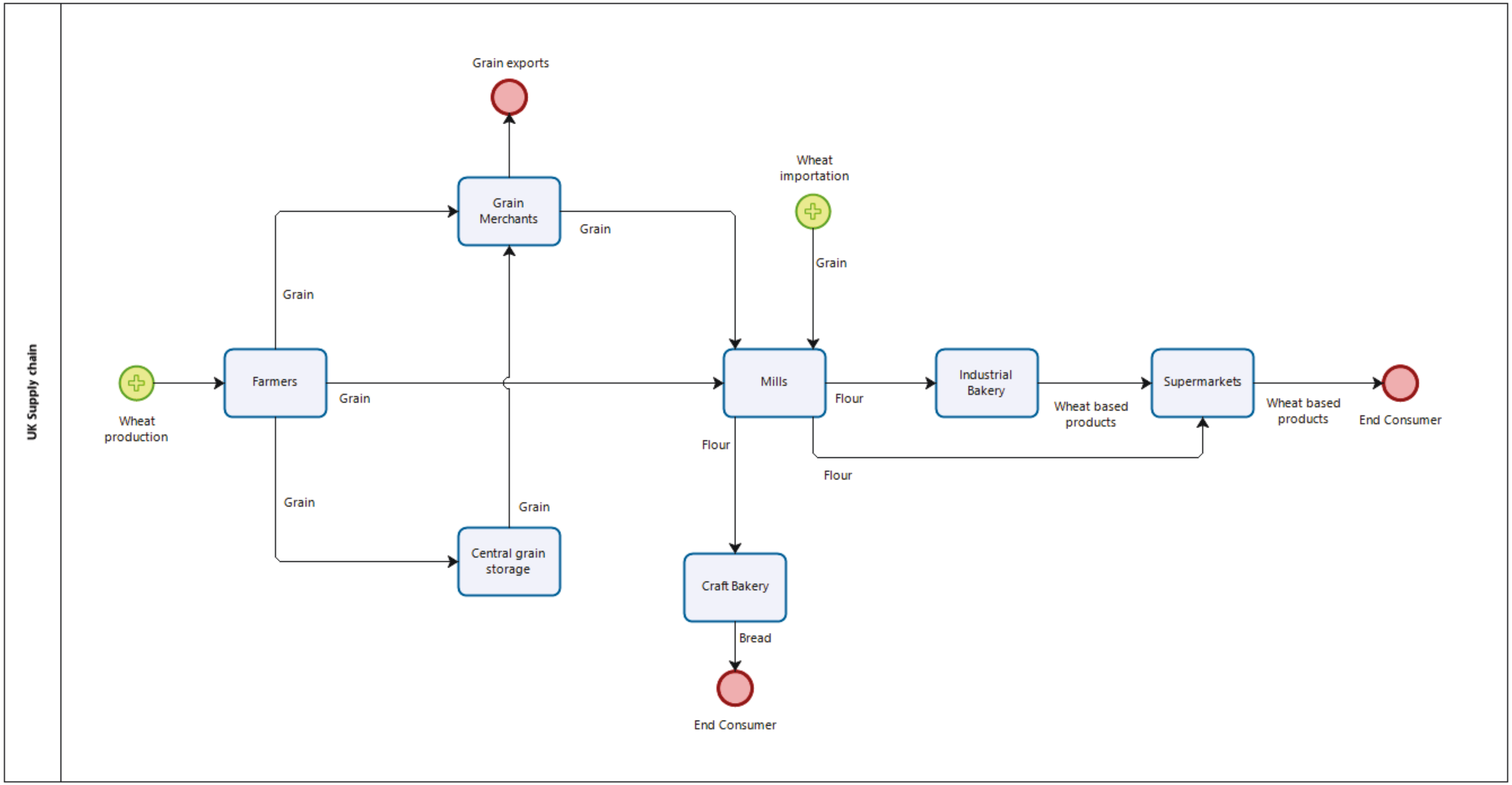



**Figure 6.28** UK's wheat food supply chain.

6.2.2.2 Circular wheat food supply chain

Earlier CE literature (Yong, 2007; Chertow, 2008) mainly discussed closed loops supply chains. However, as the field developed, newer works started to consider open loops in the CE discussion (Batista *et al.,* 2018a; De Angelis *et al.*, 2018; Vlajic *et al.*, 2018). The newer perspective is evident in the design of the UK´s wheat food supply chain of Figure 6.29 - the material flow shown in the figure strengthens the need consider the open loop in CSC discussion, underpinning the considerations of open-loops as part of waste reduction strategies in food supply chains (Batista *et al.,* 2018c).

While the black arrows represent the forward (linear) supply of wheat and wheat-based materials, the orange arrows identify the circular material flow (closed and open loops). Practices such as **recovery**, **repurpose** (i.e., food to feed) or **recycling** of bread into the beer are examples of CE operations that affect the circular loops. Organisations connected to the wheat industry, but not linked directly with food (i.e., open loops) are represented by the purple boxes once again. While Smith and Barling (2014) briefly discuss the flow of wheat by-products and waste to animal feed, the model used by the authors are still part of a linear perspective, and the closed loops mentioned by the authors were not apparent in their design or analysis. Therefore, this thesis consideration of such material flow in a CE perspective is a novel approach to that.

Wheat exports (i.e., '**redistribution**') are common in the UK´s wheat supply chain and conducted by the grain-merchants team of traders. It is not possible to determine if the exported wheat is used as food or feed. The circular perspective highlights the supply chain complexity and is a more robust representation of the material flow than the linear perspective.

Six different 'snapshots' of the supply chain are discussed next. They account for the same organisations of the Brazilian supply chain as central to the 'loop' analysed and the various CE operations that affect the material flow in the supply chain. The notable difference is that the farmers' cooperatives do not play such a large role in the UK and therefore, will not be discussed separately. Alternatively, the two charities interviewed (<u>UK Beer making charity</u> and <u>UK Food distribution charity</u>) are central to one of the snapshots, which did not happen in the previous case.

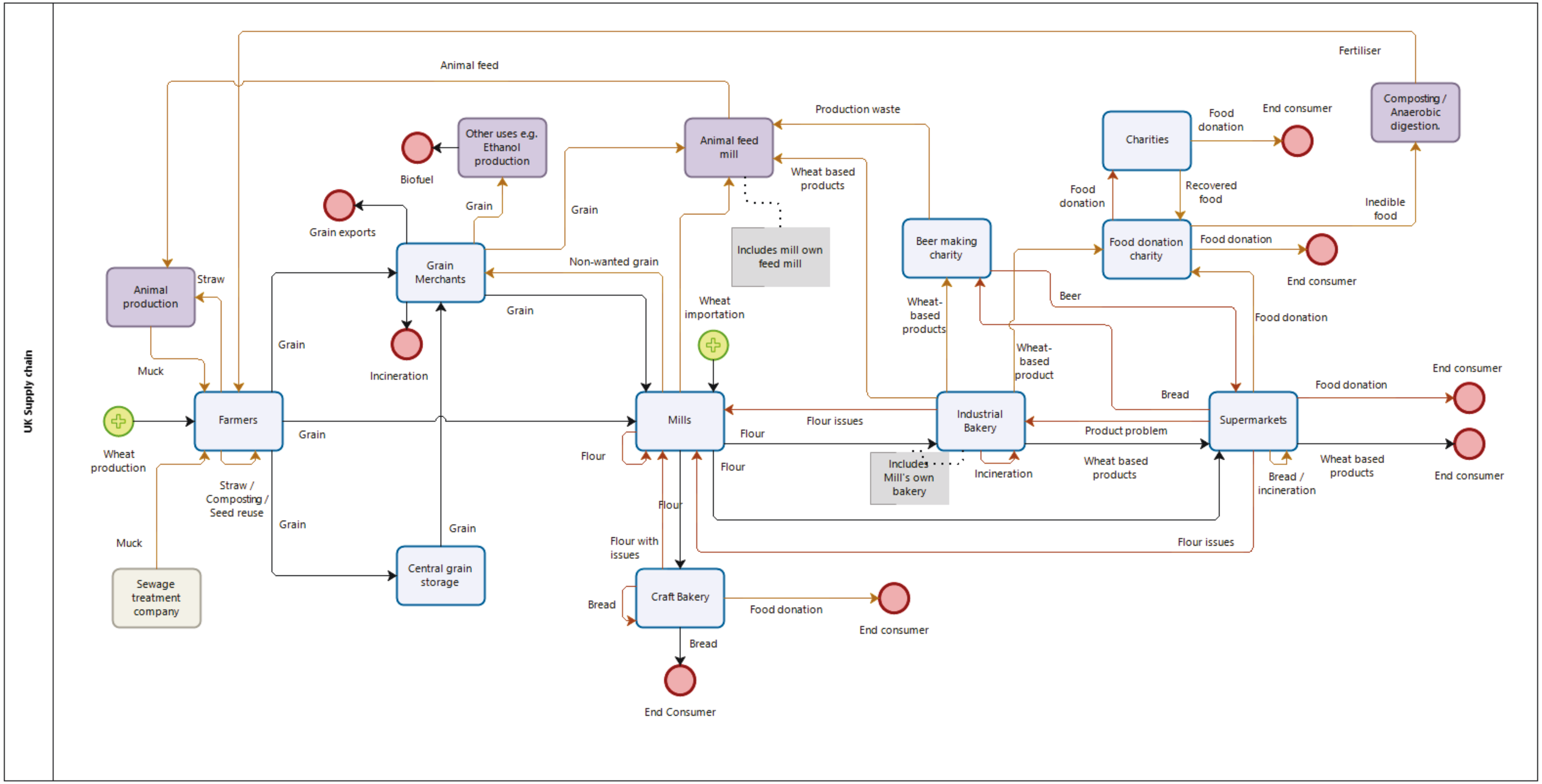



**Figure 6.29** UK´s circular wheat food supply chain.

*a) Farmers*

Figure 6.30 reinforces how animal production can be part of the circular flows of wheat food. Farmers' used sludge, waste (including from animals) and by-products from the farms to increase bio-fertility and **reduce the input** of chemical fertilisers. Another example is the **reclassification** of wheat to a lower grade and subsequent use in feed mills and the use of by-products (bran, dust, husks) from grain-merchant silos and mills (**reduction of waste**). Finally, **reuse** of seeds was also identified, although not necessarily recommended (Smith and Barling, 2014). Once more, grain directly sold to mills was not included in Figure 6.30 as this connection is more representative of the mills' operations and only available to a small subset of wheat farmers that live close to mills (e.g., UK Farmer 2 interviewed).

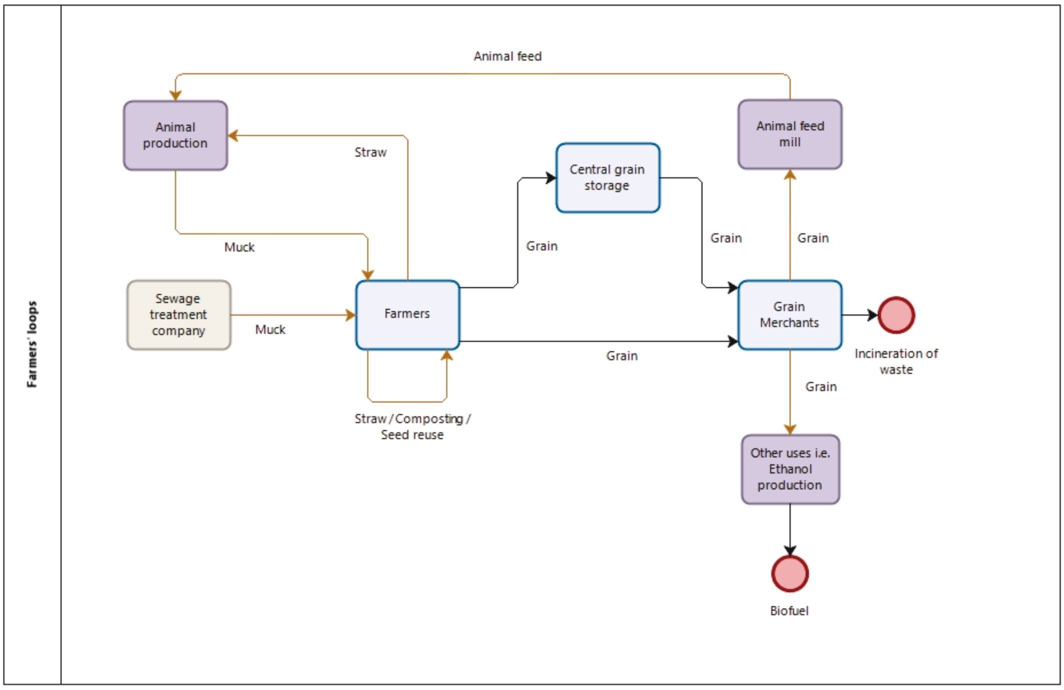



**Figure 6.30** UK Farmer circular wheat flows.

*b) Mills*

Figure 6.31 below shows the circular loops from with the mills as the central organisation.

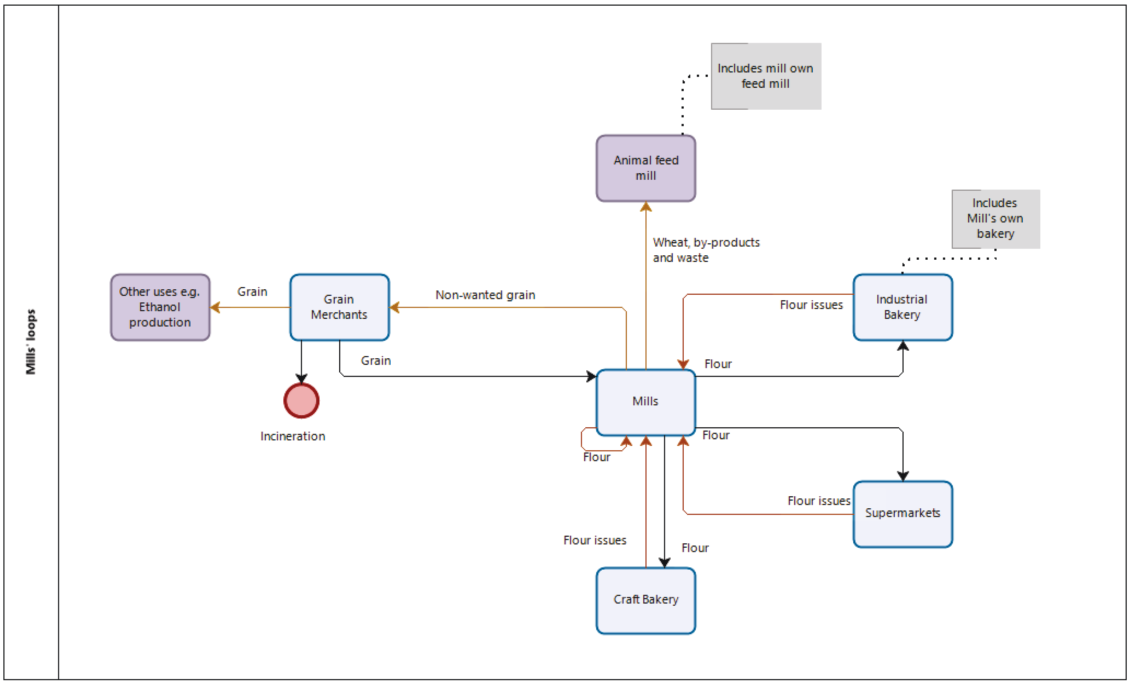



**Figure 6.31** UK Mill circular wheat flows.

Both open and closed-loops are represented in Figure 6.31. The closed-loops are connected to **recovery** of flour from clients that returned the flour mainly for food safety reasons (e.g., torn package). **Reuse** of flour is only possible before leaving the production line and for specific products with correction of characteristics, sometimes needing additives (Smith and Barling, 2014; Grain Chain, 2016). The **recovery** is connected to ensuring food safety and quality standards, not the reduction of waste per se.

Open loops identified were **reclassification** and **repurposing**. Low-grade grain, by-products (e.g., bran) and residues (e.g., grain husks and dust) are sent to feed mills. Considering that the profit margin for non-food or feed wheat-products (e.g., glue, ethanol) is lower, **repurpose** to industrial uses is avoided by the mills.

*c) Industrial bakery*

Figure 6.32 has the UK Industrial bakery as the central organisation to the material loops.

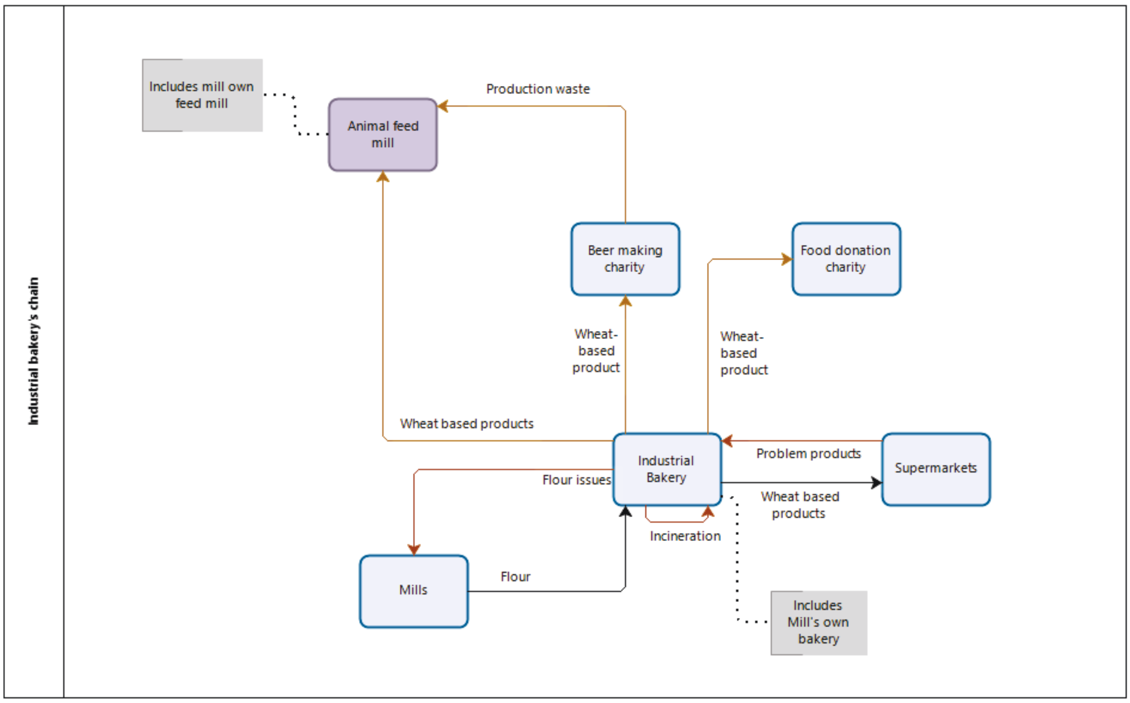



**Figure 6.32** UK Industry circular wheat flows.

The biggest clients of UK Industrial bakery are the supermarkets, both for the mainline of products as for own-brand for the supermarkets. The **recovery** of products from supermarkets are just for problems (e.g., infestation), not to **reduce waste**. Similarly, the return of flour to mills are for quality or safety issues. **Recovery of energy** (incineration) is allocated as a circular (closed-loop) practice here since the interviewee expressly mentioned that they do it so not to send waste to landfills. Therefore, there is a difference in what the UK Grain-merchant 1-private considered as the practice of incineration – avoidance of contaminating the supply chain.

The UK Industrial Bakery also **redistributes** the surplus of bread in two forms: donating surplus production to charities, including UK Food distribution charity; donating wheat-based products (e.g., crumpets) to UK Beer making charity for beer production. The organisation also **repurposes** products by selling waste and surplus production as animal feed.

*d) Supermarkets*

The supermarket chains part of the research participates are part of open and closed loops of wheat-based products in different forms. Examples of closed loops are the **recovery** of inadequate wheat-based products (already discussed) and **reclassification** of products (e.g., cheaper bread at the end of the day). Open loops they are a part of include the **redistribution** of food via donation. These three examples are some of the more commonly discussed CE's loops to avoid food waste (Eriksson *et al.*, 2015; Weetman, 2017; The Ellen MacArthur Foundation, 2019) and are present in the supply chain (Figure 6.33). **Recovery** of energy (incineration) and **redistribution** of bread to make beer (**recycling** bread) are also present (UK Supermarket 1) and part of the regular operations executed by the supermarket chain.

According to the data, **repurpose** of food as animal feed and **recycling** of food via anaerobic digestions are present in the chain, performed by both supermarkets. Still, considering that it was not possible to identify with certainty if wheat-based food products are part of those loops, they were not included in the map. This is especially important in repurposing food to feed as products with mould (common for expired bread) cannot be given to animals.

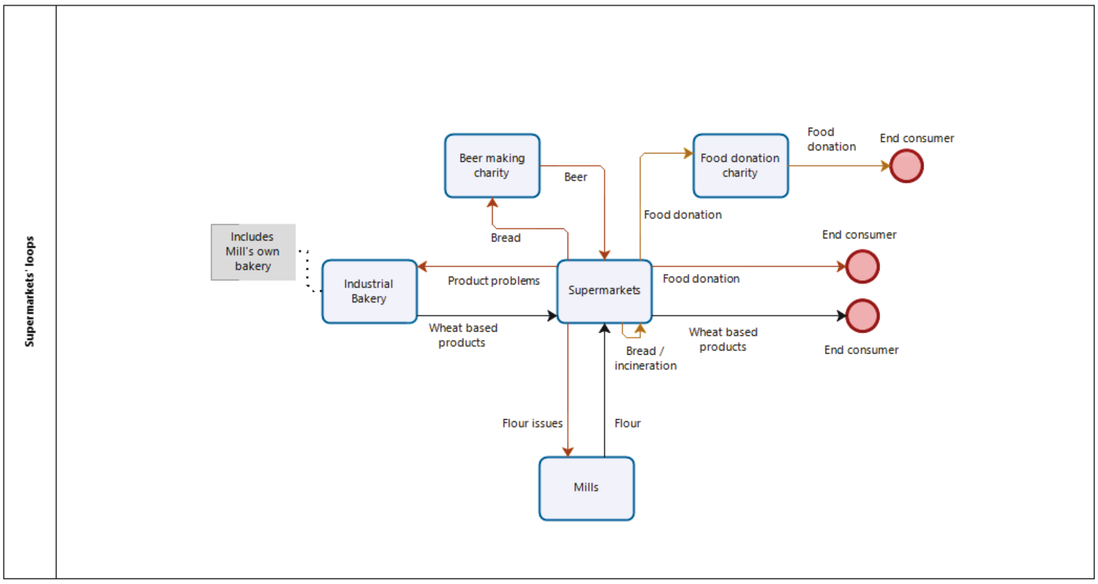



**Figure 6.33** UK´s Supermarkets circular wheat flows.

*e) Craft bakery*

The interviewed craft bakery has few circular loops, as shown in Figure 6.34. Most notably is the **reuse** of surplus day-old bread as toasties in the next day. **Redistribution** of bread via donation to a local charity also happens, although it is not systematic occurring occasionally. UK Craft bakery also returns (recovery) unwanted flour to UK Mill 2 whenever issues are identified. It should be pointed out that there is considerable control over the amount of waste generated, including consultation from a regional university, the focus on the local community (both for supply and for clients), and tight planning of daily production – these factors influence availability of bread.

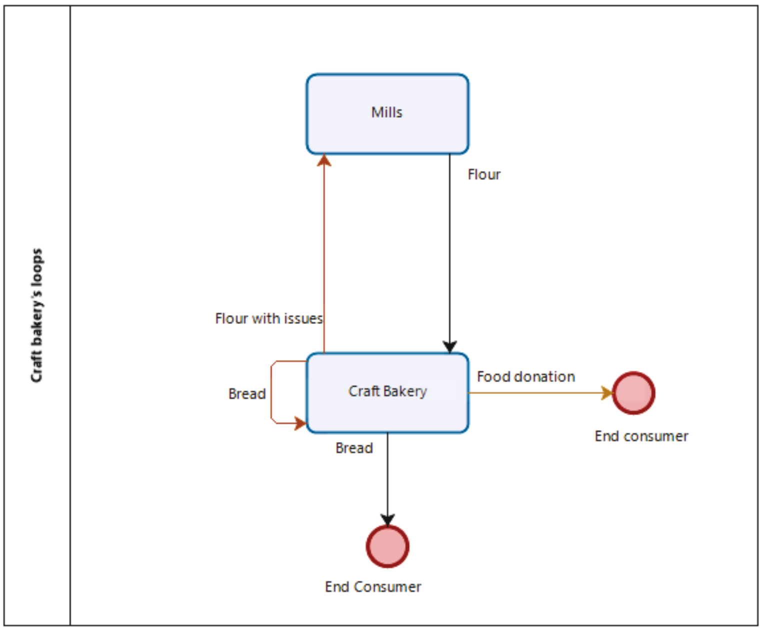



**Figure 6.34** UK Craft bakery circular wheat flows.

*f) Charities*

Figure 6.35 shows the flows of wheat-based materials with both interviewed charities as the main actors. Both organisations receive their input from industrial bakeries and supermarkets and also from other businesses that fall outside the scope of this supply chain. UK Food donation charity does not redistribute the products alone, also having other charities (e.g., churches, schools, etc.) throughout the UK that request and receive donated food. In that sense, UK Food donation charity functions as a hub for **redistribution** of food, including triage of products. Inedible food (e.g., expired or mouldy) are sent to **recycling** (composting/AD).

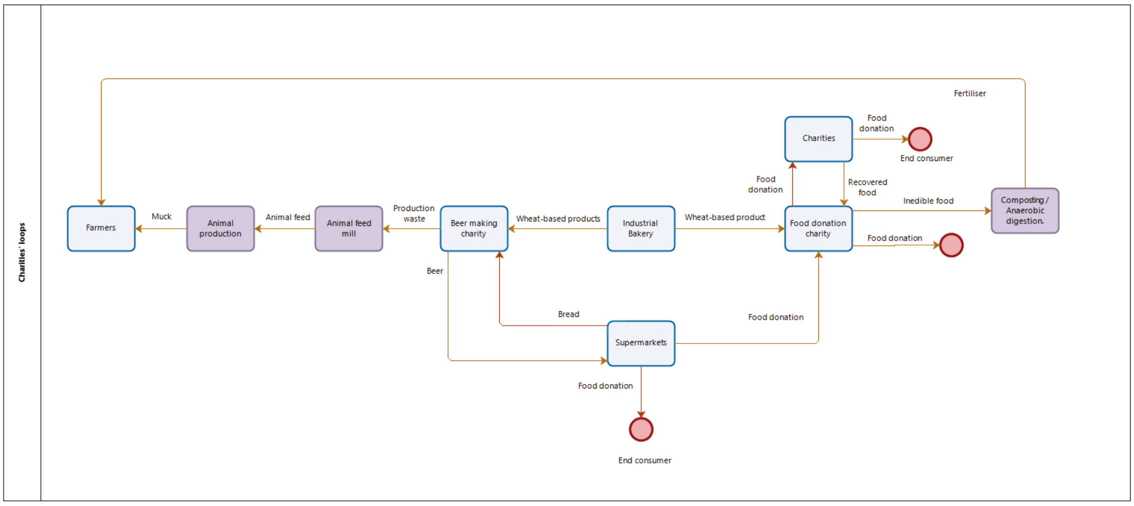


**Figure 6.35** UK Charities circular wheat flows.

The UK Beer making charity receives mostly bread from partners, as their primary beer is bread-based. Other products like crumpets are also used for special batches. Although the output of materials from the organisation seems linear in the picture, all of it is circular (**repurposing** and **recycling**) as even the residue from the brewing process is repurposed as animal feed with a partner mill.

## 6.3 COMPARISON BETWEEN CASES

Sections 6.1.1 and 6.2.1 presented the CE practices in each case investigated. To answer the third research question (i.e., 'what are the similarities and differences of the Circular Economy practices between the wheat food supply chain in Brazil and the UK?') it is possible to directly compare the practices marked by the participants and compiled in Appendices G and I. However, such a method does not convey the nuances of each case; hence the next two subsections explore the comparison in more detail.

### 6.3.1 Similarities in CE practices

Soil health and fertility are major priorities for farmers and supporting organisations in both countries and such concerns are in line with sustainable agricultural production as defined in the literature (Dani, 2015; Pretty and Bharucha, 2018). Although there are some differences in how they approach it, several of the operations aim at **reducing** chemical inputs, machinery use, reducing the loss of production and achieving the most valuable class of grain (wheat milling), all elements that fall within the CE framework.

The **reduction of inputs** via participation in special programs also appears in both countries, with formal, long-term contracting and payment of premiums (given higher asset specificity). These operations involve genetic improvement, seed varieties preferences, clear protocols in order to have well-defined grains and flour per specifications defined in the contracts.

In terms of **reuse**, the reuse of seeds, flour (during production) and packaging are similar in both cases. It is also interesting that some organisations in both cases consider the practice of 'reuse' what is more aptly defined as the practice 'recycling' according to the literature (Weetman, 2017; Kirchherr *et al.*, 2017). As it is not a case of language barrier or commonalities in a specific industry (different sectors expressed the same confusion of terms), a gap between theoretical concept and practical application may exist.

Organisations in both supply chains discussed **recycling** in terms of wheat-based products and also of auxiliary materials, especially packaging. The use of composting/anaerobic digestion (De Angelis *et al.*, 2018) - a form of food recycling - was identified in both countries, although to a greater extent in the UK. Regarding **redesign**, although most organisations in the study develop some kind of redesign of their products, practices or services, such modifications most likely aim at efficiency, not reduction of waste or other CE-related gains. This does not mean that the CE gains are not possible through those redesigns (e.g., development of seeds that use less input, or new products with longer shelf life). In a similar light, farmers in both countries had to be explained what 'redesign' meant in the context of the research, even with the glossary of terms. It is also not an issue of translation as the word 'design' is English but commonly used in Brazilian Portuguese. Instead, it can be another example of a gap between the theoretical definition of CE practices (Balboa and Somonte, 2014; Weetman, 2017) and operational uses in a specific context.

The **redistribution** of materials is similar in both cases in the context of grain. All organisations that produce or trade wheat grain redistribute material if the specifications are not met as per the client's requirements, both in spot contracts and futures contracts. Redistribution can be from moving to a different mill nearby or exporting to a country with different requirements for the grain. Grain-merchants in both countries view this as a natural part of their work.

The **recovery** of products for the reacquisition of energy is limited in both supply chains. Although some of the organisations (e.g., UK´s supermarkets) do produce some energy by incinerating the material, most recovery connected is to avoid contamination. Contaminated cargo (e.g., broken glass in the grain, excessive pesticide residue) is very rare, and the organisations are willing to incur the cost of it to avoid damaging the supply chain. The recovery for adequate disposal is less rare but still uncommon in the organisations. However, the practice is restricted to compromised products, and there are strict reasons why an organisation would do that. Ownership rights and responsibilities for food producers, processors and retailers are well-defined in both countries, and if an organisation accepts a cargo, it becomes responsible for it. Only in very clear cases, where the product comes contaminated or damaged from the supplier, will the supplier recovery the product – usually to identify reasons for the problem. Recovery to reduce waste or for sustainable disposal was not identified. Most often, the 'return' of products is administrative, where the client will claim credit for future purchases with the supplier (Vlajic *et al.*, 2018).

**Reclassification** is usual in both supply chains, especially with grain and bread. Grain specifications and how they are measured are similar in both cases (Shewry, 2009; Mori and Ignaczak, 2012; Smith and Barling, 2014), even though the use of the flour downstream is mostly different. Coincidentally, the reclassification of bread at the retail level is also practised by the retailers, as freshness is key to consumers. Thus, the waste is reduced by selling older wheat-based products cheaper.

Both supply chains have similar practices of **repurposing** of wheat, especially grain. The most common is wheat food to animal feed. In both supply chains, feed mills and therefore animal production is crucial for the reduction of waste and best use possible of wheat-based materials whenever food is not possible. Not only wheat grain with lower specifications goes to feed mills, but products and by-products throughout the CSC, such as husks, bran and surplus end-products. The open loops perspective (De Angelis *et al.*, 2018; Vlajic *et al.*, 2018) is, therefore essential in the CE discussion of wheat food supply chains in both the UK and Brazil. More vertical organisations (the Brazilian cooperatives and UK Mill 2) will have options for repurposing within the organisation itself as they own feed mills.

**Measurement of sustainable practices** through audits of performance is practised by the larger organisations in both supply chains. Smaller actors tend not to have the protocols or structure (team/funds) to this end. They can be audited by the larger clients that want to have greater control over their supply chains. **Maintaining prices of new pro-sustainability products** is not part of the commodity trade as most organisations upstream of the mills are price takers. Downstream, most actors are not willing to pay more for more sustainable wheat-based products as wheat-based products are not a priority, and the margin of profit is already very narrow. The exceptions are the speciality programs that pay premiums for specific types of products (e.g., traceable flour for the Brazilian chain and no-Nitrogen for the UK´s). The special products are still a niche and not widespread.

The **purchase of cleaner products** was identified in both cases. However, it is not a priority in the supply chain as already expressed - cost takes precedence. **Cooperation with other organisations for sustainability** is common in both supply chains, occurring with suppliers, buyers, supporting organisations (e.g., extension agencies, research institutes) and can take several forms, like cooperatives, joint ventures, short or long-term projects, among others.

Logistics play a large role in the wheat CSC of both the UK and Brazil - logistics costs are very high since the product requires large quantities to make it profitable. Additionally, the freshness of products is crucial, thus increasing the need for a constant flow of materials. Finally, wheat production and consumption are not necessarily in the same place, and transport of both forward material and circular materials is constrained by logistics costs. Therefore, **new logistical options that are more sustainable** are desired but limited.

Regarding **education and training of staff and managers,** both supply chains have similar types of training, but safety (of food and of personnel) has a larger role than environmental sustainability. It is possible to argue that food safety and the social aspects of food production are parts of agri-food sustainability (Dani, 2015). Still, waste and overall environmental sustainability have a lower emphasis in both countries in comparison with safety.

**Environmental certifications** are only common within the larger organisations such as the multinational corporations and the UK´s supermarkets. **Targeting the market of "green" customers** is not a focus of the organisations in the cases. Despite the existence of some niche strategies, they are still being developed as a general rule. Participants argued that the profit margins are too low to depend on such niches as the only source of revenue.

Finally, regarding **other practices**, only services over ownership were discussed (but not selected in the form) in some contexts, mostly farming. The farmers interviewed in both countries do not want to engage in such practices because they can increase the risk for their farms since they need specific windows of time to do certain farming operations and cannot depend on services.

### 6.3.2 Differences in CE practices

In terms of differences between the CE practices of both countries, first, it is crucial to identify that the definition of waste in the UK is less variable than in the Brazilian chain. While the UK´s supply chain tends to concentrate around the discussion of food waste, in Brazil, waste is viewed as waste of food, of money and of opportunity/time. In that sense, practices focused on **reducing waste** in Brazil are more connected to the reduction of financial loss (e.g., filters, no-tillage, tight inventory control) while in the UK they have food safety as the priority (e.g., assurance schemes, protocols for donation, etc.).

The scenario discussed above has several dimensions. Wheat in Brazil has lower profit margins, higher risk, and uncertainty in comparison with the UK. On the other hand, the UK´s food standards are higher, coming not only from legislation but also industry practices and clients. Wheat in Brazil is a secondary crop, usually planted to support soya beans production, while in the UK, it is the primary crop of the interviewed organisations. While oilseed rape and wheat feed are also hugely important in the UK´s agriculture, they are not 'subordinate' to each other, as is the case for Brazilian wheat and soya beans.

The secondary role that wheat has in Brazilian agriculture is clear when we consider that planting wheat **reduces input** use in soya bean production. It also reduces issues with pests and drought losses. Therefore, wheat production also impacts a CE perspective of soya bean production. The use of wheat in rotation with soya beans (and other crops, including maize) is part of no-tillage production in Brazil, a form of operation that is gaining traction in the UK but widely used in Brazil. On the other hand, UK´s farmers have access to organic fertilisers from sludge and cow muck to a much larger extent than Brazil.

The use of **recycled** bread is also different in each case. While in Brazil, bread is recycled as breadcrumb flour and subsequently reused in food production, in the UK´s case the recycling of bread is connected to beer production. Such differences are explained by different market preferences and structure: types of bread produced in Brazil (small French bread, easy to graze) and the UK´s high number of breweries and craft beers.

The **redistribution** of food in the UK is more structured than in Brazil. The presence of national-level organisations with infrastructure and institutional partnership with food providers (producers and supermarkets) allow organisations that want to donate their surplus production to outsource the operation. Therefore, these actors are not required to develop protocols, infrastructure, personnel and training to redistribute the food.

The use of **renewable energy** is more prevalent in the UK than in Brazil. Although the Brazilian organisations are interested in it and starting the processes to acquire the capacity to use renewable energy, the UK is already well established with more actors already operating it. Regarding **measuring sustainable practices**, the major difference between the cases is the UK´s supermarket chains. Brazilian supermarket chains, in general, are not as big as their UK counterparts, thus less pressured by end-consumers. Additionally, few Brazilian supermarket chains are traded in the stock exchange (none of the interviewed ones) and have fewer requirements for transparency. Brazilian legislation is also less restrictive in terms of sustainability issues. Therefore, the UK´s supermarket chains have created clear protocols to control themselves and their suppliers in several metrics such as carbon footprint, waste generated, social impact and so on. UK´s supermarkets measure not only their operations but also of many suppliers. They also audit partners such as the charities that redistribute their food. The policies implemented by the UK´s supermarket chains in terms of sustainability also affects the decision of **purchasing cleaner products**. Although this happens in Brazil, it appears to be a more straightforward and stricter operation in the UK.

In terms of **cooperation with other organisations to use CE practices**, the UK case has a more formal and structured approach, especially considering that CE is a framework and a policy that many organisations are aware of and act based upon it, including the charities part of the research. Additionally, the UK´s supply chain is less dependent on governmental support policies (fewer UK´s participants mentioned the government as a solution for sustainability problems), thus increasing the need for the organisations to cooperate with each other. The Brazilian case has larger cooperatives, and they have a more prominent role in the supply chain as they are more vertical than the UK´s counterparts, but the formation of the cooperatives is not related to CE. Having said that, the Brazilian cooperatives do act in support of sustainability, especially for the farmers associated with them. The use of wheat to the highest possible value (DEFRA - Department for Environment Food and Rural Affairs, 2011) is one of the mandates of the cooperatives.

For new **pathways of logistics systems**, the differences are both in storage and transportation. Most farmers in the UK have their own storage – including the research participants, while in Brazil they need the grain-merchants and cooperatives to store products. Stocks influence their capacity to market the grain and better negotiate prices (Batalha, 2001; Zipkin, 2012). In Brazil, the ability to sell wheat as fast as possible is vital because of soya bean production – the farmers will prioritise speed of delivery over other concerns, as they need to plant soya beans and cannot keep the wheat grain. Flour transport is different - in Brazil, wheat flour is transported mostly by sacks, followed by big bags, while in the UK is mostly by pressurised tankers. The reason is also connected to the market downstream and how consumers purchase and eat wheat-based products: Brazilians buy bread and pastries mostly from craft bakeries that have little storage capacity; the UK´s consumers prefer loaves of bread, mostly produced by industrial bakeries that need considerable stocks and large bulk deliveries. Both options generate different issues: while the Brazilian supply chain has empty sacks to dispose of, the UK has tankers that return empty to the mills.

Considering that sustainability has a greater weight in the UK supply chain (including CE-issues and operations), the **education and training of staff and managers** is more structured in the UK, including controls over training that affects farmers that are assured. While **environmental certifications** are growing in Brazil as the agri-food industry develops and is influenced by international markets, certification and assurance schemes are already established in the UK. In Brazil, wheat does not have assurance schemes for internal production/consumption (except for seeds and organic grain), and in the UK assurance schemes are widespread. The Brazilian participants see certification as equal or equivalent to complying to governmental regulations. In contrast, the UK´s participants have a more developed view of the responsibilities that food producers, processors, distributors and retailers have. This is partially a result of problems that the UK agri-food industry had in the late ’90s and early 2000s, and that forced the UK´s organisations to adapt to levels more significant than in other countries.

The final differences identified relate to the **services over ownership** regarding logistics. In the Brazilian supply chain, the farmers have their own lorries, while in the UK, the grain-merchants provide transport from farmer to mills (or silos), charging a fee for it. Storing the grain is another form of the practice, where most Brazilian growers (including those interviewed) need to pay a fee to store the unsold grain (e.g., future contracts). In the UK this service operation affects around 15% of wheat grain, as most farmers store the crop in their own structures.

## 6.4 DIFFUSION INFLUENCERS AND TRANSACTION DIMENSIONS

The present section aims at clarifying what the primary forces that influenced the adoption of CE practices and the transaction dimensions in both CSC are. Note that Section 6.4 presents the findings of both cases simultaneously and treat them indistinctively, safe for when clearly expressed otherwise (e.g., citing a specific organisation, practice or context). The reason for this is that, as Section 6.3 showed, there are more similarities than differences in the cases studied.

### 6.4.1 Diffusion barriers, drivers and enablers in wheat food supply chains

In considering the diffusion of CE practices, understanding the influencing factors of their adoption in the supply chain is paramount (Rogers, 1983; Straub, 2009). To that end, this section presents the barriers, drivers and enablers of said adoption in the organisations according to the participants. Figure 6.36 below shows the section of the research framework (Chapter 4) that this section draws from.

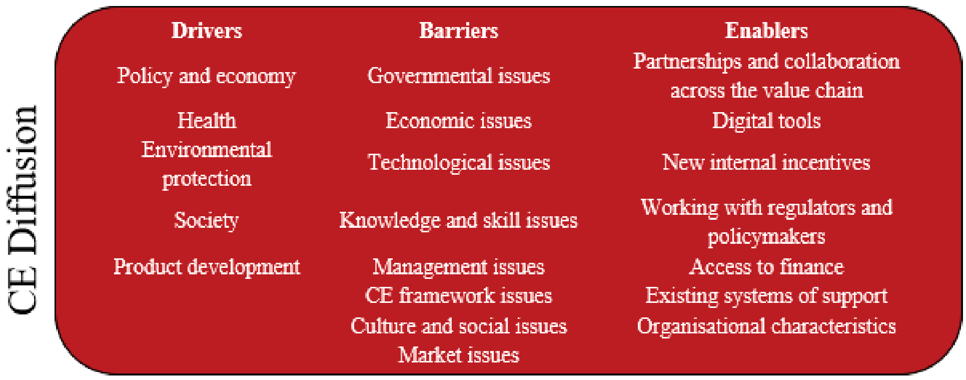



**Figure 6.36** Research model section related to Section 6.4.1.

#### 6.4.1.1 Barriers to CE diffusion

Below, Table 6.2 shows the participants' views regarding the **barriers** of adopting CE practices (Table 2.4). The categories were allocated according to the frequency expressed by the participant (highest to lowest mentions), however the barriers identified within the categories do not follow a specific order. The stars and coloured cells show in which country the barrier was identified. Appendixes H and J provides illustrative quotes from the interviewees. Barriers concerning 'Circular Economy framework issues' were not identified even by participants knowledgeable of CE.

**Table 6.2** Barriers to CE adoption in wheat food supply chains

| Barriers | Barriers identified | BR | UK |
|---|---|---|---|
| **Market issues** | Highly competitive market with risk averse managers. | ★ | ★ |
| | Wheat sustainability not a priority for end-consumers. | ★ | ★ |
| | High logistics costs. | ★ | ★ |
| **Economic issues** | High investment cost for new pro-CE infrastructures. | ★ | ★ |
| | Low-profit margins demand high volumes, risking surplus production. | ★ | ★ |
| | High transaction costs to identify new business partners. | ★ | ★ |
| **Culture and social issues** | Niche markets are pro-CE, most consumers require surplus production. | ★ | ★ |
| | Society does not value sustainable pro-CE wheat products. | ★ | ★ |
| | Poor population cannot afford more expensive pro-CE staple products. | ★ | |
| **Management issues** | Commercial and financial gains are the priority. | ★ | ★ |
| | Decision-making to change negatively influenced by several factors. | ★ | ★ |
| **Governmental issues** | Guidelines of 'use by' and 'best before' reduce capacity to donate food. | ★ | ★ |
| | Different legislations affect farmers' decision for pro-CE operations. | ★ | |
| | High and complex taxes and regulatory environment. | ★ | |
| | Infrastructure and incentives geared to sending to landfill or AD. | | ★ |
| | Limitations on the use of bio-fertilisers and pesticides. | | ★ |
| **Technological issues** | Industry characteristics (location, IT use, bread uses and lifecycle). | ★ | ★ |
| | Logistics: better use of lorries. | | ★ |
| **Knowledge and skills issues** | Increased institutional complexity. | ★ | ★ |
| | Available workforce not pro-sustainability and high turnover. | ★ | ★ |
| | Capacity to access training and support. | ★ | |

From the barriers shown above, a few deserve further development, especially those connected to market issues. In terms of a highly competitive market worldwide for grain and locally for flour and flour-based products, highly risk averse managers are afraid to change their operations (and products) if they consider the possibility of jeopardising old relationships. Additionally, change can also reduce their ability to be flexible considering the current structures and uncertainties/risks of the wheat market. Examples include the use of no-tillage practices in the UK or the very growing of wheat in Brazil if it might negatively affect soya beans planting.

For sustainability, although there is a general sense of greater importance of the topic (as expressed in the drivers below), wheat and wheat-based products are not a high priority. Priorities for wheat-based products at the end-client level are availability, freshness, variety and quality. Other products are more critical for the sustainability-aware client such as meat, fresh produce and milk, but not wheat.

For logistics costs, although they are a concern in all industries, for commodities such as grain the issue is that because of the low value of the product unit, scale is needed, thus large quantities and therefore, high costs of transportation. When considering the circular flow of materials, the issue compounds as the recovery, redistribution and even repurposing tend to be less attractive in terms of price. Therefore, the Food Recovery Hierarchy (Figure 2.8) is jeopardised in favour of lower logistical cost options. Considerations of the same nature affect another of the barriers of the table above (economic issues of low-profit margin product), especially considering high-perishability products: it is better to have surplus production and availability to clients than to have multiple deliveries of low amounts, thus increasing food waste.

The last point to be highlighted from Table 6.2 relates to **management issues** of factors that difficult change. Four factors were identified: generation of decision-makers (the older the least concerned with sustainability), risk/uncertainty aversion, short-term vs long-term strategy (the longer the greater interest in adoption pro-CE operations), and organisational structure. Organisational structure relates to easiness of decision-making. The more levels or bureaucracy the organisation had to implement changes, the greater the barrier to adopt CE. Cooperatives were especially affected by this since they can have a complex decision system that involves committees and members voting depending on the level of change (e.g., the installation of a new feed mill).

#### 6.4.1.2 Drivers to CE diffusion

The **drivers** identified in the cases are organised in Table 6.3 following the categories of drivers shown in Table 2.5. Appendix H and J show examples of quotes from the interviews that clarify information presented in Table 6.3.

**Table 6.3** Drivers to CE adoption in the wheat food supply chains

| Cluster | Driver | Drivers identified | BR | UK |
|---|---|---|---|---|
| **Society** | **Consumer demands** | Society increased concern with sustainable products overall. | ★ | ★ |
| | | Special programs for pro-CE products (special contracts). | ★ | ★ |
| | | Some demand pro-CE operations and control from suppliers. | ★ | ★ |
| **Product development** | **Increase in product efficiency** | Focused in reduction of inputs for cost reasons. | ★ | ★ |
| **Policy and economy** | **Compliance to regulation** | Different policies to inhibit bad practices. | ★ | ★ |
| **Health** | **Concern with public health** | Following health guidelines and certification requirements. | ★ | ★ |
| | | Assurance scheme as obligatory started for health reasons. | | ★ |
| **Product development** | **Increase in product value** | Driven by need for product differentiation. | ★ | ★ |
| | | Need for less input and higher reliability of raw materials. | ★ | ★ |
| | | Need for higher product value given low profit margin. | ★ | |
| **Environment protection** | **Reduce environment impact** | Dependent on organisational strategy and culture. | ★ | ★ |
| **Environment protection** | **Adapt agriculture** | Focus on long-term & crucial for organisations directly linked with agriculture. | ★ | ★ |
| **Environment protection** | **Concern with sustainable development** | Dependent on development of stakeholders. | ★ | |
| | | Dependent on culture & strategy of long-term survivability. | | ★ |
| **Health** | **Concern with animal health** | Animal safety with pesticides residue and feed standards. | ★ | ★ |
| | | Driven by animal rights activism. | ★ | |
| | | Animal welfare ranks 2nd in sustainability concerns. | | ★ |

| | | | | |
|---|---|---|---|---|
| **Environment protection** | **Fight climate change** | Connected to adaptation: how to survive and adapt to crises. | | ★ |
| | | Mitigation less common than adaptation. | | ★ |
| **Policy and economy** | **Governmental incentives** | Farmers: Cost reduction and support for training. | ★ | |
| | | Farmers: Agriculture bill - environmental services. | | ★ |
| **Society** | **Organisations expansion** | Vertical for greater control of supply & demand & profits. | ★ | |
| | | Verticalisation for different reasons. | | ★ |
| **Society** | **Urbanisation and its influences** | Need to support local community. | ★ | ★ |
| | | Need to increase urban knowledge of agricultural practices. | ★ | ★ |

Of the drivers presented in Table 6.3, three require further exploration. Regarding the first driver identified (consumer demands for more sustainable products), the issue appears in conflict with the barrier previously discussed. However, the difference is in general concern for sustainability and actually requiring more sustainable wheat-based products. Pressure groups such as environmental non-profit organisations or food waste advocates exert pressure for greater CE products and practices. However, those pressures are not focused on wheat-based products, even though it is one of the basic staples of food in both countries. The amount of industrialisation that wheat goes through was suggested as one explanation to why wheat is not a priority.

Relating to compliance to regulations it was discussed by participants in terms of rules that require operational changes to comply with policies on the reduction of food waste, protection of water sources, food safety, use of renewable energy and labour laws. Those policies drove adoption to more CE practices. Finally, relating to the driver ‘organisational expansion’, the UK supply chain, various reasons to expansion (hierarchical) were commented: food charities connected to food waste (redistribution and recycling) wanted better use of resources (logistics and stock); UK Mill 2 aimed at the reduction of risk/uncertainty; and UK Industrial bakery increased control over Tier 1 and Tier 2 suppliers, but had not verticalised its operations.

### 6.4.1.3 Enablers to CE diffusion

Considering the drivers that motivate the adoption of CE practices and the barriers that need to be overcome for implementation, some **enablers** facilitate the diffusion of CE practices throughout the supply chain. Table 6.4 shows the enablers identified in the research and with categories previously presented in Section 2.2.3.

**Table 6.4** Enablers to CE adoption in the wheat food supply chains

| Enabler | Enablers identified | BR | UK |
|---|---|---|---|
| **Partnerships and collaboration across the value chain** | Identified at all levels for both wheat products, by-products and waste. | ★ | ★ |
| | Higher importance for orgs. that need greater control of its supply. | ★ | ★ |
| | Required for maintenance of charities that reduce food waste. | | ★ |
| | Required for farmers to access biofertilisers. | | ★ |
| **Organisational characteristics** | Several characteristics affect easiness of adoption. | ★ | ★ |
| **Existing systems of support** | Public and private orgs. supporting training; input access and services. | ★ | ★ |
| **Digital tools** | Knowledge sharing strategies, food redistribution capacity and audits. | ★ | ★ |
| **New internal incentives** | New practices based on stakeholder's request/advice. | ★ | ★ |
| | Coops: Agri input sales team goals not based on pure sales alone. | ★ | |
| **Working with regulators and policy makers** | Working with public agricultural research institutes. | ★ | |
| | Government works closely with supermarkets and assurance standards. | | ★ |
| **Access to finance** | Financing and grants to acquire solar panels for farmers. | ★ | ★ |
| | Financial support for UK Food distribution charity from donations. | | ★ |

It should be pointed out that the first three categories discussed in Table 6.4 were identified in the interviews much more frequently than the rest, especially partnerships and collaboration. In relation to organisational characteristics, several were identified, including:

- Location as it influences access to knowledge, more pro-sustainability labour force, materials, supply chain partners and capacity to use renewable energy.
- Global strategy, influencing the multinational organisations and how they respond to pressure.
- Verticalisation diversification.
- Client and supplier culture, such as farmers attitude towards sustainability and their relationship with the cooperatives.
- Physical characteristics such as area to install solar panels, or water-powered generators.
- Decision-makers characteristics (e.g., generation and risk-aversion).

The last influencer to CE-diffusion that requires further discussion are digital tools. Digital tools facilitate the adoption of CE practices since they can reduce transaction costs, increase efficiency for information and knowledge gain and allow access of partners from different regions for potentially wasted products, among others. However, digital tools can also create problems through misinformation.

According to the participants, the transmission of harmful farming practices is made easier and has intensified through social media (e.g., Whatsapp, Facebook and Instagram). Even though bad operations were always present and potentially common in a given region, now there is no limit of distance and time to contain such problems. For instance, the use of inappropriate pesticides, untested mixtures of agrichemicals or seeding or harvesting the wheat too soon (through desiccant) to facilitate soya bean production, has been facilitated by digital tools. Since social media is decentralised by nature, it is not possible to control the spread (as it is impossible to prevent people from talking with each other), thus making it harder for organisations to promote more sustainable practices. It becomes a matter of not only improving current operations but also correcting problems generated by such misinformation.

### 6.4.2 Characterisation of transactions between buyers and suppliers - BR

Section 6.4.2 addresses the dimensions of transactions in the dyad buyer-supplier of both cases. The present section can be identified in the research model (Chapter 4) in Figure 6.37 and aims at answering the fourth research question – ‘what are the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated?'.

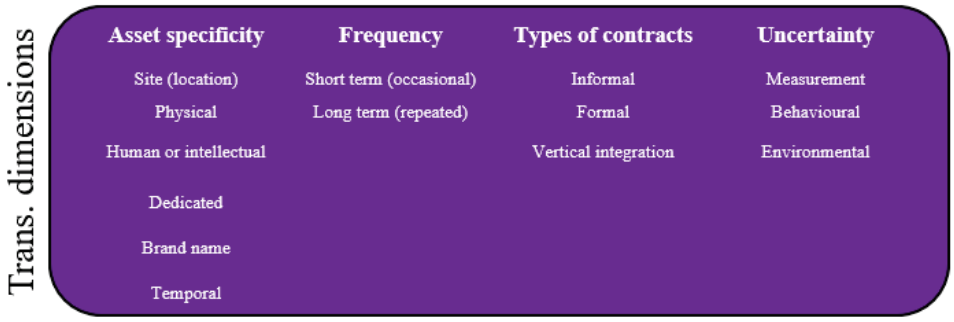



**Figure 6.37** Research model section related to Section 6.4.2.

#### 6.4.2.1 Asset Specificity

Asset specificity is not a prominent dimension of the transactions in the wheat food supply chains investigated. However, as Dani (2015) points out, transaction-specific investments can influence the nature of the exchange in the buyer-supplier dyad. In the case researched, there are cases of investments to meet specific contractual requirements. However, these assets can be redeployed to different transactions without much loss in value. The quote below exemplifies this:

> "*Oh yes, like, demands, demands, yes, technical demands of quality. So, sometimes I have a client who has a regulation there that has to be, everything has to have a metal detector, do an account here, something very specific, okay? And I don't have it, I didn't have it, so in this case, it happened and I didn't have it. And I can only serve this customer if I have this, this equipment. Then I go there, I turn around, it's not cheap, it's R$ 500,000.00 for you to do a deal like that." (...) "It ends up expanded to other customers*." BR Mill 1.

Although asset specificity is not very pronounced in the transactions of the supply chain overall, there are other instances where the dimension was identified. The two most notable case identified were in the supply of specific flours from the mills to the industries and that required control of wheat varieties, segregated silos, specific personnel and protocols in place; and the supply of wheat without the use of liquid (foliar) Nitrogen to increase protein (the special program connecting from UK Industrial bakery that connects different links in the chain. Table 6.5 lists the different types of asset specificity (Davies and Lam, 2001; Shin, 2003; Altman *et al.*, 2007) identified in the research, and that were previously presented in Section 2.4. The categories are also listed based on frequency identified.

**Table 6.5** Types of asset specificity identified in the wheat food supply chains

| Asset specificity type | Specificity identification | BR | UK |
|---|---|---|---|
| **Physical** | Specialised inputs and good for specific contracts. | ★ | ★ |
| **Dedicated asset** | Segregation of different types of products, including grain. | ★ | ★ |
| | Investments to meet standards at several levels of the CSC. | ★ | ★ |
| **Site (location)** | The financial investment in a 'hotspot' to provide fresh bread. | ★ | |
| | Farming practices & logistics of grain, flour and food surplus. | | ★ |
| **Temporal** | High spoilage of bakery goods leads investment to avoid them. | ★ | ★ |
| | Freshness and availability affect bread production year-round. | ★ | ★ |
| | Wheat sales consider storage & speed of delivery in favour of soya beans. | ★ | |
| **Brand name** | Contracts to supply own-label products for larger corporations. | ★ | ★ |
| | Link with some brands shows commitment to sustainability. | ★ | ★ |
| **Human or intellectual** | Specific trainings for particular supply programs (e.g., baby food). | ★ | ★ |
| | Training for wheat by organisations that have other focuses. | ★ | |

Classifying a particular grain, flour or bread as **physical asset specificity** can be disputed depending on the author's definition. For Jraisat (2010), physical asset specificity is connected to equipment and machines, while Altman *et al.* (2007) point to customising assets for the need of a particular partner. For Shin (2003), it can be both inputs (e.g., specialised dies) and equipment. Considering that special wheat stocks are assets and that they cannot be reconfigured for other uses without significant loss of value (even **reclassification** of wheat incur in the loss of value), the definition used by Altman *et al.* (2007) is pertinent for the wheat setting as well. Thus, it was classified as such in Table 6.5. UK Industrial bakery program and other flour transactions for pre-defined industrial products and packaging are examples of this. They did not show in circular flows of the materials, however.

**Site specificity** can play a role in the transactions between farmers, mills and cooperatives. Logistics costs and a small number (sometimes monopsonies) of potential buyers in the region increases the potential for **behaviour uncertainty**. However, it was not classified as such since both the location of the mill and the location of the farm were not decided (invested) based on this transaction. The UK presents better examples of site-specificity with mills supply to industrial bakeries, in-store bakeries for the supermarkets (also present in Brazil), and UK Food distribution charity and its network through the UK.

Although **temporal specificity** is connected to agri-food products (Mondelli and Klein, 2014) because of the potential of spoilage - in grain, flour, biscuits and pasta, this is less pronounced due to long storage life of these products. However, bread and similar products (e.g., muffins) have a high spoilage speed, thus leading organisations to choose transaction forms, partners and investments to **reduce waste** and value loss via **reclassification**. This also negatively affects both UK charities' capacity to distribute or recycle bread in their operations, thus requiring a high transportation investment when it is not possible to have on-site storage.

The Brazilian context concerning soya bean (and maize to a lesser extent) as the cash crop, also influences the transactions of parties in relation to time. Being able to harvest and deliver as fast as possible in order to plant soya bean, and to empty silos for receiving soya beans post-harvest play a significant part in decisions relating to price, operational costs, transactional costs and logistics cost. Therefore, **temporal asset specificity** has a role in wheat food supply chains beyond spoilage.

No requirements for reduction of waste or donation of surplus production were identified in the Brazilian case but were found in the UK´s case - supermarkets and their suppliers. Part of this is connected to **brand specificity,** where it is valuable to be associated with fighting food waste and organisations that operate in the field.

Another example of **brand specificity** was identified in the contracts to supply own-label branded products for larger corporations. These clients made requirements that demanded investments and frequently audit the suppliers. However, if both supplier and client are big brands, the negotiation is not too asymmetric, reducing pressure for changes functioning more as a partnership than a requirement.

**Human asset specificity** is distributed throughout the supply chain. From farming processes (e.g., soil correction and input use), relationships between traders and farmers and finally with bread and pastry making since skilled bakers (and supporting teams) are not as common as in the past.

#### 6.4.2.2 Frequency

Frequency is considerably variable throughout the transactions in the supply chain. Over the counter (spot) transactions - classical contracts without remaining obligation once the transaction is over (Williamson, 1998; Davies and Lam, 2001) - are an integral part of the supply chains. Examples include farmers and retail sales. However, the participants indicated that they also participate in long-term relationships and **repeated transactions**. These repeated transaction schemes are typical with both suppliers and clients, except the retailers, that do not have such connections with their clients.

Supply contracts also have a hybrid form of operation (Williamson, 1998). The transactions discussed by the participants typically encompass one year with repeated renewals upon audits, performance evaluations and further negotiation. The supply request (invoice), on the other hand, have shorter terms. Depending on the extent of the relationship and contract, the unrelieved hazard is greater or smaller, resulting in requirements of better pay from suppliers that have more negotiation power. The following quote illustrates this:

> "*No, it is, with the main suppliers we make an annual contract. It is not even a contract, I expressed myself badly. We do what we call a shared business plan, a joint-business plan. We do an annual with the main suppliers. With smaller suppliers we did not build this plan. But we do all of them, the biggest and the smallest weekly service, so, I may or may not have JBP, but my purchase service, my purchase cycle is weekly. Some suppliers, most of the wheat chain, all are weekly, some suppliers I have fortnightly or monthly, but in the worst case, when I talk about laundry detergent, for example, I have a fortnightly service*." BR Supermarket chain 1.

Another type of hybrid contracting are those that are more structured, with renewals upon audits, performance evaluations and further negotiation. These arrangements have a higher transaction cost but overall, less unrelieved hazard.

> "*(question about predicting incoming food and quantities) We can do that to a certain extent with some suppliers. So we know that from, as we were talking about downstairs, the main retail distribution centres, we know that on a daily basis, they're probably going to have X amount of pallets every day. We also know from some of our long-term sort of produce suppliers, there's usually a pallet every Thursday or something, so we've got some ideas, but because there is so many variables in the*

*production and in the surplus, a lot of the times they'll turn around to us and say: "normally we give you 1 pallet, on this occasion we've got 10", "normally we give you 2 pallets, today we've got nothing*"." UK Food donation charity.

In Brazil, the frequency of the farmers' trade of wheat is also related to the supplier of inputs where he purchased it. The barter strategy makes it easy for farmers to buy seeds, fertilisers and pesticides and pay with grain at the end of the season. These transactions create a bond between buyer and supplier and indirectly includes grain-merchants, cooperatives and mills since they are the organisations that will purchase grain from the input sellers. The cooperatives also use the selling of inputs and purchase of wheat as part of their business strategy. While farmers are not obliged to sell their grain to the cooperative that they are a part of, cooperatives have considerable pressure to buy grain from every associate. In the UK, farmers' frequency of the trade is very much relationship-based and tend to be repeated with the organisation that they have negotiated in the past. In both countries, repetition does not mean exclusivity, as farmers can trade their crop with multiple actors in the same year.

The **verticalised organisations**, by nature, have long-term, continuously repeated transactions between the different units or divisions of the organisation (Williamson, 2008; Hobbs *et al.*, 2012). All organisations with vertical integration of the research have such characteristics[35]. This is also true for the materials sent to animal feed mills for those that have it in their portfolio. Differently, the organisations that do not have such option (do not own feed mill) have not mentioned the frequency of **repurposing** wheat to animal feed mills. It is assumed that long-term strategies are also present in such situations.

The participants also discussed the transactions relating to circular wheat flows as **repeating** occurrences. However, despite the repetition, regularity in the transactions outside vertical integration was not discussed, with both periods and quantities varying depending on several factors such as the quantity of available product, logistics schedules, destination, etc. Thus, it is possible to conclude that, although **long-term relationships** are formed in such dyads, there is greater uncertainty in terms of supply.

Finally, the formation of cooperatives is also a type of **long-term** governance structure that required a transaction for its creation and the continuous association with them. Cooperatives also reduce farmers' overall transaction costs and facilitate repeated

[35] It is valid to point out that the profitability of each unit is also taken into consideration. For this reason, a cooperative's mill will buy grain not only from the own cooperative, but also from suppliers that can provide grain at a good price and expected quality.

transactions for and to farmers (Alho, 2015) and can also be considered a form of hybrid organisation (Williamson, 1998).

In summary, even though not continuous transactions (Davies and Lam, 2001) are present and customary occurrences, **repeated transactions** have greater influence in the supply chains investigated, both in the linear and in the circular perspectives, since they are a part of long-term relationships in buyer-supplier dyads.

#### 6.4.2.3 Types of contracts

Previous works (Schofield, 2007; Glithero *et al.*, 2013; Smith and Barling, 2014; Dawson, 2015) discussed have described in depth the commercialisation channels available and most often used the wheat industry, with particular attention to farmers. However, it is still relevant to describe these aspects based on the interviewed organisations to contextualise the governance forms existing in the cases. The classification is based on the typology discussed in Section 2.4 of the thesis.

The interviewed farmers use multiple channels to sell their grain, most notably spot market (a type of formal contract) and futures (term) contracts. Brazilian farmers also barter (informal contracts with some aspects of formal control (e.g., debt) with the organisation that sold inputs to them, be it the local cooperative or a local input retailer. UK´s farmers also take part in pools of farmers to sell grain (a form of term contract), barter straw for muck (discussed previously) and can participate in special formal programs (<u>UK Industrial bakery</u> and its suppliers).

**Informal** partnerships among farmers for collaborative and seasonal work also exists mainly for planting and harvesting. Grain-merchants and cooperatives also implement various forms of wheat purchase and sales simultaneously. Reasons for multiple channel use include the maximum on-site capacity to store grain, transportation costs and time, risk reduction, financing options, trust and long-term relationships, and the need for a constant flow of products to supply downstream organisations (e.g., mills and craft bakeries) that produce all year with a product that is only harvested once a year. These aspects are in accordance with previous works regarding multiple forms of trade arrangements in agri-food supply chains (Brum and Muller, 2008; Ménard, 2013; Mugwagwa *et al.*, 2019).

While the commercialisation channels follow commodity characteristics of standardised products and contracts (Batalha, 2001; Schofield, 2007) thus without CE-related requirements as a general rule, the UK´s supply chain implemented a contractual provision that improves the sustainability of grains (including wheat) and pulses: the use of assurance certification. At the same time, certification creates a filter (no certification, no sale) and a guarantee of a more sustainable product if compared with international competitors. In Brazil, certification exists but to a much smaller scale, focused on seeds and exports. In summary: the UK´s wheat food supply chain is able to differentiate its supply of wheat while maintaining standardised contracts that can be part of the futures market.

For the mills, the use of different strategies to purchase wheat inputs, as well as their own storage capacity (grain silos) act as a two-level strategy to continuously supply its production line (and therefore its customers) even if the availability of local (regional) grain is seasonal (Batalha, 2001; Brum and Muller, 2008). The capacity to import grain also plays a role in wheat availability throughout the year, especially for Brazil as local production (both quality and quantity) does not fulfil the total need of mills. However, exchange rates, adequate time availability and low-profit margins can reduce import attractiveness and paradoxically, part of the production from the state of Rio Grande do Sul is being exported to other countries as mills from other regions in Brazil cannot absorb that production given logistics costs and grain specifications.

Produce from mills (including the ones from cooperatives) and agri-food industries (including industrial bakery), have two basic forms of product commercialisation: i) supply contracts with repeated orders throughout the length of the contract (formal or informal); ii) contracts to supply other organisations with their own-brand products (e.g., supermarket with own brand flour). Both of these types of trade rely on the stability of the product to maintain standards of quality, flavour, appearance, and format (e.g., exact form of biscuits to fit in the package). In the UK´s case, sustainability improvement is a growing concern, although the stability of quality and price are still overriding concerns.

Special lines of products were also identified in the research. For specific products such as traceable flour in Brazil, baby food (both cases) and no-foliar Nitrogen in the UK, there is greater control in the input purchased by the organisations. This is done through specific governance programs developed by the organisations, although they do not necessarily pay a premium for the material. The organisations promote specific wheat cultivar that they want through partnerships with seed breeders, retail institutions, mills and cooperatives, fostering specific raw material and segregated in silos. As already expressed, the differentiation strategy means a **reduction of inputs and waste**, a reduction of wheat material being **repurposed** for other industries and reducing the possibility of **reclassifying** the product.

Regarding **verticalised operations** (Williamson, 2008; Hobbs *et al.*, 2012), only BR Mill 1 mentioned reduction of transaction costs as a reason to verticalise the company, but not in the downstream sense, rather, in their control of input purchase. The participant from said mill also mentioned an increase of knowledge and efficiency of purchases, elements well established in TCE literature (Williamson, 1998; Davies and Lam, 2001).

UK Grain-merchant 1 – private is a joint-venture between two large agri-food producing companies, and around 50% of the grain purchased by the trader goes to the parent companies. It is possible to argue that the formation of the joint venture represents a hybrid contract rather than a hierarchical one, but the organisation and the other players in the sector perceive the organisation as a verticalised business. UK Mill 2 has different business attached to it, including an industrial bakery, farms and feed mills. According to the interviewee, the organisation is very risk-averse, thus preferring to increase its internal transaction costs in order to control more of its operations. The strategy also increases the organisation's choice of purchasing directly from farmers whenever possible.

BR Industrial bakery mentioned a past experiment with verticalisation aiming at controlling the input for their products (including farmer connection). Still, it was a failed project. The other verticalised organisations, namely the cooperatives and the other mills discussed different reasons for verticalisation: adding value to the product; overall organisational strategy; the availability of inventory whenever needed. The verticalisation of waste use (i.e., animal feed mills) was also presented in such perspective: the maximum valorisation of a product that already has narrow profit margins: it is best to use the material within the company as much as possible instead of donating or sending to landfills as it at least pays some of the costs. The different reasons for verticalisation (besides reducing transaction costs), as pointed out the participants, are in line with some of the criticism that TCE receives – the theory lacks explanatory power for these decisions (Shin, 2003; Zipkin, 2012). Examples of criticisms include i) not considering value-generating through the transformation of products, ii) the importance of production cost in decision making, and iii) the role of stocks in relation to supply and demand. Therefore, both the arguments presented by Zipkin (2012) and by Williamson (2008) are present in the cases.

**Formal** (unwritten) and **informal** (written) contracts are part of the wheat food supply chains. Formal agreements are mostly connected guaranteeing quality and availability of stability of products in transactions (sale and purchase). Informal relationships are connected with trust, access to more favourable deals and reduction of transaction costs – it is cheaper to work with a trusted partner than to develop a new one. Table 6.6 summarises the information discussed so far concerning transactions in the supply chain.

**Table 6.6** Types of contracts identified in the wheat food supply chains

| Contract type | Contract identification | BR | UK |
|---|---|---|---|
| **Formal contracts** | Spot market transactions at several steps of the chain. | ★ | ★ |
| | Term contracts between farmers and buyers. | ★ | ★ |
| | Yearly supply contracts for special programs and/or quality maintenance. | ★ | ★ |
| | Own-label supply contract. | ★ | ★ |
| | Return of products as per legislation and upon proof of supplier fault. | ★ | ★ |
| | Importing specific grain. | ★ | ★ |
| | No requirements regarding waste reduction or CE-specific practices. | ★ | |
| | Some requirements (pre-contract) for mills and industries (legislation). | ★ | |
| | Requirements for certification. | | ★ |
| **Informal contracts** | Long term supply relationships. | ★ | ★ |
| | Partnerships amongst farmers (mostly neighbours). | ★ | ★ |
| | The partnership between BR Craft Bakery and pastry industry. | ★ | |
| | Barter between farmers and agricultural input retailers. | ★ | |
| | Barter between farmers and agricultural input retailers. | ★ | |
| | Straw for muck deals. | | ★ |
| **Vertical integration** | Identified in the cooperatives with several operations from farm to market. | ★ | |
| | Verticalisation not always successful. | ★ | |
| | Partial verticalisation (not farm to market) also identified. | | ★ |

6.4.2.4 Uncertainty

Uncertainty is a crucial dimension in the transactions in both cases and the most important one in the Brazilian supply chain. It is relevant to discuss each of the possible forms of **uncertainty** that affect transactions, considering the categories previously addressed in the framework of Chapter 4 (and Figure 6.37): *measurement*, *behavioural* and *environmental* uncertainty. The information collected is summarised in Table 6.7.

**Table 6.7** Types of uncertainty identified in the wheat food supply chains.

| Uncertainty type | Uncertainty identification | BR | UK |
|---|---|---|---|
| **Environmental** | Natural environment affects demand and supply of prices and availability. | ★ | ★ |
| | Grain price uncertainty - international market defines it. | ★ | ★ |
| | Grain quality uncertainty - depends on weather. | ★ | |
| | In futures contracts, grain quality defined at low quality. | | ★ |
| | Uncertainty of institutional environment e.g., change in legislation, Brexit. | | ★ |
| **Behavioural** | Grain selling issues: contractual breaks when buyer is not liquid. | ★ | ★ |
| | Org. implemented vetting processes pre-purchases. | ★ | ★ |
| | Large buyers pressure tier 1 suppliers for control of tier 2 suppliers. | ★ | ★ |
| | Farmers in the past broke futures contracts if market prices were better. | ★ | |
| | Retailers are afraid of legal issues with direct donation of food. | ★ | |
| | Several levels of audits to reduce behavioural uncertainty. | | ★ |
| | Food charities reduce behavioural uncertainty from bad faith actors. | | ★ |
| **Measurement** | Identified in two forms: regarding the quality and safety of products. | ★ | ★ |
| | Mills hold the capacity to verify grain quality, not the sellers. | ★ | ★ |
| | Several levels of control for food safety. | ★ | ★ |
| | Some organisations do not measure food waste. | ★ | ★ |

**Measurement uncertainty** is often regarded as the difficulty in measuring the performance of the contractor (Davies and Lam, 2001; Wognum *et al.*, 2012). In the case discussed here, measurement is also connected to the supplier being unable to measure the quality of the grain that he is selling. The quality of the grain is a concern that influences how and with whom the transactions of grain sales are done, therefore the capacity to measure grain quality influences transactions. Previous works (Wognum *et* *al.*, 2012; Man *et al.*, 2017) have discussed similar issues in other agri-food supply chains, thus showing that the Brazilian wheat supply chain is not an outlier in this regard.

Only the larger organisations participating in the research have a structured program to keep track of sustainability issues, as most participants do not have explicit sustainability requirements in their transactions:

> "*Basically, farm-level auditing is based on three pillars: economic, social and environmental sustainability. So it's a broad questionnaire, but it will go over sixty points to be evaluated, but they are the three main pillars, economic, social and environmental sustainability. So any labour problem that you have in a property, work or analogy to slave labour, child labour, the guy has no legal reserve, no APP, deforestation area, this is all point to disqualify the property and depending on the dimension disqualify even the mill that we have a commercial relationship or that we are seeking a commercial relationship*." Agrifood industry.

As pointed out by Shin (2003), previous works have identified **measurement uncertainty** as an aspect of **behavioural uncertainty**. Although the present research takes a different approach as it understands both separately, some of the practices that organisations implemented to reduce measurement uncertainty are also present in the reduction of behavioural uncertainty. The foremost example of that is the close monitoring of suppliers via the evaluation of operations and products throughout the year. For instance, organisations such as UK Farmers' cooperative have started vendor assured wheat contracts to solve the issue by having greater control of varietal choice, farm management and weather impact in grain.

In the UK, food safety issues regarding mycotoxins, contaminants and expiration dates are controlled through certification schemes, and protocols and audits (larger corporations). UK Food distribution charity has implemented strict control of use-by date, refusing products where the use-by date is not clear or that the producer cannot guarantee safety.

Waste data is lacking in the supply chain, with the exception of supermarkets. However, no organisation argued that this is an issue for them or their clients, even those pressuring for more CE-related practices (e.g., food donation).

Regarding the cooperatives' connection with their suppliers of grain, in Brazil, the nature of the cooperative reduces their capacity to pursue legal matters against grain suppliers that break contractual agreements with them. It is possible that it is the same in the UK, but no participant mentioned such issues in the interviews. Batalha (2001) argues that the multiple roles that farmers can have with cooperatives (e.g., supplier of grain, buyer of inputs and services, associate/partner) allows conflicting issues to arise in the transactions processes.

The conflicting roles of farmers increase uncertainty in relation to practices used in farms, in the availability of grain to be received by the cooperative from its suppliers and in the quality of the grain, as they cannot easily refuse purchases of grain from associates. To account for those uncertainties, cooperatives have programs of continuous monitoring of farmers (especially those that bought seeds and other inputs from the cooperative stores), although this is not very strict, as cooperatives do not have the power to force farmers to use certain operations. Not only that but in large cooperatives, the number of farmers and the amount of area that farmer technicians have to monitor can be vast, thus reducing their capacity to evaluate everything. UK Assurance scheme's annual audits reduce these risks in the UK supply chain.

**Behavioural uncertainty** was identified throughout the supply chain, but several mechanisms were discussed to reduce the potential issues. The dimension was also an important factor with the donation of food (**redistribution**). The risks associated with donating surplus food stops some of the organisation in doing so, preferring alternative practices (already discussed). Structured organisations such as UK Food distribution charity are crucial in the UK supply chain to facilitate the donation of food by large corporations, as its protocols and structure help to reduce behavioural uncertainty from bad actors, thus the suppliers have less need to structure their internal redistribution programs. The two quotes below show the contracts between both cases in the study:

> *"(...) I know that in the past, you know, the supermarkets were very cautious about who was accessing that, you know, they put padlocks on the skips outside to stop anyone from going into their bins outside their stores to get it, for that reason, they were worried that people would eat out-of-date food, bad food, and then sue them. But, the way that we operate, there's, there's no possibility for that because the food is fine. The food is always fine. The problem with it is, maybe the label isn't perfect, or it's the wrong colour or things like that because there's so many different ways that surplus exists*." UK Food distribution charity.

> "*No, a product that, let's say, has a problem, is not made (the donation)" (...) "Or that it is very close. No, but it is too much, let's say, 2 days to spoil, if it is not consumed in those two days, on the third day it is already a problem. And often, it can stay inside the place, "a, where did it come from?", I'm going to create a problem, then." (...)*

> *"Yes, I think the risk is greater than the benefit, therefore. So, one, I could do it, it would be very good to do it, but then there is the evil, many times, behind people, situations that may occur*". BR Cooperative 2 – supermarket.

Farmers are part of long-term relationships with their traders; therefore, trust plays a role in the interactions that farmers have with the organisations marketing their crops. However, farmers also employ multiple simultaneous channels of commercialisation. In the UK farmers will maintain control of most of their stocks, and in that sense, they differ from Brazil. The financial health of the partner is also vital, as is insurance for the parties - previous experiences where a trader went bankrupt before paying agreed contracts happened in both countries. Such situations increased interest in spot sales and barter.

The most verticalised organisation of the UK´s case, UK Mill 2, has developed the hierarchical structure with farms, direct purchase from farmers, mill, feed mill and industrial bakery to reduce their exposure to uncertainty. The use of long-term formal supply contracts, such as the ones providing flour to industrial bakeries and bread to supermarkets, require procedures of supplier control and development. Similar audits also extend to the food redistribution charities that receive products from the supermarkets. Therefore, audits are a common occurrence when formal, long-term contracts are formed. Considering that the UK´s case had more occurrences of such transactions, it makes sense to conclude that audits are more common in the UK than in Brazil for wheat food supply.

Behavioural uncertainty is present in the UK Industrial bakery´s reduced inputs program. Since there are no audits within these transactions, trust is required for the bakery to consider that the farmers part of the program, are following the protocol. The bakery visits some farms and is visited by the supermarkets, but these are not formal audit processes.

**Environmental uncertainty** has different influences in supply chains and was the most discussed type of uncertainty in the Brazilian case. One of the major points identified is connected to the natural environment uncertainty (e.g., weather and pests), or as Shin (2003) puts it, uncertainty from exogenous sources. As climate issues can influence volume availability both negatively (e.g., less grain for previously agreed contracts) or positively (too much grain), a high level of uncertainty influences the decisions of the actors concerning how (i.e., forms of contracts) and with whom they do transactions. Bakeries can also be affected by climate uncertainty, as the following quote illustrated when the participant was asked about issues with the flour provided by internal transactions of BR Cooperative 2:

> "*Ah, no, it always happens, right. Suddenly a bread that didn't grow properly, you know, it fell off, you know, that's normal. Suddenly the climate changes, it's cold, you would have to have a little more yeast in the dough. It's a product that, let's say, it's not just the recipe that makes it an excellent product, you know. So it is influenced by the climate, the temperature. As we make frozen bread to take to other stores, right now, we are in a climate that is warm, but a few days ago it was a little cold, so you had to have a different dough job, right. But no problem like that, getting mould, no. No, not that.*" BR Cooperative 2 – supermarket.

Similarly, flour and industrialised products must maintain well-defined characteristics, price and daily availability to clients and end-consumers. Thus, formal supply contracts that are too long and strict reduce the capacity of organisations to adjust to environmental changes (Williamson, 2008; Wever *et al.*, 2012; Ghadge *et al.*, 2017).

> *"(...) Which can be difficult when you're dealing with a commodity like wheat, which can fluctuate quite significantly. If you're locked into a contract for two years, sometimes there's an advantage in locking in your margin, if you can see that: "I can get this much wheat delivered", you're buying, you do forward purchasing, so you purchase wheat at a set price over the course of a number of, you know, a year or more. And you've locked in your flour contract, that you know that you have that margin. But yeah, I think it goes back to what we were saying about something being a commodity and then something being very specific afterwards. So the majority of... I don't know if I have those figures available. The majority of flour is going to be sold for food contracts. There is the majority of times at least, it's sold through contracts. That's where the big tonnage comes in.*" UK Mill Association.

Uncertainty of quality is a larger problem in Brazil than in the UK, as UK´s wheat is quite stable. Even so, farmers in futures contracts select feed mill specifications as their baseline for price and obligation, even if it is unlikely that the wheat quality does not reach food specifications (and thus, milling premium).

In the UK´s supply chain, environmental uncertainty from 'institutional issues' were more prevalent than those of the natural environment and are still developing. Brexit (quote below) modified the capacity of millers and supermarkets to import EU wheat-base products. Change in pesticide regulation (quote below), government subsidies and inflation are also affecting the actors of the supply chain.

"*A lot of customers are afraid of Brexit. So they've now taken flour out of their, sorry, wheat, French, out of their flour mix. So they're going to be using more English, just to protect themselves. We're still taking a fair amount of wheat… from Canadian and DNS: Dark Northern Spring from the States, that goes into Tring most of it and it's quite big on our Jewish trade. And so we'll have to carry on that relationship. I mean, I think, hopefully nothing will change there. But we... if that happens that we have an awful harvest, and we don't have enough to satisfy internal demand we'll really have to think about where we want to go. Russia, I don't know, it depends on how things go with them, how their harvest is like or it could just be a case of going back to the States. It's a huge, big question mark. Nobody has any idea, no idea.*" UK Mill 2.

Price uncertainty is also a considerable factor influencing in the transactions in the supply chain. Considering that wheat grain is a commodity traded in the global market, price volatility affects the decision making of actors that trade with the product (Batalha, 2001; Ghadge *et al.*, 2017). While the buyers (i.e., grain-merchants, cooperatives and mills) do have some leeway in defining what they are going to pay, the flexibility to do so is not great. For wheat feed grain, the capacity to set prices is even narrower, as the product tends to be cheaper and competes with other materials. For special programs that pay a premium for specific types of wheat grain, uncertainty is different, as the need to have a standardised product in the expected quantity, incentivises the organisations to increase payment to ensure supply.

The low-profit margins and the fierce competition between retailers, pressure staple foods such as wheat products (i.e., bread, pasta and biscuits) to be as cheap as possible. Therefore, industrial suppliers are also pressured to meet price expectations while having to deal with price uncertainty from their supplier of flour. The reduction of risk and uncertainty influences the decision of implementing various strategies of buying and selling wheat products throughout the supply chains. The flexibility to adapt to changes is in line with previous works regarding transactions, uncertainty and risk in supply chains (Williamson, 2008; Wever *et al.*, 2012; Ghadge *et al.*, 2017). In other words, some organisations in the supply chains have a trade-off between flexibility for complying with prices (both for sales and purchases) - thus not formalising long-term supply contracts - with the need to keep a constant production that has stable specifications for inputs and outputs.

## 6.5 INFLUENCES OF TRANSACTIONS CHARACTERISTICS ON CE PRACTICES ADOPTION

Having clarified the CE diffusion barriers, drivers and enablers and the dimensions of the transaction of the wheat food supply chains, it is now possible to better understand how one interacts with the other. To facilitate the discussion of the findings, Figures 6.38 to 6.40 were created, showing the relationship between both sets of operational concepts. Each link represents instances in the data where connections between topics were identified.

The thicker the link between two categories, the greater frequency of connections were identified. Not all the connections are discussed here as there is a considerable amount of them, and the focus is only in the main group of links. As it was the case for Section 6.4, the current section also presents the data joining both cases. There are two reasons for that: the similarities in the data of the cases and to better expresses the relationships between the factors in the wheat food supply chains.

### 6.5.1 Diffusion barriers and transaction dimensions

Figure 6.38 shows market issues as a central hub with connections to several dimensions.

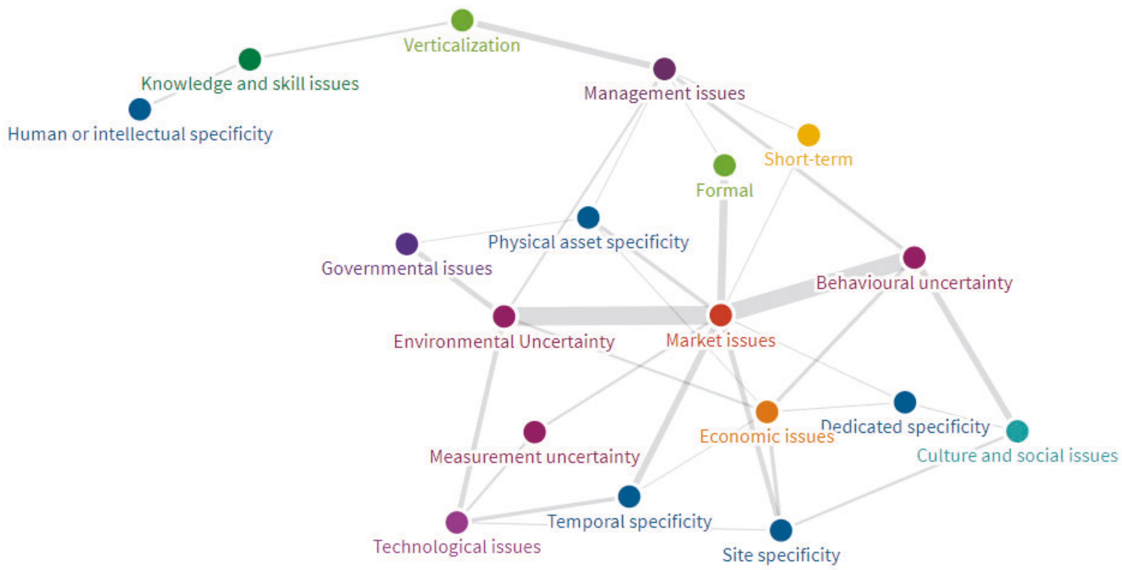



**Figure 6.38** Barriers to CE diffusion and transaction dimensions

Market issues has the highest number of connections with different dimensions (nine connections) and has the highest number of connections overall (49). Considering that market issues was the most common barrier identified in the supply chains (Table 6.2) this was expected. However, the strength (represented by the thickness of the lines) of the connections between environmental and behavioural uncertainty to market issues in comparison to other dimensions should be highlighted, since they have the most perceptible (thickest) of the connections between the categories, representing the highest frequency of interactions identified in the data.

Given the definition of market issues by Govindan and Hasanagic (2018) regarding externalities that create problems for adopting CE, transactions with a high level of uncertainty will heighten the market issues, as unknown externalities are more problematic than known ones. In transactions that lack pro-sustainability requirements, even if they are formal (e.g., spot transactions), market issues will be more relevant in the decision to not adopt CE if the organisations in the supply chain do not have explicit demands for it. In other words, market barriers are strengthened in situations where clients are not requiring the adoption of a pro-CE change, especially considering transactions with high uncertainty. This can be visualised in the connection with formal contracts and market issues, the third in frequency of all the other connections.

It is also relevant to highlight the connection between market issues and asset specificity, or more precisely, temporal, site and physical asset specificity. As expressed by the participants, there are market requirements for freshness, location, and specific products. This means that some of the investments required in the transactions (e.g., availability of fresh bread every day or segregated silos and lorries) go against the adoption of CE practices, thus reinforcing market issues. To put it plainly, organisations will not invest in CE if the market requires something else (e.g., surplus production for bread to be fresh).

Another relevant hub of barriers and transaction dimensions is management issues. Organisational priorities and decision structures that do not care for CE adoption (e.g., money focused managers) are affected by internal transactions (hierarchical or vertical organisations) especially when buyers cannot refuse the purchase (e.g., cooperatives and farmers) of non-CE products. In other words, the internal transactions of a supply chain positively affect the difficulty of adopting CE operations (e.g., buying more CE-like products) as they focus on pure money issues or in the reduction of uncertainty that changes might bring.

Similarly, economic issues (e.g., cost) - third and final relevant hub for barriers - are worst when specific investments are required (asset specificities). Not only that, but behavioural and environmental uncertainties in transactions also increase the problem of such investments, thus jeopardising the diffusion of CE. It creates a trap, where the market is not very concerned with wheat-sustainability thus requiring products that are against the CE philosophy, reducing the interest in new investments that are pro-CE and that could change the market and the uncertainty of adopting CE.

### 6.5.2 Diffusion drivers and transaction dimensions

Considering the drivers to CE adoption (Figure 6.39), the main hub of connections between drivers and transaction dimensions is **consumer demands**. The data showed 12 connections between said driver and the different dimensions, most significantly formal contracts and physical asset specificity, respectively. Consumer demands represented more than half of all the connections of drivers and dimensions. Two others, less expressive hubs are **concern with public health** and **compliance to regulation**, each connecting with five dimensions.

The two main dimensions connecting with **consumer demands** are **formal contracts** and **physical asset specificity** (expressed by the thicker links between the factors). In other words, transactions that are formalised and that require specific products are the strongest form of CE adoption driver in the wheat food supply chain. As previous sections show, however, they are not explicitly mentioning sustainability (and CE less so) necessarily but can have CE-like requirements such as less input use, specific protocols of production, commitments to reduce waste among others.

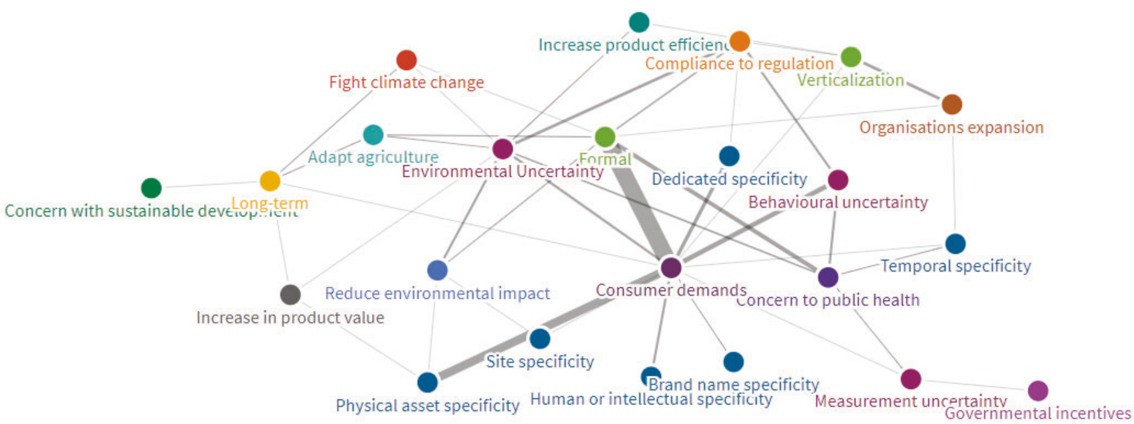



**Figure 6.39** Drivers to CE diffusion and transaction dimensions

The connection between **consumer demands** and **behaviour uncertainty** also needs to be highlighted as they reinforce the position of behavioural uncertainty for barriers. Formalising the contracts that required specific investments is done to mitigate behavioural uncertainty, especially given the need for asset specificity. Therefore, in this instance, behavioural uncertainty does not strengthen consumer demands directly; instead, it functions as a catalyst to other dimensions that do support consumer demands. In simpler terms, formal contracts reduce behavioural uncertainty, making it more attractive to adopt pro-CE practices and products. This can be perceived in the connection with the asset specificity dimensions, as it connects to all of them.

Another relevant hub of driver-dimension is the **concern to public health**. Its connection with **formal contracts** as well **as uncertainties** can be explained by food safety concerns that affect food supply chains. The need to follow clear guidelines in production, distribution and redistribution of the wheat-base products drives the adoption of CE practices. These guidelines come not only from legislation but also clients and redistributors (e.g., food donation charities) in a formalised way, showing that these dimensions reinforce the driver of concern with public health.

The final important hub is the one related to **compliance to regulations**. **Environmental** and **behavioural uncertainties**, **formal contracts** and **verticalisation** are dimensions that reinforce CE adoption motivated by compliance to regulation. While following rules prescribed in written contracts and that aim at reducing environmental and behavioural uncertainty is clear cut and easily understood (they did not differ from previously discussed interactions), verticalisation is different. The connection relates to an organisation that develop certain operations in their structure, and those structures become responsible for CE practices. The example in the research comes from the Brazilian farmer cooperatives that, by selling agrichemicals (not the original objective of the cooperative) are now required by legislation to implement reverse logistics programs with the package of such products. Therefore, verticalisation reinforced the compliance to regulations driver to adopt CE practices.

### 6.5.3 Diffusion enablers and transaction dimensions

The final influencers of CE diffusion are the enablers. As with the barriers and the drivers, enablers also have three main hubs of connections with transaction dimensions (Figure 6.40). The enabler **partnerships and collaboration across the value chain** is the one with the most links, which was expected, given that it is the enabler most commonly identified in the data. It connected with 11 dimensions and has over 60% of all connections identified between enablers and transaction dimensions.

**Long term (repeated)** transactions and **formal contracts** are the two most robust interactions with partnerships, appearing multiple times throughout the research. **Informal partnerships** are also part of it, as organisations do not always formalise these types of relationships. The different forms of uncertainty also increase the need for partnerships as stable interaction amongst partners tends to be safer if changing operations and products. The integration of different links in the supply chain also facilitates the circularity of products as materials can be more easily transferred to other uses or transformations (e.g., recycling of bread).

Although the partnerships discussed in this thesis are mostly in the buyer-supplier dyads, some of the participants also discussed them in relation to partnerships with stakeholders (e.g., public research organisations). Previous works in the different schools of SCM (including CSC) had already described the importance of such partnerships for integrated supply chains (Seuring and Müller, 2008; Ashby *et al.*, 2012).

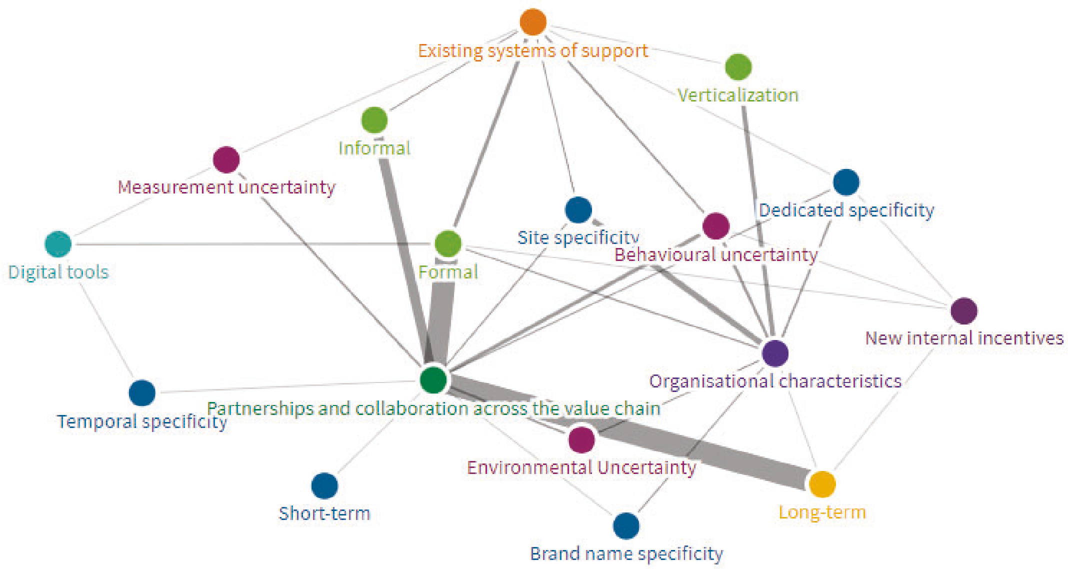



**Figure 6.40** Enablers to CE diffusion and transaction dimensions

**Organisational characteristics** are strengthened by **site specificity** and **verticalisation** (internal transactions). Site specificity, that is the transaction dimension that required investment in a particular place (e.g., grain silos near a mill) influences how an organisation sets its physical structures and therefore, operations. In other words, where an organisation or part of its operations are situated, influence their capacity to access tools that facilitate the adoption of CE practices, including supplier development, finance, etc. The verticalisation of organisations is also part of the organisation's characteristics and can influence how the wheat, its products and by-products flow. The actors that implemented their own feed mills have a dual source of income from wheat, not only from the flour but also its by-products and waste. Therefore, the flow of the circular materials is facilitated when done in-house.

Lastly, the **existing systems of support** around a supply chain (e.g., extension agencies, financing options, infrastructure, etc.) are influenced by the contractual relationships with the actors in the dyads, both **formally and informally**. This has overlap with the partnerships expressed previously but focusing outside of the supply chain. These aspects are also relevant to solve uncertainty issues, especially behavioural uncertainty, as they provide greater safety to invest in changes relating to sustainability (e.g., farm insurance).

Chapter summary: Chapter 6 presented the findings of the thesis, considering all research questions. The CE practices of both countries, as well as the material flow in the supply chains were discussed separately. The reduction of inputs and waste, the repurpose of materials as feed and the redistribution of grain and food were especially important and more clearly shown with the mapping of the material flow. A comparison of the CE practices of each case followed, showing that there are more similarities than differences between the countries. The diffusion influencers and the transaction characteristics followed, which provide the basis for an examination of the interactions between the two concepts in the final section of the chapter. Having presented the findings of the research as well as analysed in light of the literature reviewed (and research framework used), the seventh chapter discusses the findings of Chapter 6 with direct connection to the research questions and problem.

# 7. DISCUSSION

Chapter 7 presents the discussion of the data previously shown in Chapter 6, considering the research questions and literature reviewed. Each section of this chapter addresses one of the research questions (in order) with the final section addressing the research problem.

## 7.1 CE PRACTICES IN THE WHEAT FOOD SUPPLY CHAINS.

The thesis first research question was stated as follows:

| What are the main Circular Economy practices in wheat food supply chains in Brazil and the UK? |
| --- |

In order to answer the question, a set of CE practices was gathered from the literature and 17 different operations were listed and identified in semi-structured interviews with organisations from farm to market in both Brazil and the UK.

Sections 6.1.1 and 6.2.1 presented the CE practices being executed in the Brazilian and the UK´s supply chains, respectively. Appendices G (Brazil) and I (UK) show CE practices that the participants interviewed identified as being performed by their organisations. The findings demonstrate that all CE practices listed were identified in the wheat food supply chains (Table 7.1). Nevertheless, the operations are highly context-specific and there is considerable variation in terms of the understanding of the practices and forms of application. It is crucial, therefore, to discuss the implications of this.

**Table 7.1** CE practices identified in the UK´s and Brazilian wheat food supply chains

| **CE practices in wheat food supply chains** | | | |
| --- | --- | --- | --- |
| Reduction of inputs and/or reduction of waste | Recovery of products for disposal and/or recovery of materials for energy use | Identifying the correct prices for CE products | Environmental certifications |
| Reuse | Reclassify | Green purchasing | Marketing products to green customers |
| Recycle | Repurpose | Cooperating with other organisations to implement and use CE operations | |
| Redesign products, services and/or processes | Renewable energy use | New logistics systems | |
| Redistribute | Auditing for evaluation of CE operational performance | Staff and managers training | |

First, the different definitions of waste influence how the organisations tackle one of the central components of CE. The research focused on a particular type of waste: food waste, and the definition used here ('all food that is removed from the supply chain originally intended for, even if it is still edible"), was not necessarily the same as the one used by the participants. Korhonen *et al.* (2018a) anticipated the differences in definitions of waste as the authors argue that it is context-dependent, that is, it can vary from people, organisations and culture. According to those authors, the lack of clear definitions relating to CE reduces the possibilities of adopting CE practices.

Explicit questions about food waste led to several responses referring to lack of food waste or lack of control over food waste. Three reasons, not necessarily mutually exclusive, might explain this:

a) **Lack of engagement with the topic of food waste**. This is an unlikely option in the UK as there is considerable societal awareness and concern for food waste. However, Brazil has not developed food waste sensitivity to that extent, although it is gaining momentum. The lack of organisations in Brazil, such as both the UK´s charities interviewed reinforces this position.
b) **Fear of showing the organisation in a bad light**. The lack of participation by some of the organisations approached to participate in the research, especially the UK´s supermarkets, suggests this, compounded by some participants that explicitly said that they could not tell the amount.
c) **No food waste in their operations**. Previous literature (WRAP, 2013; Rocha *et al.*, 2017) suggests that the industries' part of the supply chain is not the issue for wheat-based food waste, as it is more concerning at farm and retail/consumer levels. This option makes sense when considering the low-profit margins of the product, thus leading the organisations to reduce any amount of waste and find different revenue streams from the product. Additionally, the wheat industry is one of the oldest in food processing, thus leading to enough time to find solutions and be as lean as possible.

Another finding that deserves exploration relates to wheat production and soya beans production. Crop rotation is a common practice for farmers, but the use of wheat residue (waste) as a component to improve soya bean production is underexplored in the CE literature. Although systems' boundaries are a vital element in the discussion of food waste and CE (Sorensen *et al.*, 2010; Korhonen *et al.,* 2018a), when discussing production systems in farming, especially those that use no-tillage, it is relevant to encompass the crops part of the rotation. In other words, if CE of food is being analysed, looking at only one crop might restrict the understanding of the circularity. According to Denardin *et al.* (2012), in sustainable farming, a systems approach must be used to encompass not only one crop but how that crop interacts with its environment and the rotation process.

The use of no-tillage systems that keeps the straw in the soil mimics nature's plant cycle. A broader perspective shows that wheat with no-tillage production reduces inputs in soya bean application, helps to structure the soil (especially significant for drought periods), reduces run-offs and water losses and increases organic matter. Therefore, it is relevant to consider wheat cultivated with no-tillage as a CE practice in food production. Ball *et al.* (2017) briefly mentions a similar proposal, albeit considering agroecology and not conventional production as is the case in the present research.

It is also relevant to the point that most participants directly connected to farming (i.e., farmers, extensionists, cooperatives) discussed soil health and fertility as a crucial component of sustainability. None of them, however, was necessarily operating with a pro-CE or pro-sustainability mindset that would differentiate them from their peers in the field (i.e., they are not atypical). Such considerations suggest that the topic of soil needs greater deliberation in agri-food CE literature (Gallaud and Laperche, 2016; Pagotto and Halog, 2016; De Angelis *et al.*, 2018). Current references are sparse and with a superficial knowledge of main-stream large-scale agriculture as they tend to propose complete changes in farming systems. It could be argued that 'adapting modern agriculture', one of the drivers identified by Govindan and Hasanagic (2018) already encompasses the issue of soil. Nevertheless, the eminence of soil in the interviews and the fact that soil protection and crop rotation are not new to farming and agriculture, suggests that highlighting soil sustainability might be a good strategy for improving agri-food CSCs.

Other sustainable farming systems also fall within the CE philosophy. Examples identified in the investigation include integrated crop-livestock production systems (wheat and cattle with dual-purpose wheat), genetic improvement (non-GMO) of seeds and the use of biofertilisers from sludge, composting and animal muck. All of these practices reduce input use, are regenerative and restorative and mirror nature. They are also widespread, used in small, medium and large-scale agriculture. Therefore, Pimbert (2015) is misguided in his assertion that for a CE-agriculture, a completely new model of production is needed. The predominant biological nature of farming already accounts for much.

Returning to the issue of definitions and CE practice, a few terms deserve further reflection. Reuse and redesign were two terms that had to be explained several times throughout the research, even with the glossary of terms supporting the participants. Ideally, terms and definitions should be self-explanatory. Still, the practice in both countries showed a different perspective between theory and practice as participants without prior knowledge of the topic of CE had some difficulty understanding some of the options and questions. Of those, interviewees that are closer to the industrialisation of materials had a greater and an easier understanding of the terms, reinforcing the position that CE theory originates primarily from technical rather than from the biological side (Vlajic *et al.*, 2018).

Additionally, reuse as a practice relating to farming can be controversial: while the farmers reuse seeds and that helps them reduce costs and be independent of seed suppliers, grain produced with reused seeds are less stable, potentially reducing yield, quality and resistance to pests. Therefore, CE-literature that recommends such practice should highlight the issue. The same is valid for the use of animal muck for fertiliser as the increase in Nitrogen levels beyond recommended levels act as a pollutant, especially close to water sources. This means that CE-food production practices need considerations that go beyond reusing materials to reduce waste as complex systems can be affected in different ways.

Reclassification and repurpose, as expressed in Chapter 6, are not necessarily different when it comes to wheat. The participants identified them almost indistinctively since traditionally, wheat with lower classes go to animal or industry (e.g., ethanol, glue, etc.). Such consideration mirrors the EPA Food Recovery Hierarchy, including the preferred destinations as wheat for food has a premium in comparison to other uses. It is possible to argue that the practical application of ‘R practices’ is more nuanced than the academic distinctions between the practices might suggest. Furthermore, when considering that some of the ‘R practices’ that exist on the broader CE literature (i.e., remanufacture, repair, refurbish) are not applicable to agri-food CSC; and that participants of the research had difficulty in understanding the terminology, it might be appropriate for the generation of new concepts and definitions of agri-food CSC that are separate from the technical concepts. To propose these new categories goes beyond the scope of the present research.

The use of renewable energy has considerable variation throughout the supply chains. The use of solar energy, while routine in operations with large areas (e.g., farming and hypermarkets), it is not ideal for milling sites. The reason is that the type of micro-particles that are not captured by filtering systems and can get lodged in solar panels, reducing their operational capacity. Wind generators are costly for most individual corporations, and water generation is dependent on environmental legislation and nearby water sources. Considering the average age of the organisations in this study (especially the mills), with industrial sites that were constructed before concerns for renewable energy, and that new sites need to be both close to input production & storage, and the end-consumer, it is a challenge do implement renewable energy production and use throughout the CSC. Such consideration echoes Batista *et al.* (2015a) argument of the complexity in studying agri-food CSC and how the actors' specific constraints might influence their capacity to operate in a CE-perspective.

De Angelis *et al.* (2018), in their analysis of the differences between traditional, sustainable supply chains and circular supply chains (Figure 2.8), argued that one of the fundamental differences relates to strategy. According to those authors, CSC employs leasing and service outcomes as strategies for CSC, while the other two have an ownership approach. Classic examples in the CE literature for such services include flight rather than aero engines, illumination rather than lightbulbs or transportation rather than cars (Batista *et al.*, 2017). It is assumed by this thesis that for food it would be nutrition rather than food. There are social and cultural aspects that preclude (i.e., people like food and like to choose what to eat); thus the discussion of the CE practices should centre around the tools and paths for food production and distribution rather than the food itself.

In the cases investigated here, two types of service over ownership were identified clearly, both relating to grain: storage and transportation. Arguably, renting an area of land could also be classified within such a practice. However, land ownership or renting does not increase or reduce the amount of land available for agriculture[36], thus escaping the scope of the discussion on the practice. In Chapter 2, the argument for the problems of contracting farming machinery centred around the risk that machinery could bring in terms of pests. However, the interviewed participants argue that the issue is availability at the right time, not necessarily transporting pests within the machinery.

---

[36] This is the case for wheat agriculture in the UK and Brazil. However, if areas of Russia and Africa were considered, this could be the case as these places are still expanding wheat production landwise. Although there is still farming expansion in Brazil, it does not contain wheat production.

Farming operations can only occur in specific windows of time (e.g., pesticide applications cannot happen if it is too hot, windy or when it is raining), thus farmers prefer to have their own machinery to avoid the risk of not accessing the service in time. For the Brazilian case, this is compounded by the need to plant soya beans; thus, any day that harvest is delayed can cause damage to the cash crop, leading farmers also to have their own lorries to speed the process of wheat delivery to silos and reduce the chance of sowing delay. The issues with said CE practice (service over ownership) in the wheat sector – and potentially other grain and pulse crops - does not exclude that the wheat food supply chains studied are circular supply chains (as the next section will explore further).

## 7.2 MATERIAL FLOW

The thesis second research question was stated as follows:

| |
|---|
| What are the material flows, including wastes and by-products, in a wheat food supply chain in Brazil and the UK? |

In order to answer the research question, it was necessary to identify buyers and suppliers through primary (interviews) and secondary data (documents, websites and reports) data sources. It included main products like flour, biscuits, pasta and bread, and also residues, by-products and waste. To answer the research question, a map of the material flow was constructed that included both the linear and circular supply chains' perspective. Figure 7.1 shows the mapped material flow of both supply chains, thus achieving the second research objective. Figure 7.1 is a composition of Figures 6.11 and 6.29 to facilitate the discussion of the current section. Black arrows show the forward (linear) flow of the material while orange arrows show the circular loops. Open and closed loops are both represented, as well as the start of the flow (production or imports) and the end (incineration, end-consumer or exports).

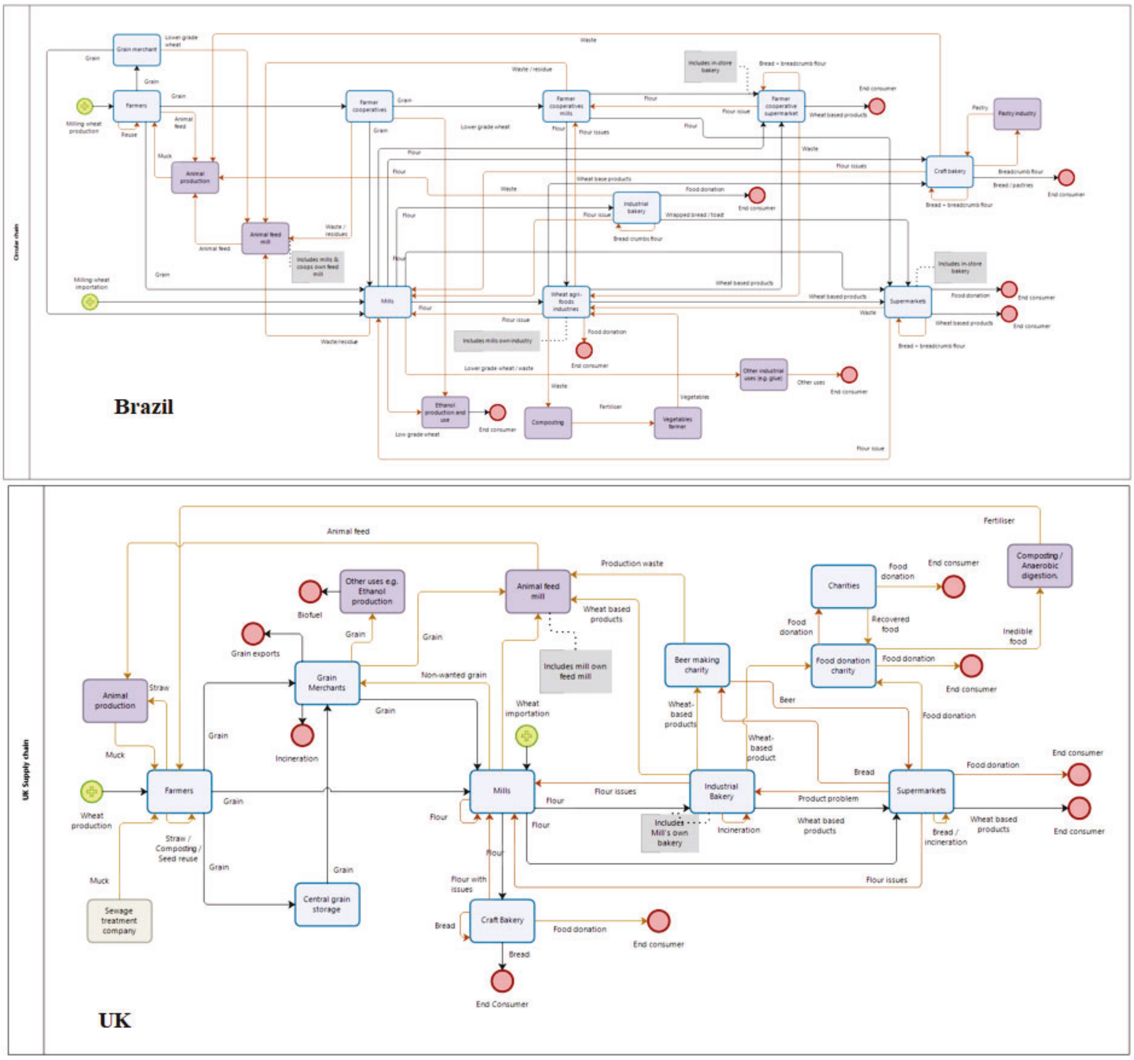



**Figure 7.1** Material flows, including wastes and by-products, in a wheat food supply chain in Brazil and the UK.

Imported grain - directly supplying the mills - is connected in both countries to reaching specifications for different flour production. Exported grain, on the other hand, redistributes wheat that is not within local market requirements, either by quality or price.

It is crucial to consider the significant complexity of CSC, especially when compared with the linear perspective (Figures 6.10 and 6.28). This increased complexity is created by the inclusion of different organisations, processes and loops as pointed out by Batista *et al.* (2018a). It is also possible to note that the schematic model discussed by Vlajic *et al.* (2018) (Figure 2.10) to represent CSCs is an accurate representation of wheat food supply chains if 'remanufacture' is considered as encompassing reclassify and repurpose. There is an increase in the number of loops, as predicted by CE theory with the circular perspective, pointing to materials circling longer and with more significant value capture between production and end of life of the products.

The flow of wheat and wheat-based materials support Vlajic *et al.* (2018) in their argument that monetary value is not the only factor of the decision to determine the destination of those products. If the economic value was the only influencer, donation of food (redistribution) would not be identified; instead, any surplus would go to somewhere with a financial return, such as animal feed. Food surplus redistribution not only has no monetary payment, but it can also incur costs to the donor. Similarly, support for local communities are also part of the decision, considering support of local farmers or preference for local bakery or flour mill. These are examples of other values (beyond financial) that Vlajic *et al.* (2018) described in their work, and that differentiate closed loops supply chains from CSC that encompass open loops as well.

The material flow is influenced by the structure of the CSC, including internal transactions and diversifications/verticalisation of activities by the actors in the chain. If financial value is not the only relevant form of value when an organisation decides to design a CSC, a consideration of the supply chain structure is vital, including the different levels of verticalisation within it. For instance, the Brazilian supply chain has several cooperatives that have multiple roles in the flow of wheat, including its waste and by-products. The cooperatives cannot merely refuse the purchase of the farmers that are its members, thus influencing the material flow. The internal transactions of wheat to supply the cooperatives' mills (food and feed) affect the supply and demand of other actors, thus increasing the complexity significantly when compared with the UK´s supply chain. All of these considerations, in turn, increase the complexity of the CSC, leading to an increase in transaction costs, discussed later in this chapter.

The recovery of products, although present in the map, needs closer examination than other forms of CE practices in relation to material flow. Considering the logistics cost and the low-profit margin - large quantities of product are required for the activity to be profitable - further reducing the chance that recovery operations will occur. To put it plainly, wheat-based products are not commonly recovered since it is too expensive, especially for imports. Vlajic *et al.* (2018) anticipated this issue when discussing fresh food, and in this sense, long and short food supply chains are similar. Recovery happens when the supplier is clearly at fault (and sometimes not even then), when there is a need for further investigation of the problem, or when there are large cargos. For imported and exported products, the chance for recovery is lower still.

Batista *et al.* (2018a) argue that open loops need to be considered in CSC as materials can flow back to the original supply chain or can also cascade into other supply chains.

Such a perspective was identified in the present thesis, with wheat materials being used as raw materials for animal feed, industrial feed, beer production, composting, among others. If open loops are not considered in the discussion of CE, considerations of waste would be incomplete, as there is a clear and valuable destination for those materials. In that sense, animal feed mills are a crucial component of CSC of wheat food, as most organisations will send wheat-based resources (e.g., husks, bran, surplus bread, among others) to be converted into feed. Animal supply chains constitute, in that sense, a fundamental part of wheat food supply chains if a systemic view of CSC is taken. Not only that, but muck from animals improve wheat production back, those showing that even within an open-loop supply chain, there is a return to the original supply chain.

The very nature of some of the organisations' role in the supply chain is connected to facilitating the loops. Both the UK´s charities (brewery and food donation) and the traders facilitate the movement of materials and their use to the highest value possible. Grain-merchants (and cooperative that trade grain) function as hubs that affect what type of loop the material will go through, whether it is staying in stock until conditions improve, a less demanding flour mill, a feed mill, glue or ethanol production or a different country.

Two final points need to be addressed in relation to material flow. The first one is relative to scale, one of the differences identified by De Angelis *et al.* (2018) between CSC, traditional and sustainable supply chains. According to those authors, a CSC operates with medium-low volumes of materials. This is not necessarily the case as the present study demonstrated. Large-scale operations and transactions are possible within the CE context. However, the above-mentioned authors are correct if only the special programs described in the thesis are considered. The special programs identified (i.e., no-liquid Nitrogen, traceable wheat grain) are in fact medium-low volumes and have a higher number of CE-practices attached to them (especially reduction of inputs). The second point relates to the three levels of materials and practices implementation in a CE, discussed by Masi *et al.* (2018). The maps presented in Figure 7.1 have representations of micro (intra-organisational and CE practices), meso (different industries) and macro (imports/exports with other regions) levels. Even though the present work did not have a focal company, the identification of these levels' vis a vis Masi *et al.* (2018) work, reinforces that the material flow mapped here are in conformity with the current CE-literature.

## 7.3 SIMILARITIES AND DIFFERENCES BETWEEN CASES

The third research question was:

| What are the similarities and differences of the Circular Economy practices between the wheat food supply chain in Brazil and the UK? |
| --- |

In order to answer the research question, each of the described practices of Sections 6.1.1 and 6.2.1 was compared and Tables 7.2 and 7.3 below summarise those similarities and differences.

**Table 7.2** Similarities between CE practices of the cases - summary

| CE practice | Similarity |
| --- | --- |
| Reduction of inputs | It is viewed as necessary. Includes soil health & fertility concerns. Special programs help foster it. |
| Reuse | Similar in both countries as the product is also similar. Issues with terminology identified in both supply chains. |
| Recycle | Occur in both supply chains, but composting plays a larger role in the UK. |
| Redesign | It is aimed at efficiency. Organisations in both had issues with the term. |
| Redistribute | Similar in the context of grain and by-products of milling. |
| Recovery | It is limited in both countries. The product reduces the capacity of it. |
| Reclassify | Similar in both grain trade and bread at the retail level. |
| Repurpose | Wheat uses other than food are similar but varied in volume. |
| Auditing of CE performance | Practised by the larger organisations |
| Correct prices for CE products | Prices are driven by the market, not by policies for sustainability |
| Green purchasing | The priority is cost, not environmentally better options. |
| Cooperating for CE operation | Common throughout the supply chain and includes other stakeholders. |
| New logistics systems | Limited by costs, volume and need for the freshness of end-product. |
| Staff and managers training | Greater focus on food and workers safety, less so on environmental sustainability. |
| Environmental certifications | More common in the larger organisations than in the smaller ones. |
| Marketing to green customers | Only in niche programs. |

**Table 7.3** Differences between CE practices of the cases - summary

| CE practice | Differences |
|---|---|
| Reduction of waste | The UK has greater institutional concern and infrastructure to deal with food waste, including legislation, non-profits, partnerships, etc. Brazil interprets waste more as financial loss. |
| Reduction of inputs | Farming: limited by production systems & edaphoclimatic differences. Support from outside the supply chain is different. |
| Recycle | Market/cultural choices influence form of recycling and consumption. |
| Redistribute | Redistribution of food in the UK is more structured than in Brazil. |
| Renewable energy | More common and cheaper in the UK. |
| Auditing of CE performance | Large supermarket chains demand better control from the supply chains. |
| Green purchasing | More common in the UK, especially given supermarkets' requirements. |
| Cooperating for CE operation | In the UK cooperation does not require governmental participation. |
| New logistics systems | Storage and transportation - influenced by social consumption patterns. |
| Staff and managers training | More structured in the UK, including more environmental aspects. |
| Environmental certifications | Greater in the UK, especially considering assurance schemes for farmers. |

In essence, there are more similarities than differences in the CE operations of the UK´s and Brazilian wheat food supply chain, particularly within the larger organisations.

The similarities between the practices are primarily connected to the similarity of the products, especially considering the grain, types of flour, pasta, biscuits, types of waste and by-products of the industrialisation process. This means that the flow of the materials, as described, have similar destinations, including the use in feed. The differences, on the other hand, deserve further discussion.

The overall pro-sustainability societal concern is more established in the UK than in Brazil, considering governmental policies, business strategy & operations and consumer requirements. There are multiple indications of that, such as policies for waste reduction, market standards (e.g., assurance requirements), access to training and finance for pro-sustainability practices and online reports and statements. The fact that some interviewees in the UK knew about CE and none of the Brazilians did, also support that particular point. Discussion on food waste is newer[37] in Brazil, with many of the participants still not as aware of the topic or even the definitions of waste in a food context. One reason

[37] During the writing of this chapter, new legislation was passed in Brazil to tackle food waste, especially considering legal protection for food donors. The legislations were not active during data collection or analysis and thus was not discussed in this thesis.

for that might be the stage in the development of each country, with Brazil lacking resources (human, financial, governmental, etc.) to the same extent than are available in the UK to develop in the same speed the topic of sustainability, or more precisely, CE.

Farming production systems are varied between both countries, especially considering crop rotation (and cash crop), season length, forms of soil management, available support, among others. This leads to different approaches on how to tackle more pro-CE farming and food supply. The various supporting structures connected to agri-food supply chains also influence the countries differently. Brazil relies more on governmental support (e.g., extension agencies, research and development, insurance and crop financing) not connected with direct payment as is the case for the UK. Brazil also has larger cooperatives that have a more varied role in the supply chain. The UK, on the other hand, has the agriculture board, direct subsidies to farmers (that now include environmental services requirements), assurance schemes and are more integrated from farm to market. These aspects must be considered when comparing how each country tackle the implementation of CE in food.

The difference in the recycling of food, more specifically recycling of bread is also relevant to consider. Most Brazilian consumption of bread is of French rolls, and the surplus produced and sold by supermarkets and bakeries is toasted and grazed to become breadcrumb flour, used in day to day pastries. Brazilians also buy their bread daily in bakeries, with specific counting of units, which reduces home waste and surplus production (Brum and Muller, 2008; Morioka and Carvalho, 2016). In the UK, the bread consumed is mostly loaves, purchased from supermarkets (Smith and Barling, 2014; Shewry and Hey, 2015). Recycling of bread is less widespread, although it was identified in the production of beer and as composting (less desirable according to the EPA hierarchy). This means that the type of food consumption, which is influenced by culture, also affects the forms of recycling available for organisations part of agri-food CSC. Furthermore, consumption also influences how the product is stored and distributed, as craft bakeries (the primary source of wheat-consumption for Brazil) lack the reception and storage capacity to receive bulk orders like the UK.

The UK has better-structured redistribution of food surplus while in Brazil redistribution of food is not as organised, with supply chain actors afraid to donate and incur problems. Food distribution charities in the UK absorb that risk and reduce it with the implementation of clear protocols and control, thus reducing the uncertainty that other actors might face in donating food. Similarly, the use of renewable energy is also less pronounced in Brazil. However, the energy matrix of the country is cleaner (The World Bank, 2015), which leads to the question of the importance of developing renewable energy use in agri-food CSC in countries that already use most of its energy (> 70%) from renewable and clean sources.

Supermarket chains play a larger role in the UK than in Brazil. The small number of large players have a greater capacity to influence and audit suppliers, require certification and more donation of surplus production, with stricter contracts and penalties that affect direct (tier 1) and indirect (tier 2 and further) suppliers. In summary, the differences in the CE practices of the supply chains are generated by basically three factors: i) size and the number of the organisations participating in the chain (larger organisations have structures in place to be more circular and require it from its partners); ii) overall societal concern for sustainability (especially waste); iii) market preferences for specific products (e.g., bread roll vs bread loaf).

Previous literature on CE implementation has been diverse on the considerations of country-specific contexts that influence the adoption of CE (The Ellen MacArthur Foundation, 2015a; D'Amato *et al.*, 2017; Mangla *et al.*, 2018). However, there is less of a focus on culture-specific definitions and consumption patterns that can influence not only CE adoption but also the CE practice itself. In this thesis, the clearest examples of that are the uses of surplus bread, where in the UK with a strong culture of craft beers, recycles its loaves into beer, while in Brazil, with a pastry tradition that uses breadcrumb flour, recycles surplus French-type bread rolls as an input for said pastries. Therefore, even considering 'bread' as a single type of food, the different types of bread preferred in each country influence the type of CE-product made from its surplus.

## 7.4 TRANSACTION DIMENSIONS

The fourth research question was stated as follows:

| |
|---|
| What are the characteristics of the transactions between the organisations that are part of the wheat food supply chains investigated? |

In order to answer the research question, the three main dimensions of transactions (and their subcategories) – asset specificity, frequency, and uncertainty, plus type of contract, where identified and described in the transactions of the buyer-supplier dyads that form the cases. They are discussed in Section 6.4.2. The research question can be answered as follow: The main characteristics of the transactions are low asset specificity, varying levels of contract formality & verticalisation, long-term (repeated) transactions, and mid-high uncertainty. Such characteristics varied in neither linear nor CSC perspectives.

'Low asset specificity' was identified as a main dimension of transaction in the study, although the data analysis identified different forms of asset specificity. This may seem contradictory, but the reason is connected to the word 'specificity'. Most investments that related to the transactions in the supply chain are not necessarily specific to the dyad. In other words, those assets can, most of the time, be deployed to other transactions without significant loss in value (Williamson, 1998; Davies and Lam, 2001). The more prominent exceptions to that are special programs contracts, that require different levels of investments for training, segregation of materials, premium payments, etc. However, most products commercialised in the chains are subject to market conditions as any other, including the materials in the circular loops. These considerations are in line with previous works with transaction dimensions and CE such as Maaß and Grundmann (2018) and overall TCE and agri-food supply chains (Wever, 2012; Man *et al.*, 2017).

Frequency and type of contracts can be looked at simultaneously. Most dyads have long-term (repeated) commercial relationships with their counterpart, but most arrangements are discussed yearly (or even less). This means that although the informal commercial relationships have longer timespans, the formal transactions are shorter and such considerations are greater in the transactions with more frequent use of spot-transactions (e.g., grain sales or flour purchases from craft bakeries). Considering that the more extended supply contracts (e.g., flour for industries or food donation) are also present in the research, this means that overall, the transactions are repeated, but with varying degrees of formality. Hybrid types of contracts that facilitate the coordination but allow flexibility for adaptations to changes when needed are good options for deals with high uncertainty (Lahti *et al.*, 2018; Maaß and Grundmann, 2018; Carvalho *et al.*, 2018), which is the primary dimension of the transactions in the CSCs investigated.

Lahti *et al.* (2018) identify the capacity to adapt in collaboration with the counterpart of the dyad as crucial to respond to growing sustainability concerns, including excess food waste. In a similar fashion, Carvalho *et al.* (2018) described the importance of having well-developed written contracts and long-term relationships with trust amongst partners to fight food waste. The authors add that high-power imbalance can also act as a catalyst to food waste in a supply chain, given that some actors cannot force their counterpart in changing their practices to be more circular. This was identified in the case for the craft bakeries in both countries, that despite having a good and long relationship with their flour suppliers, they lack the negotiation capabilities to request for meaningful changes if they want.

Uncertainty is the most relevant dimension in both cases, albeit it is higher in Brazil. As the theory indicates, uncertainty has three distinctive forms; measurement, environmental and behavioural (Shin, 2003). Measurements of waste, of wheat quality and of food safety, are part of the issues connected to decisions within both supply chains. Behavioural uncertainty affects several levels of the cases, including the development of auditing processes and assurance requirements. In that sense, the UK´s supply chain displays a greater level of protection that has developed over the years, especially after issues such as mad-cow disease and horse meat in the supply chain (Abramson, 2004; Mol and Oosterveer, 2015). In other words, historically, the UK´s food industry has had to adjust to fight potential opportunistic threats and adapt to strict European Union legislation on the topic.

The UK wheat food supply chain is also facing an increase in environmental uncertainty that goes beyond more sustainable products, as changes in the institutional environment are affecting their capacity to participate in new transactions and the creation of better contracts of purchase and sales. With Brexit and environmental legislations changing, the food industry faces uncertainty in several forms. Nevertheless, the product is still stable and the consumption more certain than in Brazil, since economic uncertainties are lower, wheat is more reliable in the UK and supply contracts tend to be more well defined.

In the last few years, a push for more pro-sustainability foodstuff has created new pressures within agri-food supply chains that affect how the dyads transact, in a bullwhip effect that requires adaptations from the different actors upstream of the suppliers. For instance, if supermarkets require a reduction of inputs in their own-label pasta, all upstream links in the chain need to adapt to this new variable in the negotiations. Such considerations support Lahti *et al.* (2018)'s reflection on the changes that are occurring in supply changes given pro-sustainability concerns, and also Wever *et al.* (2012) model of how Tier 2 suppliers are affected by changes in Tier 1 suppliers-buyers transactions.

Finally, it needs to be pointed out that no influence of import or export of wheat grain was identified as a difference in how the organisations work. Initially, it was expected that the UK being a net exporter of wheat and Brazil a net importer, could influence the perspectives and transaction dimensions in the CSCs. However, this was not the case, as no significant difference in that regard was commented on as being an issue for the participants. It is assumed that since wheat grain is traded as a commodity in the international market, and that the organisations that operate with the product have structures in place to coordinate imports or exports without issues, that the participants do not notice differences in the supply or demand of the material considering the international market. It is just part of normal operations.

## 7.5 DIFFUSION INFLUENCERS AND TRANSACTION DIMENSIONS

The fifth research question was stated as follows:

| How the characteristics of the transactions between the organisations of the supply chains studied interact with the Circular Economy diffusion influencers? |
|---|

In order to answer the research question, two sets of operational concepts had to be linked: the Diffusion Influencers (Section 6.4.1) and Transaction Dimensions (Section 6.4.2). Three network maps of the connections between influencers and dimensions were created and presented in Section 6.5. Figure 7.2 illustrates how the characteristics of the transactions interact with the CE diffusion influencers. The Figure was created as a composite of Figures 6.38 to 6.40 and is explored further below.

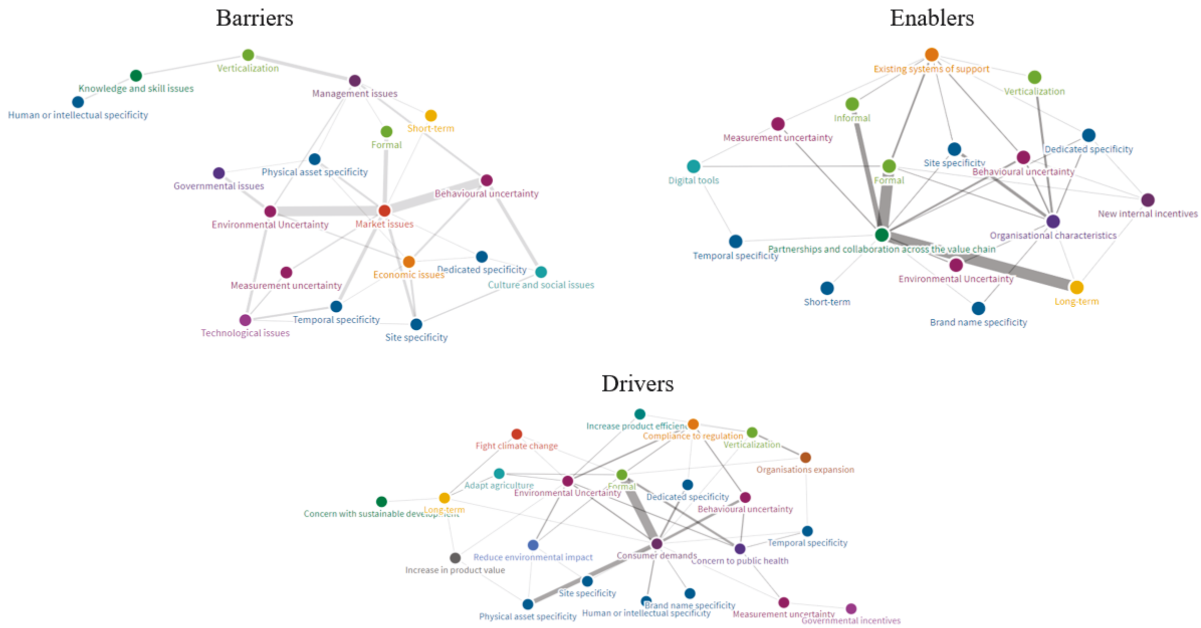



**Figure 7.2** Map of interactions between CE diffusion influencers and transaction dimensions

Figure 7.2 shows that at least one barrier, one driver and one enabler have both a greater number of connections with different dimensions (a hub) and also a stronger link between it and a few dimensions. However, it is also possible to note that there are multiple simultaneous interactions between the different categories of influences and the various dimensions, thus creating a web of potential roles. In that sense, it is valid to explore some of the more significant aspects identified *vis a vis* the current literature on transactions and CE. It needs to be highlighted once more, that the literature does not explore how the transaction dimensions influence CE diffusion; instead, it focuses on the transactions already in place in CE arrangements.

### 7.5.1 Barriers and Transaction dimensions

The three main barriers concerning transactions are market, management and economic issues. In a supply chain with transactions that have high uncertainty, the links between the barrier Market Issues and Environmental and Behavioural Uncertainty (most robust links for the barriers), make sense. The main problem is that wheat sustainability is not a concern for most clients. A concrete example of that can be provided: if a mill is not certain that the grain-merchants will be able to provide wheat within the specifications of their flour because of environmental reasons (e.g., too much rain), it is unlikely that they will initiate a reduction of additives (CE practice – reduction of inputs) for their products unless specific contractual agreements with their clients are provided as a guarantee (Maaß and Grundmann, 2018). Examples of this were identified both in the UK (with the special program from the industrial bakery) and in Brazil (with the mill from the cooperative). Both cases implement unique purchasing systems to avoid such issues. At the same time, they have not compromised their entire purchase-production systems, as they still require flexibility to adapt to unexpected changes that could compromise their supply of products, thus keeping multiple channels open for their supply. In a market that is not requiring more circular wheat-based products, inertia leads to difficulty in adopting new practices.

In a similar vein, the verticalisation of an organisation is linked with management issues. Organisations that are highly-risk averse face difficulty in changing their operations for more pro-CE products as their priorities and goals are not connected to CE necessarily. As Whiteside and Dani (2020) point out, different organisational culture attributes can influence differently how an institution can tackle issues such as supply disruption or purchasing requirements. According to Williamson (2008) organisations that have a decision structure that is too complex (e.g., large cooperatives) and with many divisions participating in decision-making, have high internal transactional costs. These organisations might prefer not to adopt any new form of pro-CE practice since paying those high costs can be too expensive to justify changing current operations. The interviewed cooperatives, as well as some of the larger corporations' in the research, experience similar problems. Economic issues are affected by both uncertainty and different types of asset specificity – site, physical, dedicated and temporal specificity. In simple terms, it is not easy for an organisation to invest in CE transaction-specific locations, products, structures or time-constrained arrangements, within a market that is low-profit margin, highly competitive and uncertain in both the behaviour of the actors and the environment itself.

### 7.5.2 Drivers and Transaction dimensions

For drivers, consumer demands, concern to public health and compliance to regulation are the three most important influencers. Consumer demands are positively affected by formal contracts that require specific investments in physical and dedicated assets. This was expected. In a supply-buyer dyad that, through negotiation, included a formal agreement with requirements for particular products and equipment, it is much more likely that they will initiate more pro-CE practices. The need for formal contracts is compounded in transactions with high uncertainty as stated. However, the capacity to create good arrangements is paramount to that (Lahti *et al.*, 2018; Maaß and Grundmann, 2018).

Additionally, paying a premium for products that fall within the CE-spectrum will drive the adoption of said practices, considering that they are needed to balance the specificity of a transaction. In other words: including in a contract, the requirements for CE-practices and paying a premium for it, will reduce uncertainty and increase the motivation for the adoption of CE practices. In this sense, although other forms of value (Vlajic *et al.*, 2018) do appear in the supply chain and the decision to operate in a CE-operation mindset (for example, donating bread for producing beer), a more important motivator is the requirement of a client and additional financial incentives.

Undoubtedly consumer demands for CE-practices have been significantly investigated in CE literature as several works have shown (Mangla *et al.*, 2018; Govindan and

Hasanagic, 2018; Kirchherr *et al.*, 2018). Furthermore, there is a clear link between client requirements and the very definition of CE, when considering the terms “by intention and design” that are a part of many CE definitions (Kirchherr *et al.*, 2017). However, the present research has shown that it is possible to have CSC and CE practices without knowing the topic of CE. The Brazilian supply chain is significant here, as it is clearly a circular chain (Figure 7.1). This apparent paradox is resolved when considering the desire for more CE or pro-CE operations/products. In other words, although a chain can be formed without previous CE intention, it is more likely that the participants will develop a CSC if there is an intention in the requirements of it.

The other two drivers previously mentioned – the concern to public health and following regulations - act in the same way. The need to keep food and workers safety and to adhere to regulations is critical in the transactions within the wheat food supply chains and are integral to the commercialisation of wheat and wheat-based products. This includes the products within the loops, as shown by the concerns related to food redistribution, the repurpose of grain or the reuse of materials. These practices (loops) were not executed with CE-philosophy in mind, and many of the operations predate CE (Section 2.1.1) by a considerable margin. They still are, however, within the CE-framework and do operate in the mindset of decision-makers on how they do transactions.

### 7.5.3 Enablers and Transaction dimensions

In relation to enablers, some of the interactions identified are also logical at first glance, especially the enabler ‘partnerships and collaboration across the value chain’ and its connection with formal and informal long-term (repeated) transactions. In other words, it makes sense that transactions that have repetition and several years of duration, facilitate the adoption of CE practices. The reason for this was described in the two previous sections, considering that such relationships reduce uncertainty, thus promoting the investment in specific assets for a transaction. Formality, although having a more robust connection, is not necessarily required. Previous TCE literature (Adams and Goldsmith, 1999; Gërdoçi *et al.*, 2016) addressed this: trust and the risk of jeopardising future transactions will create the space for informal transactions and relationships to develop over time.

An organisation’s part of a buyer-supplier dyad is heavily influenced by its own characteristics (enabler ‘organisational characteristic’) that include how vertical it is and where its operations are (site specificity). The latter point is critical, given the above discussion of partnerships. Investment in specific sites to comply with requirements of a particular transaction influences and is influenced by the organisation characteristics such as level of verticalisation, type of service/product, liquidity, risk-aversion, among others. As Maaß and Grundmann (2018) discuss, better forms of contracting are needed to avoid the need for verticalisation, especially in transaction-specific investments, including those connected to CE. Concrete examples of this are the supermarket in-store bakeries, especially the one from the Brazilian cooperative interviewed. These operations need investments and partnerships with the flour supplier for reception and storage and even training provided by the flour mill that supplies it, thus allowing a reduction of waste and inputs (CE practices) in their operations.

The final point to be made in relation to the fifth research question is connected to the enabler ‘existing systems of support’. It was identified that it has many links with formal contracts and behavioural uncertainty. The capacity to access support (e.g., Research and Development, training institutions, financing, etc.), is made easier with formal ties, as organisations will be obliged to help. This leads to a reduction in behavioural uncertainty, both in the interaction with the supporting system itself, but also with the partner in the dyad, as the perceived uncertainty (or risk, in some cases) is lessened when support is present. Support also relates to the capacity to access and create good contractual instruments, as buying-supplying agreements with too much complexity increases uncertainty (Lahti *et al.*, 2018).

## 7.6 FROM RESEARCH QUESTIONS TO REVISITED FRAMEWORK

Having answered the five research questions (sections 7.1 to 7.5), it is now suitable to recap the path (flow) taken so far, thus allowing us to address the problem statement (section 7.7). The first step to that end consists of reviewing the two-part approach undertaken to formulate said research questions, followed by revising the methodology applied and revisiting the research framework used.

Figure 7.3 revisits the research framework[38], previously presented in Chapter 4. To reiterate, it is possible to identify that there are four sections: main theory (CE),

[38] Figure 4.3 shows a larger version of the framework.

supporting theory (TCE), operational concepts (OC) that derived from both approaches, and finally, field of application (FA), that is, the supply chains investigated.

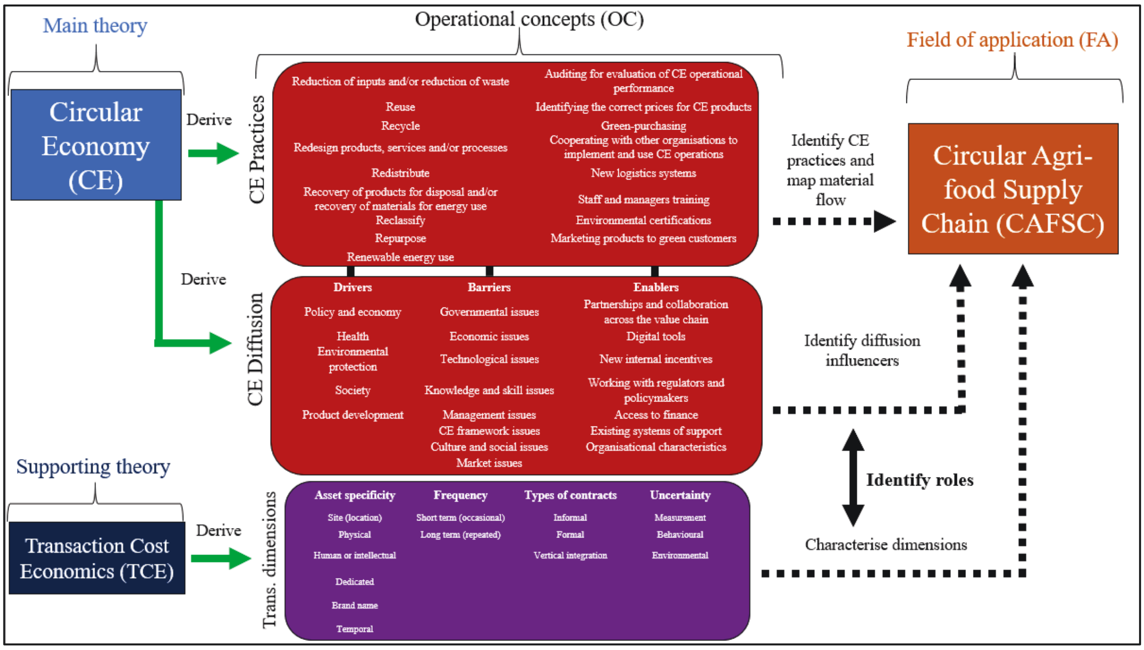



**Figure 7.3** Revisiting the research framework

The dotted black arrows are connected to the research questions, while the black double-ended arrow relates to the research problem itself. The first three research questions addressed the application of CE in an underexplored topic of CE: wheat. Even though wheat is a crucial type of food worldwide, thus with a considerable impact if its sustainability is improved, CE scholars have not sufficiently addressed these materials before the present work.

Two wheat food supply chains, one in Brazil and one in the UK were chosen to that end, thus clarifying how CE is present in said chains and how these materials flow from a CSC perspective. Additionally, it compared the CE practices in both countries, as local applications can differ in many ways.

The last two research questions – the characterisation of transaction dimensions in wheat food supply chains and the connection between said dimensions and CE diffusion influencers - were also answered. These questions originated from a gap in the literature relating to the lack of previous works on the connection between transactions dimensions and CE diffusion/adoption processes. Even though there is ample work on the role of relationships in the diffusion/adoption of CE practices in supply chains, with theories such as network theory and stakeholder theory, TCE has not been addressed to the same extent prior to this work.

With the research gaps identified, it was necessary to determine the best methodology to address the research problem. A qualitative approach was chosen, specifically, a comparative dual-case study. The reason for choosing as such relates to the interpretative nature of the study as well as its exploratory-descriptive characteristics since it allowed the inclusion of different perspectives in the investigation, with greater depth of the phenomena explored – the roles that transaction dimensions can have in the diffusion of CE practices.

Figure 7.4 graphically summarises the process described: the green dotted arrows represent the flow from the main theory to the research questions, methodology and field of application. The blue arrows represent where the research questions are connected in the original framework.

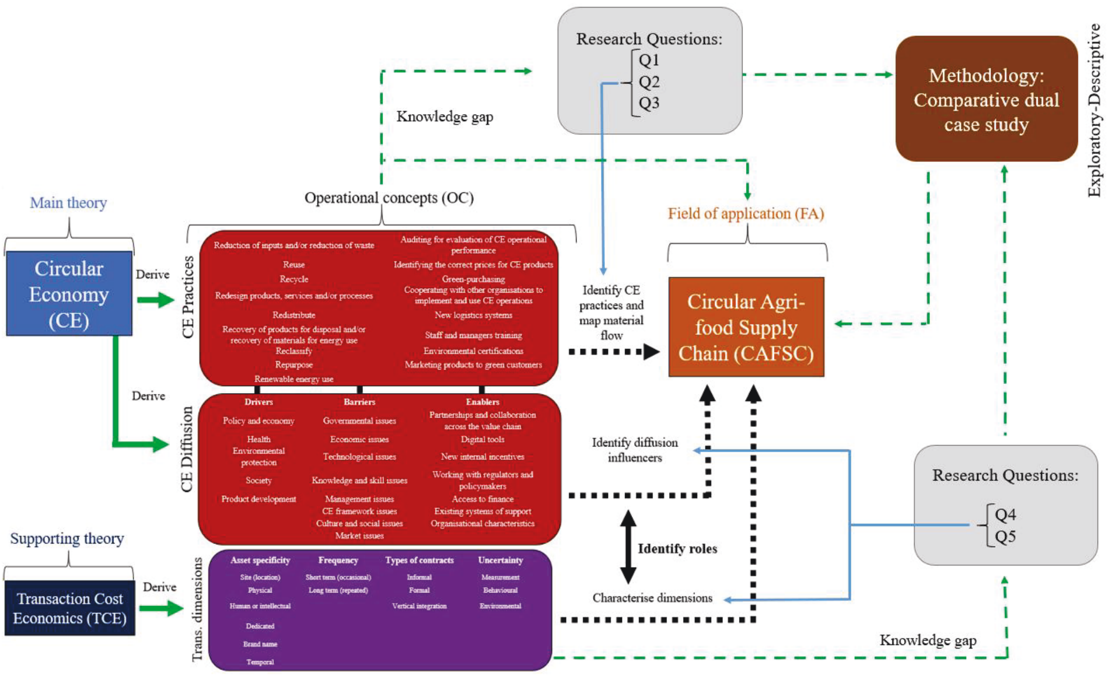



**Figure 7.4** Flow from theory to methodology and research questions

Considering such flow and with the answers to the research questions (sections 7.1 to 7.5), it is now viable to directly address the research problem (section 7.7) and to update the framework (section 7.8) with the findings from this thesis.

## 7.7 ADDRESSING THE RESEARCH PROBLEM

The research problem was stated as follows:

| |
|---|
| Problem statement: CE literature has shown that there are many influencers – driver, barriers and enablers – in the adoption/diffusion of CE practices within a supply chain, including the relationships between actors. However, the ways in which transaction dimensions in buyer-supplier dyads affect the diffusion influencers in wheat food supply chains is a phenomenon still requiring further study and understanding. |

In order to address the research problem, five research questions were answered and discussed (Sections 7.1 – 7.5). Three propositions are put forward as a result of those and address the research problem as follows:

- Proposition 1: High uncertainty in transactions will increase barriers for diffusion.
- Proposition 2: Asset specificity and formal contracts help drive the diffusion of CE practices; however, asset specificity is also influenced by demands for CE (reverse role).
- Proposition 3: Long-term relationships (both formal and informal) facilitates the diffusion of CE practices. These influences are fluid, however, as negotiations might change the intensity of each dimension.

At first glance, these propositions seem simple and obvious, but there is a considerable amount of nuances that deserve further discussion. Many factors can hinder the adoption of CE practices by a single organisation (or diffusion within a supply chain) as the abundant literature on CE barriers have explored (Kirchherr *et al.*, 2017; Mangla *et al.*, 2018; Jesus and Mendonça, 2018; Govindan and Hasanagic, 2018). However, the present investigation identified that this is particularly true in markets with higher levels of uncertainty (as is the case for wheat food supply chains, especially in Brazil). The actors in the chain will avoid committing to change in favour of CE, even if those changes show some economic, social or environmental value.

The wheat food industry is still not as developed as other industries in relation to sustainability and end-consumer demands for sustainability. Comparisons can be made with the meat or the fresh produce industry, where those supply chains are demanded much more strictly than cake, pasta, biscuits or bread industry. Not only that, consumer preferences in wheat-based product favour standardisation for industrial goods (e.g., same flour to make the same biscuit that will fit in the same package) and freshness for bakery and pastry goods. These preferences tend to foster surplus production and require more inputs and continuous transport of goods, all elements that go against CE philosophy.

On the other hand, asset-specific investments help drive the diffusion of CE practices, but this happens indirectly through requirements in contracts as it helps reduce uncertainty. Asset specificity usually will require paying a premium for the product that complies to the needs of the buyer (Batalha, 2001; Magnan, 2011; Kassie *et al.*, 2017; Carillo *et al.*, 2017). However, in some instances, it is not a matter of paying a premium, rather, it is a matter of continuing doing business with the partner, especially if the buyer is a large corporation that presents asymmetric power in a negotiation. In other words, asset specificity has a double direction - it can support the drive to the diffusion of CE practices when accompanied by premium payment and other forms of guarantees/advantages to the seller, or it can be driven by CE diffusion when the buyer demands pro-CE changes.

For enablers, long-term (repeated) relationships, both formal and informal, facilitate the diffusion of CE in the supply chains. Such interactions within the supply chain reduce the level of uncertainty in the transactions, thus creating a better organisation context to change and adopt CE. The other enablers are also connected with the reduction of uncertainty, especially the access to supporting systems in and around the supply chain. These elements also reduce transaction costs as they can facilitate learning, forms of contracts, clear regulatory issues, among others. Therefore, the capacity to dampen the uncertainty is critical to facilitate the diffusion of CE. Additionally, transaction-specific pro-CE investments also have reduced risk considering that trust constructed through long-term relationships minimises the chance of opportunism by the players in the dyad. In other words, robust and long-term connection eases (enables) the diffusion of CE practices, preferably with formal contracts.

There is fluidity in how the dimensions interact with the diffusion influencers, meaning that they can change over time during negotiations. For instance, the level of uncertainty can affect the adoption of a new CE practice depending on the guarantees that the actors in the dyads can infuse in the transaction. Nevertheless, contractual negotiations cannot have too much power imbalance, as one of the players can simply refuse, force the counterpart, or use standardised agreements that ignore negotiations. It is not possible, therefore, to change the roles and influences in all transactions.

One final point to be made relates to flexibility. The capacity to change and adapt to changes (primarily environmental) is a crucial part of the transactions and the decisions to adopt practices. This is illustrated by the different channels of commercialisation that farmers use or by the various sources of wheat that mills use. Too much constrain in a trade (e.g., too high asset specificity or too high behavioural uncertainty) will lock the players in place and reduce the chance to adopt new practices. In other words, in negotiations for more CE practices, the capacity of actors to adapt is a key factor in the discussion of CE adoption.

## 7.7 UPDATED RESEARCH FRAMEWORK

The research framework (Chapter 4) can now be changed/contextualised considering the findings and discussions originated from the present investigation. The updated version was influenced by the exploratory nature of the thesis and can also serve as a starting point for future research (section 8.4). Figure 7.5 presents the new version with the updated categories.

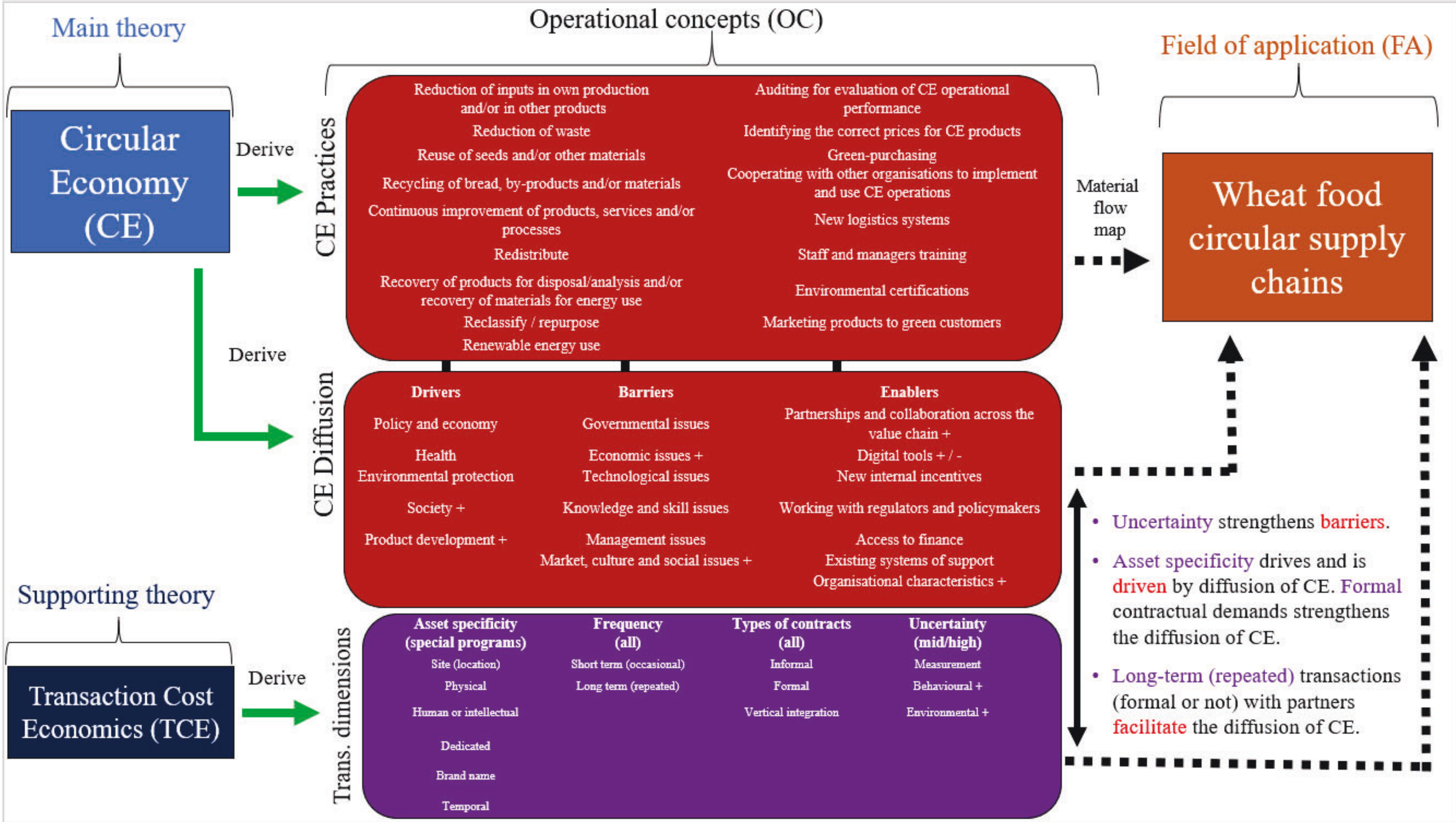



**Figure 7.5** Updated research framework

All CE practices used in the original research framework (Figure 4.3) were kept. However, some changes have been included to better represent the CE operations identified in the cases. First, the separation between reduction of waste and inputs. This was done in order to highlight that reduction of inputs is not only connected to wheat, but also with other products that are a part of other supply chains like soya beans in no-tillage production. Reuse now identifies the reuse of seeds or other materials, considering that it is a more accurate way to describe the practices in the wheat food supply chains investigated. Similarly, recycling now explicitly shows bread, by-products and/or other materials. This way, the use of straw from wheat production, the production of composting or the use of anaerobic biodigesters, besides the auxiliary materials (e.g., packaging), are clearly represented.

Redesign, as it was a term that participants in both the UK and Brazil had problems with, was changed to continuous improvement. Recovery is now more precise, as it includes the recovery of products for analysis, not just disposal. Reclassify and repurpose are now side by side, since this distinction is not very relevant in wheat as shown in sections 6.1.1, 6.2.1 and Figure 6.6. All other practices remained unaltered.

It is necessary to add three caveats that are not part of the framework: there is considerable differences in the interpretation of what ´waste´ is; sharing of products/services is made difficult by the nature of the product (food) and by constrains in the production method (i.e., timing and uncertainty); and government issues could have a better term, such as governmental problems or policy difficulties.

The updated version kept the requirement to map the material flow as it is relevant to guarantee that there is a CSC in analysis and to identify the loops (especially open loops) that were/are part of the investigation. Considering that different supply chains can have different loops (e.g., pastry made with breadcrumbs, beers made from surplus bread or production of animal feed), it is necessary to understand such idiosyncrasies to better comprehend the variations of CE and also the transaction dimensions in play.

In the CE diffusion influencers, ´CE framework issues´ was removed from the barriers, because no participants commented on it, and market issues were merged with culture and social issues. The reason for this later change relates to the product itself. Food preferences and types (i.e., markets) varies according to culture, so to separate cultural issues from market issues when discussing food supply chains only increase the complexity of the analysis without bringing noticeable benefits. In the present research this was clear with the influence that bread preferences (e.g., type, place of purchase, characteristics) can have in the decision to adopt certain CE practices in relation to other priorities. For example, increase in production that leads to surplus (and thus, waste) in order to have fresh bread available all the time.

Additionally, the influencers categories that were more relevant were identified with a +. The exception is the enabler ´digital tools´ since it was identified that this enabler can also become a hinderance, so it now has a +/- mark. For the transaction dimensions, similar markings were made in the types of uncertainty. Since a clear difference in other categories were not identified, no marking was added. However, in the types of dimensions, the main points identified in the research were added in relation to each. Asset specificity is clear in special programs, frequency and types of contracts were identified in all forms, and uncertainty is mid to high.

The three assumptions presented in section 7.7 were added in the discussion of the roles, as the identification of these roles was the problem tackled by in this thesis. Finally, ´wheat food supply chains´ was added in the field of application, thus making it explicit that the new framework relates to said CSC.

Chapter summary: In this chapter the research problem was addressed with three propositions that contribute to CE and TCE theory. The five research questions were also answered with a brief overview of each finding, including figures and tables which provided a summarised the main findings. The research framework was revisited and updated. The next chapter (Chapter 8) concludes the present thesis.

## 8. FINAL CONSIDERATIONS

Consumers, governments, academia and businesses are increasingly worried about the sustainability of food supply chains. In the present study, sustainability's definition was inspired by the Brundtland Commission report (United Nations, 1987), understood here as the balance between social, economic and environmental concerns and practices that meets present and future needs, without one compromising the other. It is possible, therefore, to maintain supply levels without endangering food safety and food security for both present and future generations. Wheat is one of the main agri-food products, representing around 30% of world grain crops and approximately 20% of daily calorie intake, with extensive usage in flour, bread, pasta and biscuit manufacturing (Mori and Ignaczak, 2012). Consequently, wheat agri-food sustainability is an important topic to tackle as it affects all aspects of the TBL: Environment, Society and Economy.

Brazil and UK are two countries with considerable production and relevance in the agri-food world. While Brazil is a net exporter of food, it is a net importer of wheat and the UK is the opposite, exporting wheat but importing food. The countries also have other differences in the wheat sector, such as the structure of the industry, preferences in consumption and institutional environment. These characteristics, plus easiness of access of participants, made both countries attractive options for case study.

CE is one of the more prominent approaches to sustainability (Ghisellini *et al.*, 2016; Murray *et al.*, 2017), encompassing both a philosophical and a practical framework for industry, academic research and public policy. Circular supply chains, that is, supply chains that embody CE principles (De Angelis *et al.*, 2018) have fewer studies investigating circular agri-food supply chains in comparison to technical products (Geissdoerfer *et al.*, 2017; Kirchherr *et al.*, 2017; Vlajic *et al.*, 2018). The diffusion of CE practices in supply chains has considerable scrutiny within CE literature (Jesus and Mendonça, 2018; Govindan and Hasanagic, 2018; Kirchherr *et al.*, 2018; Mangla *et al.*, 2018) and the relationship of actors in the supply chain play a role in said processes. For the present thesis, TCE was chosen as the supporting theory to the research to address the relationship between buyers and suppliers in said diffusion.

The use of TCE in the study of CE presented various advantages such as a clear and structured body of work regarding transaction dimensions, the support in understanding how organisations can better plan their CSC strategies and also clarifying uncertainties relating to adopting CE practices.

Despite the advantages, it was identified that a gap in both CE and TCE literature existed, as past studies do not clarify how these elements interact with each other in the diffusion of practices within an agri-food supply chain. Previous studies (Maaß and Grundmann, 2018; Lahti *et al.*, 2018; Nozharov, 2018; Neves *et al.*, 2019) have joined both TCE and CE theories, including in real-life contexts. Nonetheless, no previous work was identified in wheat food supply chains, nor in the understanding of transaction's roles in the diffusion of CE. With such a backdrop, the research aim was to investigate the role that the transactions between organisations in the UK´s and Brazilian wheat food supply chains can have in the diffusion of Circular Economy practices.

In summary, high uncertainty in transactions strengthens the barriers to diffusion as organisations do not feel secure enough to change their practices. Asset specificity and formal contracts help drive the diffusion of CE practices, but asset specificity can also be increased through demands for CE (bidirectional role). Long-term relationships (both formal and informal) supports the diffusion of CE practices as organisations have a reduction in uncertainty with their actions and with the transactions. Negotiations can change the power of such influences, but negotiations are limited to transactions where power imbalance is not too great. Flexibility is also a crucial factor as organisations need the capacity to adapt to changes.

## 8.1 IMPLICATIONS FOR THEORY

Before the discussion on implications for theory that originated from this thesis, it is relevant to identify the academic contributions (publications) already made during the execution of the present research. Besides seminars at the University of Northampton, the Brazilian Embassy in the UK and Embrapa, four papers in conferences were presented:

- Dossa, A. A., Batista, L., Gough, A. (2018) IoT adoption in agrifood operations: A conceptual model for technology transference. In 25th International EurOMA Conference. Budapest: European Operations Management Association, pp. 1–10.
- Dossa, A. A., Batista, L., Gough, A. (2019) The Diffusion of Circular Economy Practices in Agri-Food Supply Chains: A Transaction Cost Economics Perspective. In 26th International EurOMA Conference. Helsinki: European Operations Management Association, pp. 1-10.
- Dossa, A. A., Gough, A., Batista, L. (2019) Diffusion of Circular Economy Practices in the UK Wheat Food Supply Chain. In 24th Annual Conference of the CILT (UK) Logistics Research Network. Northampton: Logistics Research Network, pp. 15.

- Dossa, A. A., Gough, A., Batista, L., Mortimer, K. Transaction costs perspectives in the diffusion of Circular Economy in supply chains. In: 8th International EurOMA Sustainable Operations and Supply Chain Forum 2021, La Rochelle. Anais… La Rochelle: European Operations Management Association, 2021.

The listed presented earlier versions of sections of the present thesis, such as framework and preliminary data of the UK case. These events allowed the academic community to contribute with suggestions for the research, some of which were incorporated in the thesis. An example relates to the distinction between adoption and diffusion used in the thesis. Most interest in the research so far relates to the novel application of TCE in the CE diffusion setting, more thoroughly discussed below. Furthermore, the CILT conference paper also generated a journal publication:

- Dossa, A. A., Gough, A., Batista, L., Mortimer, K. (2020): Diffusion of circular economy practices in the UK wheat food supply chain, **International Journal of Logistics Research and Applications**, DOI: 10.1080/13675567.2020.1837759

One of the contributions brought from this thesis relates to CE practices definitions and shown in the updated version of the framework (section 7.8). The overlapping of reclassification and repurposing in wheat deserves further attention in CE literature that investigates the topic. For wheat – and probably for most foodstuff as the EPA food waste hierarchy shows – repurposing is the only option after a certain level of downgrading, thus making little sense in differentiating both practices after the said threshold. Additionally, many participants did not immediately understand the ‘R’ practices, mainly redesign. The problem was especially relevant for the farmers, with most participants preferring the term “improvement” or even “continuous improvement”. Future works must consider changing the names of those CE practices, even if it does not keep with the ‘R’ theme as it can improve the understanding of the participants. Finally, the definitions of waste were also varied, with considerable difference between both countries. The work of Korhonen *et al.* (Korhonen *et al.,* 2018b) had anticipated the issue, and the present research reinforces that some conceptual/theoretical definitions might be misaligned for some contexts and can affect how data is collected or interpreted. It is clear, therefore, that the present research proposes more accurate terminology in the consideration of CE practices. By changing the terms, more precise data collection is available and reduces the chance of both internal and construct validity problems in future quantitative research, especially surveys.

The findings also demonstrated that there are large scale pro-sustainability practices in agriculture that can be categorised as CE practices. Research that discusses CE and agri-food systems, especially CSC, usually do not focus on farming practices, which makes the discussion incomplete as there is no food system without food production. Farming as a general rule function within nature's cycle and developed several practices to reduce waste and input, mimic nature, use renewable energy (the sun itself), among others. No-tillage production, integrated crop-livestock-forestry, genetic improvement, use of biomaterials (fertilisers, pesticides, Nitrogen fixation) are some of the examples of modern, large scale practices used in agriculture that needs better exploration within the CE perspective. In other terms, the academic perspective of CE in agriculture (sometimes called circular agriculture (Jun and Xiang, 2011) is broaden by the considerations on CE and farming practices brought from the present research, thus bringing closer academic research on food production and the industry´s practice. Such considerations originated from answering the first research question.

Additionally, other research findings have implications for the theories used, its concepts and its definitions. Many of the CE definitions, including the one used for this thesis, consider that a CE is done 'by intention and design'. The research demonstrated that this is not always true. The material flow maps (both cases) revealed several loops in the wheat supply chain, many of which cascaded materials to other supply chains and industries, particularly animal husbandry. The connection between wheat agri-food supply chains and animal farming is ancient and was not intended or planned to be restorative or regenerative for sustainability/TBL purposes (as is the case for CE). Two additional elements support this consideration. First, the fact that most participants knew nothing about CE, even those that are the owners or main decision-makers for the origin and destination of the wheat products, and this did not stop them from being a part (and forming in some cases) the loops. Second, the fact that almost all organisations part of the research are typical organisations in their industries (it was one of the criteria for participant selection) and did not have CE as their *raison d'être*. The need for efficiency is one of the reasons that can explain that, thus the inclusion of Lean management and its body of knowledge can bring greater understanding of the subject, although it is outside the scope of the present research. With the knowledge that supply chains do not have to be designed to be circular, but can be it anyway, a new range of possibilities open to calculate circularity in materials, in the identification of new circular flows and in the impact that such supply chains can have in the TBL. In other words, to simply consider planned CSC, reduces the understanding of CE as a whole and thus reduces potential new research into the topic. Therefore, the present thesis expands the understanding of CE and its application in academia and were a direct product of answering the second research question.

There is a general sense of change in society for a more sustainable way of consuming food, including eliminating food waste. It is just not felt as strongly within wheat yet. Initially, it was expected that the number of actors between end-consumer and farmers would influence the issue, as the aggregate in actors and dyads increases chain complexity, the potential for waste, market imperfections and so on (Cannella *et al.*, 2016; Gallaud and Laperche, 2016; Batista *et al.,* 2018b). What was identified was similar but not equal: it is not the number of actors that differentiate the wheat food supply chain in terms of diffusion of CE practices in comparison to short supply chains like meat and vegetables; instead, it is the level of transformation that is greater, thus reducing the pressure felt upstream of the retailers. Additionally, different countries and markets have both different capacities to implement such changes, but also different interests and pressures as the answer to the third research question demonstrated. These points should be taken into consideration by academics discussing the application of CE in different supply chains.

Future works that include analysis on barriers, drivers and enablers, need to include the consideration on how this is affected (and affects) the transactions between buyers and suppliers. It is particularly relevant to consider the fluidity of these influences based on negotiations, which means that CE adoption cannot be discussed statically (unchanging) especially in situations where both buyer and supplier have similar levels of power in a transaction. Issues such as small numbers of players (as discussed within TCE literature) that influence how the other actors in the supply chain act, is highly relevant in that regard. Finally, the use of standardised contracts also affects the process, and commodities are routinely traded using such tools, which also influences diffusion of CE. Therefore, analysis of information and power asymmetry, commercialization instruments and tools, and expected dimensions in a transaction can help better understand the phenomena of CE diffusion. These factors are a direct product of answering research questions four and five.

The use of TCE in the diffusion of CE deepens the understanding of how relationships between businesses can influence the adoption of more sustainable practices. Future research (section 8.4) can use said approach in other sectors and contexts and is an alternative to other theories such as network theory or social contagion theory. The updated framework is a concrete addition for other academics in their analyses of circular agri-food supply chains. The research provided a better understanding of the roles of transactions within CE, especially in the effect that dimensions of transaction have on CE adoption and diffusion in supply chains. These are made plain by the three propositions expressed in section 7.7.

## 8.2 IMPLICATIONS FOR PRACTICE

Throughout this research, various practical implications were identified. The CE practices described in the thesis (especially Sections 6.1.1 and 6.2.1) can serve as guidance/inspiration for managers in similar organisations. This is especially true for decision-makers in Brazil and the UK. The organisations that are clearly different in the two supply chains, namely the cooperatives and the charities, are particularly relevant as role models within a CE perspective as their operations are not necessarily found in the same way in both cases. In other words, the UK´s charities can serve as inspirations for new operations to be installed in Brazil and the Brazilian cooperatives can serve as inspirations for similar operations for the UK´s cooperatives.

The inclusion of certifications and assurance schemes in standardised agri-food contracts (including grain and pulse term contracts) is also worthy of attention, especially Brazilian managers. Despite issues that the assurance schemes have faced throughout their development in the UK, the know-how accrued by the UK´s organisations, such as systems of audit, documentation and requirements, marketing and finance, can function as a starting point for other countries that want to implement similar controls. The use of such certifications allows better traceability (and thus, food safety) and reduce the chance of breaks in the supply chains. Nevertheless, the certifications have a considerable cost, including transactional cost, and require an "institutional infrastructure" to be set in place.

The last implication for practice relates to transactions and organisations that want to promote or adopt CE. Managers that consider CE a desirable model to implement in their organisation or supply chain must be aware of how transactions influence said adoption. Requiring that suppliers (or buyers, depending on the case) adopt pro-CE practices can considerably affect if and how the organisations to whom the requirements were made, are able to operate. In other words, in a supply chain with low-profit margins and high uncertainty, any change can affect the business negatively. Therefore, most managers will require assurances before accepting new requirements for pro-CE products/operations. Having said that, however, in cases with too much of a power imbalance (e.g., small craft bakeries purchasing flour from big mills or small industrial bakeries supplying large supermarket chains), one of the parts does not have the capacity to negotiate, and different considerations need to be made in those cases, including ethical ones. Even so, to facilitate the process, the inclusion of the requirements into contracts, the payment of premiums (or discount for suppliers) will make the process of adopting CE easier.

## 8.3 RESEARCH LIMITATIONS

The main research limitations of this study are caused by the limitations of case study research itself. This type of research strategy/methodology does not allow for statistical generalisations; only theoretical generalisations (Collis and Hussey, 2014; Yin, 2018). Said argument is in contrast with the heterodoxy of positivist research. However, considering the epistemological positions underlining this research, this limitation is not necessarily accurate. Although it is agreed that qualitative research such as this one, does not have statistical generalisation power, that was not the final objective of the study. The investigation's aim was to explore and describe how two concepts interact with each other in a real-life context. Therefore, the case study approach permitted bridging the knowledge gap in a more appropriate way as it brought greater nuance to the topic.

Case studies are instrumental in exploratory research such as the present one and are useful to clarify details in a given setting. They are, however, also limited by the boundaries of the case, and here, by the boundaries of the supply chain. It is not possible to represent all potential organisations in a networked supply chain, and the present research did not include some of those (e.g., an UK´s biscuit industry). One of the reasons for that was the use of the snowball approach as access and availability were deemed a greater priority in the inclusion of organisations than merely broadening the types of participants. The biggest issue in terms of lack of participation was the UK´s supermarket chains that refused to be interviewed. To account for that, secondary data from websites, reports and presentations available online were used as secondary data.

The use of semi-structured interviews as the method for data collection also brings limitations, such as the limitations of each participant to verbalise or even remember all the elements to be considered to respond to the interview. Techniques proposed by Braun and Clarke (2013) were used, such as the use of silence or affirmative/empathic verbal and non-verbal reinforcements. Another limitation is in the potential bias caused by the researcher own self in the analysis and interpretation of the data and by the opinion of the participants relating to the subjects at hand. However, in interpretivist research such as this one, this is not a limitation, rather it is part of what makes the study richer and allows the greater depth and nuanced approach (Lincoln and Guba, 1985; Saunders *et al.*, 2016; Babbie, 2018). Having said that, following protocols for data collection and analysis (including using transcripts and Nvivo) reduces such limitations if they are considered as such.

Another limitation relates to transactions and its use in the research. In the last 50 years, a large body of knowledge has been developed involving TCE. However, only transaction dimensions were used in this thesis. This is, at the same time, a strength, since it shows the knowledge gap that this research has addressed. If transactions had been the embedded cases, a greater discussion on contractual types and governance schemes would have to be made and this may be an area for future research. In this study the emphasis has been placed on the exploration of CE in the wheat food context.

The final limitation to be highlighted relates to interdisciplinarity. Although some modern academics have advocated for such approaches to strengthen research (Brown, 2018; Alamar *et al.*, 2018; de Bakker *et al.*, 2019), especially considering complex issues such as agri-food sustainability, interdisciplinarity brings its own challenges. The present research falls within the business operations field but also draws considerably from economics and agronomy. This creates issues with nomenclature that was compounded by complexities from research with two different cultures and languages. One example relates to 'contract farming', where it can be interpreted both as a supply contract for specific agri-food products and as a partnership between farmers or landowners and tenants to cultivate the land. To avoid problems of such nature, terms that could be understood by all participants were preferred over specialised terms that could be more difficult to understand.

## 8.4 FUTURE STUDIES

Four different lines of inquiry can be suggested using the present research as a starting point for future investigations. The first relates to different commodity-based food besides wheat and investigating its CE practices and their adoption. Barley and its uses (especially for beer) is recommended as standardisation for maintaining the requirements from breweries is greater than in the wheat industry, particularly for legacy brews. There are many similarities between both cereals and between Brazil and the UK, serving as a comparable case study that can expand on the findings. Examples of such similarities include high consumption of beer but with different forms of end-product, imports of barley in Brazil and exports in the UK, and finally the role that small retailers versus large retail chains can have in the diffusion of CE practices.

Secondly, the investigation could be replicated by considering other countries (cases) that include different aspects in the analysis. For instance, France has a pattern of bread purchasing similar to Brazil, but it is as developed as the UK and with similar awareness for sustainability. Alternatively, Nigeria could serve as a parallel for a developing country and its wheat agri-food supply chain and CE instead of Brazil. The African nation also have a strong wheat consumption culture, having to import almost 5 million tonnes of wheat a year, while producing only 60 thousand tonnes (Beillard and Nzeka, 2019). It also consumes bread as loaves, made in craft bakeries, thus producing a different form of consumption pattern that might influence food waste and CE practices associated with it (Mollenhauer, 2019).

The third form of research that can be suggested relates to calculations of transactions costs in the circular wheat agri-food supply chain. Since the information gathered here showed the main dimensions in such transactions, it is easier now to anticipate what and where these costs are. For instance, in the special programs, costs involved in identifying and preparing the suppliers are greater as there is greater asset specificity, in comparison with spot market sales of wheat grain. In other words, the present research facilitated the calculation of transaction costs in a CSC. These costs need to be observed alongside other commonly occurring ones such as operational, training and marketing costs for circular products.

Finally, quantitative research could be undertaken to verify how statistically generalisable the findings of this research are. Although the epistemological paradigm that guided the present research was interpretivism, it is possible to consider a quantitative survey to further understand the phenomena in question. A broad survey of CE practices performed by each link in the supply chain is particularly interesting to reveal how common the practices discussed here are. Additionally, the capacity to corroborate the roles of transactions in the diffusion of CE practices is also welcome, thus increasing the knowledge of the topic.

## REFERENCES


ABIMAPI (2018a) ABIMAPI - Institutional. *Institutional information*, 1–3. [online]. Available from: https://abimapi.com.br/institucional.php [Accessed October 25, 2018].

ABIMAPI (2018b) ABIMAPI Statistics. *Statistics*, 1–6. [online]. Available from: https://abimapi.com.br/estatistica-geral.php [Accessed October 25, 2018].

ABIP (2018) *Balanco e Tendencias do mercado de panificacao e confeitaria*.

ABIP (2019) Numero de padarias por estado. *Numero de Padarias no Brasil*, 2. [online]. Available from: http://www.abip.org.br/site/wp-content/uploads/2018/10/abip.jpg [Accessed January 31, 2019].

ABITRIGO (2017a) Brazilian Mills profile. *Brazilian wheat sector profile*, 1. [online]. Available from: http://www.abitrigo.com.br/conhecimento-raio-x.php [Accessed October 25, 2018].

ABITRIGO (2017b) *Estimativa de moinhos em atividade no Brasil - 2016*. Sao Paulo.

ABITRIGO (2017c) The Brazilian WAIC. *Raio x da cadeia do trigo e dos moinhos brasileiros*, 1. [online]. Available from: http://www.abitrigo.com.br/conhecimento-raio-x.php [Accessed October 25, 2018].

ABITRIGO (2017d) Wheat sales.pdf. *Industry profile*, 1–2. [online]. Available from: http://www.abitrigo.com.br/conhecimento-raio-x.php [Accessed October 25, 2018].

ABITRIGO (2018a) *Brazil milling estimates*. Sao Paulo.

ABITRIGO (2018b) *Brazilian wheat exports*. Sao Paulo.

ABITRIGO (2018c) *Milled and flour consumption estimates - 2005-2017*. Sao Paulo.

ABITRIGO (2018d) number of mills.pdf. *Associacao Brasileira da Industria de Trigo*, 1. [online]. Available from: http://www.abitrigo.com.br/quem-somos.php [Accessed October 24, 2018].

ABITRIGO (2018e) *Wheat flour import - by country*. Sao Paulo.

ABITRIGO (2018f) *Wheat import - 2013-2018*. Sao Paulo.

ABITRIGO (2018g) *Wheat per capita consumption Brazil*. Sao Paulo.

Abramson, M.D. (2004) Mad Cow Disease: An Approach to its Containment. *Journal of Health Care Law and Policy*. **7**(2), 316–362.

ABRAS (2018a) *18ª avaliacao de perdas no varejo brasileiro de supermercados*. Sao Paulo.

ABRAS (2018b) *ABRAS Essencial*. Sao Paulo.

ABRAS (2018c) Perdas do setor supermercadista somaram R$ 6.4 bilhoes em 2017. *Noticias ABRAS*, 1–2. [online]. Available from: http://www.abras.com.br/clipping.php?area=20&clipping=65617 [Accessed October 26, 2018].

Acosta, A. da S., Lemainski, J., Farias, A.R., Mingoti, R., Dossa, A.A., Nascimento-Júnior, P.C.D. do (2018) *Dinâmica e cenário para a produção de trigo em áreas de atuação de cooperativas no Brasil*. Passo Fundo.

Adams, C.-L., Goldsmith, P.D. (1999) Conditions for Successful Strategic Alliances in the Food Industry. *International Food and Agribusiness Management Review*. **2**(2), 221–248.

Agrawal, S., Singh, R.K., Murtaza, Q. (2015) A literature review and perspectives in reverse logistics. *Resources, Conservation and Recycling*. **97**, 76–92.

Agrawal, S., Singh, R.K. (2019) Analyzing disposition decisions for sustainable reverse logistics: Triple Bottom Line approach. *Resources, Conservation and Recycling*. **150**(August), 104448.

AHDB Cereals & Oilseeds (2017) *AHDB Cereals & Oilseeds : Exports and the UK market*.

AHDB Cereals & Oilseeds (2019) Practical grain marketing tips from Northampton Monitor Farm. *News*, 1–3. [online]. Available from: https://www.ahdb.org.uk/news/practical-grain-marketing-tips-from-northampton-monitor-farm [Accessed January 31, 2019].

Ahi, P., Searcy, C. (2013) A comparative literature analysis of definitions for green and sustainable supply chain management. *Journal of Cleaner Production*. **52**, 329–341.

AIC - Agricultural Industries Confederation (2019) Approved AIC contract note for home grown grain and pulses.

Alamar, M. del C., Falagán, N., Aktas, E., Terry, L.A. (2018) Minimising food waste: a call for multidisciplinary research. *Journal of the Science of Food and Agriculture*. **98**(1), 8–11.

Alexandratos, N. (2005) Countries with Rapid Population Growth and Resource Constraints: Issues of Food, Agriculture and Development. *Population and Development Review*. **31**(2), 237–258.

Alho, E. (2015) Farmers' self-reported value of cooperative membership: evidence from heterogeneous business and organization structures. *Agricultural and Food Economics*. **3**(1).

All-Party Parliamentary Sustainable Resource Group (2014) *Remanufacturing: Towards a resource efficient economy*. London.

Altman, I.J., Sanders, D.R., Boessen, C.R. (2007) Applying Transaction Cost Economics : A Note on Biomass Supply Chains. *Journal of Agribusiness*. **25**(1), 107–114.

Amico, S.D., Hrabalova, M., Müller, U., Berghofer, E., D'Amico, S., Hrabalova, M., Müller, U., Berghofer, E. (2010) Bonding of spruce wood with wheat flour glue — Effect of press temperature on the adhesive bond strength. *Industrial Crops and Products*. **31**, 255–260.

Andrade Jr, E.R., Cavenaghi, A.L., Gumarães, S.C., Carvalho, S.J.P. (2015) *Primeiro relato de Amaranthus palmeri no Brasil em áreas agrícolas no estado de Mato Grosso*.

De Angelis, R., Howard, M., Miemczyk, J. (2018) Supply Chain Management and the Circular Economy : towards the Circular Supply Chain. *Production Planning & Control*. **29**(6), 1–13.

Angot, J., Milano, P. (2001) Linking concepts and data. In R.-A. Thietart, ed. *Doing management research: a comprehensive guide*. London: Sage Publications, pp. 132–146.

Antunes, J.M. (2015) Pesquisadores ingleses buscam Embrapa Trigo para projetos em parceria. *Noticias*, 1–4. [online]. Available from: https://www.embrapa.br/busca-de-noticias/-/noticia/8430749/pesquisadores-ingleses-buscam-embrapa-trigo-para-projetos-em-parceria [Accessed August 7, 2018].

ANVISA - Agencia Nacional de Vigilancia Sanitaria (2004) Regulamento Técnico de Boas Práticas para Serviços de Alimentação. , 1–14.

ANVISA - Agencia Nacional de Vigilancia Sanitaria (2005) Regulamento Tecnico para produtos cereais, amidos, farinhas e farelos. , 1–2.

Ashby, A., Leat, M., Hudson-Smith, M. (2012) Making connections: a review of supply chain management and sustainability literature. *Supply Chain Management: An International Journal*. **17**(5), 497–516.

Babbie, E. (2018) *The practice of social research*. 14th ed. Boston: Cengage.

de Bakker, F., Crane, A., Henriques, I., Husted, B.W. (2019) Publishing Interdisciplinary Research in Business & Society. *Business and Society*. **58**(3), 443–452.

Balbino, L.C., Cordeiro, L.A.M., Oliveira, P. de, Kluthcouski, J., Galerani, P.R., Vilela, L. (2012) Agricultura sustentavel por meio da integracao Lavoura-Pecuaria-Floresta (iLPF). *INFORMAÇÕES AGRONÔMICAS*. **138**(July 2012), 1–18.

Balboa, C.H., Somonte, M.D. (2014) Circular economy as an ecodesign framework: the ECO III model. *Informador Técnico*. **78**(1), 82–91.

Baldez, L.H. (2020) Logistica e Infraestrutura. In *27º Congresso Internacional da Industria do Trigo - Mudancas recentes e o futuro*. Online: ABITRIGO, pp. 1–63.

Ball, B.C., Hargreaves, P.R., Watson, C.A. (2017) A framework of connections between soil and people can help improve sustainability of the food system and soil functions. *Ambio*, 1–15.

Bannock, G., Baxter, R.E. (2011) *The Penguin dictionary of economics*. 8th ed. London: Penguin Books.

Barbier, E.B. (2011) Transaction costs and the transition to environmentally sustainable development. *Environmental Innovation and Societal Transitions*. **1**(1), 58–69.

Barbosa-Póvoa, A.P., da Silva, C., Carvalho, A. (2018) Opportunities and challenges in sustainable supply chain: An operations research perspective. *European Journal of Operational Research*. **268**(2), 399–431.

Bartholomeu, D.B., Rocha, F.V. da, Péra, T.G., Caixeta Filho, J.V. (2016) Postharvest

Losses in the Wheat Logistics Chain: A Brazilian Case Study. *Journal of Agricultural Science and Technology B*. **6**(5), 321–329.

Batalha, M.O. (2001) *Gestao Agroindustrial*. 2nd ed. M. O. Batalha, ed. Sao Paulo: Editora Atlas.

Bateman, H., Curtis, S., McAdam, K. (2017) *Dictionary of Agriculture*. 3rd ed. London: Bloomsbury Information.

Batista, L., Saes, S., Fouto, N. (2015a) Sustainability of Food Supply Chains – Mapping Food Waste and By- Product Synergies. In *Proceedings of the 20th Annual Conference of The Chartered Institute of Logistics & Transport, Logistics Research Network (LRN)*. Derby: The Chartered Institute of Logistics & Transport, Logistics Research Network (LRN), pp. 9–11.

Batista, L., Saes, S., Fouto, N., Fassam, L. (2015b) Industrial ecology perspectives of food supply chains: a framework of analysis. In *17th International Conference on Industrial Ecology (ICIE 2015)*. Instanbul, pp. 1–16.

Batista, L., Davis-Poynter, S., Ng, I., Maull, R. (2017) Servitization through outcome-based contract – A systems perspective from the defence industry. *International Journal of Production Economics*. **192**(October 2015), 133–143.

Batista, L., Bourlakis, M., Smart, P., Maull, R. (2018a) In Search of a Circular Supply Chain Archetype – A Content-Analysis Based Literature Review. *Production Planning & Control*. **29**(6), 438–455.

Batista, L., Bourlakis, M., Liu, Y., Smart, P., Sohal, A. (2018b) Supply chain operations for a circular economy. *Production Planning & Control*. **29**(Special), 419–424.

Batista, L., Gong, Y., Pereira, S., Jia, F., Bittar, A. (2018c) Circular supply chains in emerging economies–a comparative study of packaging recovery ecosystems in China and Brazil. *International Journal of Production Research*. **7543**.

Baumgartner, R.J. (2011) Critical perspectives of sustainable development research and practice. *Journal of Cleaner Production*. **19**(8), 783–786.

BBSRC Media Office (2016) £ 4M awarded for new UK-Brazil joint projects in wheat research. *Food security News*. (July 2016), 1–2. [online]. Available from: https://bbsrc.ukri.org/news/food-security/2016/160722-pr-new-uk-brazil-joint-projects-in-wheat-research/ [Accessed August 7, 2018].

Beillard, M.J., Nzeka, U.M. (2019) *Nigeria Grain and Feed Annual 2019 Nigeria ' s Imports of Wheat and Rice to Rise*. Lagos.

Bell, J. (2005) *Doing your Research Project: a guide for first-time researchers in education, health and social science*. 4th ed. Berkshire: Open University Press.

Benyus, J. (1997) Echoing Nature: why Biomimicry now? In *Biomimicry: innovation inspired by Nature*. New Y: Harper Collins, pp. 1–13.

Beske, P., Seuring, S. (2014) Putting sustainability into supply chain management. *Supply Chain Management: An International Journal*. **19**(3), 322–331.

Biomimicry Institute (2018a) Jenine Benyus. *About Jenine Benyus*, 1–8. [online]. Available from: https://biomimicry.org/janine-benyus/ [Accessed August 20, 2018].

Biomimicry Institute (2018b) What is biomimicry? *What is biomimicry?*, 1–7. [online]. Available from: https://biomimicry.org/what-is-biomimicry/ [Accessed August 20, 2018].

Biscuit People (2014) Biscuit market in UK making a packet. *The global biscuit industry overview*, 1–9. [online]. Available from: http://biscuitpeople.com/biscuit-market-uk-making-packet/ [Accessed October 30, 2018].

Bolis, I., Morioka, S.N., Sznelwar, L.I. (2014) When sustainable development risks losing its meaning. Delimiting the concept with a comprehensive literature review and a conceptual model. *Journal of Cleaner Production*. **83**, 7–20.

Braathen, N.A. (2007) Instrument mixes for environmental policy: how many stones should be used to kill a bird? *International Review of Environmental and Resource Economics.*. **2**(May 2007), 1–43.

Braun, V., Clarke, V. (2013) *Successful qualitative research: a practical guide for begginers*. 1st ed. London: Sage Publications.

Braungart, M., McDonough, W., Bollinger, A. (2007) Cradle-to-cradle design: creating healthy emissions - a strategy for eco-effective product and system design. *Journal of Cleaner Production*. **15**(13–14), 1337–1348.

Braz, A.C., De Mello, A.M., de Vasconcelos Gomes, L.A., de Souza Nascimento, P.T. (2018) The bullwhip effect in closed-loop supply chains: A systematic literature review. *Journal of Cleaner Production*. **202**, 376–389.

Brennan, L.L. (2011) *Operations management*. 1st ed. London: McGraw Hill.

Brintrup, A. (2010) Behaviour adaptation in the multi-agent, multi-objective and multi-role supply chain. *Computers in Industry*. **61**(7), 636–645.

Brown, B. (2018) Interdisciplinary Research. *European Review*. **26**(S2), S21–S29.

Brown, M., Haselsteiner, E., Apró, D., Kopeva, D., Luca, E., Pulkkinen, K., Rizvanolli, B.V. (2018) *Sustainability, Restorative to Regenerative: an exploration in progressing a paradigm shift in built environmental thinking, from sustainability to restorative sustainability and on to regenerative sustainability*. Vienna: RESTORE - REthinking Sustainability TOwards a Regenerative Economy.

Brum, A.L., Muller, P.K. (2008) A realidade da cadeia do trigo no Brasil: o elo produtores / cooperativas. *Revista de Economia e Sociologia Rural*. **46**(1), 145–169.

Bryman, A., Bell, E. (2015) *Business Research Methods*. 4th ed. Oxford: Oxford University Press.

Buainain, A.M., Alves, E., Silveira, J.M. da, Navarro, Z. (2014) *O mundo rural no Brasil do século 21 - a formação de um novo padrão agrário e agrícola*. 1st ed. Brasilia: Embrapa; Unicamp.

Cannella, S., Bruccoleri, M., Framinan, J.M. (2016) Closed-loop supply chains: What reverse logistics factors influence performance? *International Journal of Production Economics*. **175**, 35–49.

Cardoso, S.R., Barbosa-Póvoa, A.P.F.D., Relvas, S. (2013) Design and planning of supply chains with integration of reverse logistics activities under demand uncertainty. *European Journal of Operational Research*. **226**(3), 436–451.

Carillo, F., Caracciolo, F., Cembalo, L. (2017) Do durum wheat producers benefit of vertical coordination? *Agricultural and Food Economics*. **5**(1).

Carter, C., Cowman, S. (2020) *Anticipated trends in global consumption - Wheat 2030*. Perth.

Carvalho, Í.C.S. de, Guimarães, C.M.C., Vieira, L.M. (2018) The influence of relationships on loss and food waste in agrifood chains. In *25th Annual EurOMA Conference*. Budapest: European Opertions Management Association, pp. 1–10.

Carvalho, S.J.P., Netto, A.G., Nicolai., M., Cavenaghi, A.L., Lópes-Ovejero, R.F., Christoffoleti, P.J. (2015) Detection of Glyphosate-Resistant Palmer Amaranth (Amaranthus palmeri) in Agricultural areas of Mato Grosso, Brazil. *Planta Daninha*. **33**(3), 579–586.

CBA (2018) Market Information. , 3–5. [online]. Available from: http://www.craftbakersassociation.co.uk/bakery-info.php [Accessed October 30, 2018].

CEH - UK Centre for Ecology and Hydrology (2020) CEH Land Cover Plus: Crops 2019. . (August), 1–12.

Chertow, M.R. (2008) Industrial ecology in a developing context. In C. Clini, I. Musu, & M. Gullino, eds. *Sustainable Development and Environmental Management: Experiences and Case Studies*. Springer, pp. 1–19.

Collis, J., Hussey, R. (2014) *Business research: a practical guide for undergraduate and postgraduate students.* 4th ed. New York: Basingstoke : Palgrave Macmillan.

CONAB (2020) Custos de Producao do Trigo 2020. , 8.

COOP (2015) *Agricultural co-operatives: report on the co-operative farming sector*. London.

COOP (2018) UK agricultural co-operatives: key facts. *Agricultural package*, 1. [online]. Available from: https://www.uk.coop/agri/uks-agricultural-co-operative-sector [Accessed October 29, 2018].

Cooper, D.R., Schindler, P.S. (2014) *Business research methods.* 12th ed. London: McGraw-Hill.

Cordeiro, L.A.M., Vilela, L., Marchão, R.L., Kluthcouski, J., Martha Júnior, G.B. (2017) Integração Lavoura-Pecuária E Integração Lavoura-Pecuária-Floresta: Estratégias Para Intensificação Sustentável Do Uso Do Solo. *Cadernos de Ciência & Tecnologia*. **32**(1/2), 15–53.

Creswell, J.W. (2013) *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*.

Crisp, A. (2018) UK food and grocery market to grow 14.8% by £28.2bn by 2023. *IGD*, 1–5. [online]. Available from: https://www.igd.com/about-us/media/press-releases/press-release/t/uk-food-and-grocery-market-to-grow-148-by-282bn-by-2023/i/19052 [Accessed October 31, 2018].

D'Amato, D., Droste, N., Allen, B., Kettunen, M., Lähtinen, K., Korhonen, J., Leskinen, P., Matthies, B.D., Toppinen, A. (2017) Green, circular, bio economy: A comparative analysis of sustainability avenues. *Journal of Cleaner Production*. **168**, 716–734.

Daneshkhu, S. (2017) UK biscuit makers seek ways to get their bite back Industry. *Financial Times*, 13–16.

Dani, S. (2015) *Food supply chain management and logistics*. 1st ed. London: KoganPage.

Davies, H., Lam, P.-L. (2001) *Managerial Economics: an analysis of business issues*. 3rd ed. Essex: Pearson.

Dawson, P.J. (2015) Measuring the Volatility of Wheat Futures Prices on the LIFFE. *Journal of Agricultural Economics*. **66**(1), 20–35.

Debes, J. (2015) What Does a Bushel of Wheat Mean to Me ? *Kansas Wheat*. [online]. Available from: http://kswheat.com/news/2015/07/22/what-does-a-bushel-of-wheat-mean-to-me [Accessed May 21, 2018].

Defee, C.C., Williams, B., Randall, W.S. (2010) An inventory of theory in logistics and SCM research. *International Journal of Logistics Management*. **21**(3), 404–489.

DEFRA - Department for Environment Food and Rural Affairs (2011) *Applying the Waste Hierarchy: evidence*. London.

DEFRA (2012) *The UK Cereal Supply Chain*. London.

DEFRA (2017) *Crops Grown For Bioenergy in England and the UK: 2016*. London.

DEFRA (2018a) *Agriculture in the United Kingdom 2017*. London.

DEFRA (2018b) Numbers of holdings and land areas / livestock numbers by size group: UK (a).

DEFRA (2019a) *Agriculture in the United Kingdom*. London.

DEFRA (2019b) Cereal and oilseed area, yield and production.

DEFRA (2020a) *Farming Statistics – First estimates of 2020 UK wheat and barley production*. London.

DEFRA (2020b) UK wheat production by region. , 3.

Denardin, J.E., Kochhann, R.A., Faganello, A., Denardin, N.D., Santi, A., Wiethölter, S. (2012) *Diretrizes do sistema plantio direto no contexto da agricultura conservacionista*. Passo Fundo.

Denardin, J.E. (2015) *Plano ABC - Boletim Técnico Informativo*. Porto Alegre.

DEPEC (2017) *DEPEC – Departamento de Pesquisas e Estudos Econômicos OUTUBRO DE 2016*. Sao Paulo.

Despoudi, S., Papaioannou, G., Saridakis, G., Dani, S. (2018) Does collaboration pay in agricultural supply chain? An empirical approach. *International Journal of Production Research*. **56**(13), 4396–4417.

Dicks, H. (2016) The Philosophy of Biomimicry. *Philosophy and Technology*. **29**(3), 223–243.

Dossa, A.A., Eichelberger, L. (2016) *Diagnóstico do complexo agroindustrial do trigo - panorama global no período 2012-2015*. Passo Fundo.

Dossa, A.A., Batista, L., Gough, A. (2018) IoT adoption in agrifood operations: A conceptual model for technology transference. In *25th Annual EurOMA Conference*. Budapest: European Opertions Management Association, pp. 1–10.

Dossa, A.A., Gough, A., Batista, L., Mortimer, K. (2020) Diffusion of circular economy practices in the UK wheat food supply chain. *International Journal of Logistics Research and Applications*. **0**(0), 1–20.

Dubey, R., Gunasekaran, A., Papadopoulos, T., Childe, S.J., Shibin, K.T., Wamba, S.F. (2017) Sustainable supply chain management: framework and further research directions. *Journal of Cleaner Production*. **142**, 1119–1130.

Easterby-Smith, M., Thorpe, R., Jackson, P.R. (2015) *Management & Business Research*. 5th ed. London: Sage Publications.

Ehrenfeld, J.R. (2005) The roots of sustainability. *MIT Sloan Management Review.*. **46**(2), 23–25.

Eisenhardt, K.M. (1989) Building Theories from Case Study Research. *Academy of Management Review*. **14**(4), 532–550.

Elkington, J. (1997) *Cannibals with Forks: the triple bottom line of 21st century business*. Oxford: Capstone.

Ellen MacArthur Foundation (2018) Circular Economy System Diagram. *Circular Economy Overview*, 1–5. [online]. Available from: https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram [Accessed July 5, 2018].

Embrapa (2018a) Integrated Crop-Livestock-Forest Systems. *Integrated Crop Livestock Forestry Systems - ICLFS/FAQ*, 1–4. [online]. Available from: https://www.embrapa.br/en/tema-integracao-lavoura-pecuaria-floresta-ilpf/perguntas-e-respostas [Accessed August 27, 2018].

Embrapa (2018b) Integrated Crop-Livestock-Forest Systems. *Integrated Crop Livestock Forestry Systems - ICLFS/About the theme*, 1–10. [online]. Available from: https://www.embrapa.br/en/tema-integracao-lavoura-pecuaria-floresta-ilpf/nota-tecnica [Accessed August 27, 2018].

Embrapa Trigo (2018) Pesquisa e Desenvolvimento. *Pesquisa e Desenvolvimento*. [online]. Available from: https://www.embrapa.br/en/trigo/pesquisa-e-desenvolvimento

[Accessed March 16, 2018].

EPA - Environmental Protection Agency (2018) Spanish Translation of the Food Recovery Hierarchy. *Sustainable Management of Food*, 1–2. [online]. Available from: https://www.epa.gov/sustainable-management-food/sustainable-management-food-basics [Accessed July 24, 2018].

EPA - United States Environmental Protection Agency (2017) Food Recovery Hierarchy. *Sustainable Management of Food*, 1–2. [online]. Available from: https://www.epa.gov/sustainable-management-food/food-recovery-hierarchy [Accessed August 26, 2018].

Eriksson, M., Strid, I., Hansson, P.A. (2015) Carbon footprint of food waste management options in the waste hierarchy - A Swedish case study. *Journal of Cleaner Production*. **93**, 115–125.

Espinoza-Orias, N., Stichnothe, H., Azapagic, A. (2011) The carbon footprint of bread. *International Journal of Life Cycle Assessment*. **16**(4), 351–365.

Essila, J.C. (2018) The Dynamics of Electronic Supply Chains and Enterprise Resource Planning Systems. *International Journal of Computers in Clinical Practice*. **3**(1), 40–54.

Estado do Rio Grande do Sul (2016) Brazilian wheat production - by state. *Atlas Socioeconomico do Rio Grande do Sul*, 1. [online]. Available from: https://atlassocioeconomico.rs.gov.br/upload/recortes/201708/07120155_20838_GDO.png [Accessed October 25, 2018].

European Commission (2008) Directive 2008 / 98 / EC on waste Waste Framework Directive ). *Environment - European Commission*, 1–2. [online]. Available from: http://ec.europa.eu/environment/waste/framework/ [Accessed August 26, 2018].

Evans, J., Bocken, N. (2013) Circular Economy Toolkit - maintain / repair. *Circular Economy Toolkit*, 1–2. [online]. Available from: http://circulareconomytoolkit.org/maintain-repair.html [Accessed July 17, 2018].

Evans, R. (2015) *Briefing - Agricultural Co-operatives in the UK*. London.

FAO; WHO (2003) *Assuring food safety and quality: guidelines for strenghtening national food control systems*. Rome.

FAO (2002) *Bread Wheat: improvement and production*. B. C. Curtis, S. Rajaram, & H. G. Macpherson, eds. Rome: FAO - Food and Agriculture Organization of the United Nations.

FAO (2014) *Mitigation of Food Wastage: Societal Costs and Benefits*. FAO - Food and Agriculture Organization of the United Nations.

FAO (2017) *FAO - Cereal Supply and Demand Brief Summary Tables*.

FAO (2018a) FAO Cereal Supply and Demand Brief. *Crop Prospects and Food Situation*, 1–16. [online]. Available from: http://www.fao.org/worldfoodsituation/wfs-home/csdb/en/ [Accessed May 15, 2018].

FAO (2018b) Value of Agricultural Production - 2010-2014. *FAOStat*. [online].

Available from: http://www.fao.org/faostat/en/#data/QV [Accessed May 17, 2018].

FAO (2020a) *Climate change: unpacking the burden on food safety*. Rome: FAO - Food and Agriculture Organization of the United Nations.

FAO (2020b) Wheat worldwide production and area. , 4.

FAO (2021) New Food Balances. , 1.

Farsi, M., Erkoyuncu, J.A. (2021) An agent-based approach to quantify the uncertainty in Product-Service System contract decisions: A case study in the machine tool industry. *International Journal of Production Economics*. **233**(March 2020), 108014.

Ferguson, M.J. (2007) *A Social contagion model of organizational misbehaviour*. Vanderbilt University.

Fisch, M. (2017) The Nature of Biomimicry: Toward a Novel Technological Culture. *Science Technology and Human Values*. **42**(5), 795–821.

Fisher, C. (2007) *Researching and writing a dissertation: a guidebook for business students*. 2nd ed. London: Prentice Hall.

FOB (2018a) About the bread industry. *Federation of Bakers*. **85**, 1–4. [online]. Available from: https://www.fob.uk.com/about-the-bread-industry/ [Accessed October 30, 2018].

FOB (2018b) Market Snapshot. , 1–2. [online]. Available from: https://www.fob.uk.com/about-the-bread-industry/industry-facts/market-snapshot/ [Accessed October 30, 2018].

Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S., Gerber, J.S., Johnson, M., Mueller, N.D., O'Connel, C., Ray, D.K., West, P.C., Balzer, C., Bennett, E.M., Carpenter, S.R., Hill, J., Monfreda, C., Polasky, S., Rockstrom, J., Sheehan, J., Siebert, S., Tilman, D., Zaks, D.P.M. (2011) Solutions for a cultivated planet. *Nature*. **478**, 337–342.

Fonseca, F., Berk, C. (2016) *Brazil Retails Foods 2016*. Sao Paulo.

Fortnum, B.A., Gooden, D. (2008) Transmission and survival of Ralstonia solanacearum on tobacco machinery. *Contributions to Tobacco Research*. **23**(3), 137–143.

Foster, S.T. (2017) *Managing quality: integrating the supply chain*. 6th ed. London: Pearson.

Gallaud, D., Laperche, B. (2016) *Circular Economy, Industrial Ecology and Short Supply Chain: Towards Sustainable Territories*. Hoboken, NJ: John Wiley & Sons, Incorporated.

Gebremikael, M.T., Ranasinghe, A., Hosseini, P.S., Laboan, B., Sonneveld, E., Pipan, M., Oni, F.E., Montemurro, F., Höfte, M., Sleutel, S., De Neve, S. (2020) How do novel and conventional agri-food wastes, co-products and by-products improve soil functions and soil quality? *Waste Management*. **113**, 132–144.

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J. (2017) The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*. **143**, 757–768.

Gërdoçi, B., Skreli, E., Panariti, S., Repaj, E. (2016) Relational Ties and Transaction

Costs – The Moderating Role of Uncertainty. *International Food and Agribusiness Management Review*. **19**(2), 189–206.

Gerring, J. (2017) *Case study research: principles and practices*. 2nd ed. Cambridge: Cambridge University Press.

Ghadge, A., Dani, S., Ojha, R., Caldwell, N. (2017) Using risk sharing contracts for supply chain risk mitigation: A buyer-supplier power and dependence perspective. *Computers and Industrial Engineering*. **103**, 262–270.

Ghadge, A., Er Kara, M., Mogale, D.G., Choudhary, S., Dani, S. (2020) Sustainability implementation challenges in food supply chains: a case of UK artisan cheese producers. *Production Planning and Control*. **0**(0), 1–16.

Ghisellini, P., Cialani, C., Ulgiati, S. (2016) A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*. **114**, 11–32.

Gillham, B. (2005) *Research interviewing: the range of techniques*. 1st ed. Maidenhead: Open University Press.

Gimenez, C., Tachizawa, E.M. (2012) Extending sustainability to suppliers: a systematic literature review. *Supply Chain Management: An International Journal*. **17**(5), 531–543.

Gladek, E. (2018) The Seven Pillars of the Circular Economy. *Metabolic Website*, 1–5. [online]. Available from: https://www.metabolic.nl/the-seven-pillars-of-the-circular-economy/ [Accessed July 25, 2018].

Glithero, N.J., Ramsden, S.J., Wilson, P. (2013) Barriers and incentives to the production of bioethanol from cereal straw: A farm business perspective. *Energy Policy*. **59**, 161–171.

Govindan, K., Hasanagic, M. (2018) A systematic review on drivers, barriers, and practices towards circular economy: a supply chain perspective. *International Journal of Production Research*. **56**, 1–34.

Govindan, K., Soleimani, H., Kannan, D. (2015) Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. *European Journal of Operational Research*. **240**(3), 603–626.

Grain Chain (2016) Wheat farming in the UK. , 1–18.

Grix, J. (2010) *The Foundations of Research*. 2nd ed. London: Palgrave Macmillan.

Guarienti, E.M., Miranda, M.Z. de, Bassoi, M.C., Scheeren, P.L., Lima, M. da C. de (2017) Classificação comercial indicativa de cultivares de trigo da Embrapa - Paraná, Mato Grosso do Sul e São Paulo, safra 2018. In *Reunião da Comissão Brasileira de Pesquisa de trigo e triticale, 11.; Fórum Nacional de Trigo.* Cascavel - PR: Comissão Brasileira de Pesquisa de trigo e triticale, pp. 195–198.

Gustavsson, J., Cederberg, C., Sonesson, U. (2011) *Global food losses and food waste - Extent, causes and prevention.* FAO - Food and Agriculture Organization of the United Nations.

Haanstra, W., Toxopeus, M.E., Van Gerrevink, M.R. (2017) Product Life Cycle Planning for Sustainable Manufacturing: Translating Theory into Business Opportunities. *Procedia CIRP*. **61**, 46–51.

Hawken, P., Lovins, A., Lovins, L.H. (1999) *Natural Capitalism: the next industrial revolution*. First. Back Bay Books.

Herczeg, G., Akkerman, R., Hauschild, M.Z. (2018) Supply chain collaboration in industrial symbiosis networks. *Journal of Cleaner Production*. **171**, 1058–1067.

Hill, A., Hill, T. (2011) *Essential Operations Management*. 1st ed. London: Palgrave Macmillan UK.

Hobbs, J.E., Weseen, S., Kerr, W.A. (2012) Transaction Costs, Hold-ups and Governance in Ethanol Supply Chains. In *International Association of Agricultural Economists (IAAE) Triennial Conference*. Foz do Iguaçu, Brazil: Association of Agricultural Economists (IAAE), pp. 1–23.

Homrich, A.S., Galvão, G., Abadia, L.G., Carvalho, M.M. (2018) The circular economy umbrella: Trends and gaps on integrating pathways. *Journal of Cleaner Production*. **175**, 525–543.

Hyman, M., Turner, B., Carpintero, A. (2013) *Guidelines for National Waste Management: Moving from Challenges to Opportunities*. Osaka: UNEP - The United Nations Environment Programme.

IBGE (2017) Trigo - grao - Brasil - Censo 2017. *Rural Census*, 1. [online]. Available from: https://censoagro2017.ibge.gov.br/templates/censo_agro/resultadosagro/agricultura.html?localidade=0&tema=76533 [Accessed October 23, 2018].

IBGE (2018a) *Produto das Lavouras Temporárias - Trigo (em grãos) - 1988 - 2018*. Rio de Janeiro.

IBGE (2018b) *Valor da producao trigo 2013-2017*. Rio de Janeiro.

IBIS World (2018) pasta Product Manufacturing - UK Market Research Report. , 1–6. [online]. Available from: https://www.ibisworld.co.uk/industry-trends/market-research-reports/manufacturing/manufacture-of-food-products/pasta-product-manufacturing.html [Accessed January 31, 2019].

International Grain Council (2020) Worldwide wheat usage - world grain council. , 2.

Jackson, V. (2014) BBSRC / Embrapa Joint Wheat Call. *Funding*, 1–3. [online]. Available from: https://bbsrc.ukri.org/funding/filter/embrapa-joint-wheat-call/ [Accessed August 7, 2018].

Jawahir, I.S., Bradley, R. (2016) Technological Elements of Circular Economy and the Principles of 6R-Based Closed-loop Material Flow in Sustainable Manufacturing. *Procedia CIRP*. **40**, 103–108.

Jesus, A. De, Mendonça, S. (2018) Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. *Ecological Economics*. **145**(July 2017), 75–89.

Jraisat, L.E. (2010) *Information Sharing in an Export Supply Chain Relationship: the Case of the Jordanian Fresh Fruit and Vegetable Export Industry*. Brunel University.

Jun, H., Xiang, H. (2011) Development of circular economy is a fundamental way to achieve agriculture sustainable development in China. *Energy Procedia*. **5**, 1530–1534.

Kanojia, V., Kushwaha, N., Reshi, M., Rouf, A., Muzaffar, H. (2018) Products and byproducts of wheat milling process. *Ijcs*. **6**(4), 990–993.

Kassie, G.T., Abdulai, A., Greene, W.H., Shiferaw, B., Abate, T., Tarekegne, A., Sutcliffe, C. (2017) Modeling Preference and Willingness to Pay for Drought Tolerance (DT) in Maize in Rural Zimbabwe. *World Development*. **94**, 465–477.

Kee, K.F. (2017) Adoption and Diffusion. In C. Scott; & L. Lewis, eds. *The International Encyclopedia of Organizational Communication*. Hoboken, NJ: Wiley-Blackwell, pp. 1–14.

Kersting, H.-J., G.Lindhauer, M., Bergthaller, W. (1994) Application of wheat gluten in non-food industry — wheat gluten as a natural cobinder in paper coating. *Industrial Crops and Products*. **3**(1–2), 121–128.

Kirchherr, J., Piscicelli, L., Bour, R., Kostense-Smit, E., Muller, J., Huibrechtse-Truijens, A., Hekkert, M. (2018) Barriers to the Circular Economy: Evidence From the European Union (EU). *Ecological Economics*. **150**, 264–272.

Kirchherr, J., Reike, D., Hekkert, M. (2017) Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*. **127**(September), 221–232.

Kolmar, M. (2017) *Principles of Microeconomics: an integrative approach*. 1st ed. St. Gallen, Switzerland: Springer Switzerland.

Korhonen, J., Honkasalo, A., Seppälä, J. (2018) Circular Economy: The Concept and its Limitations. *Ecological Economics*. **143**, 37–46.

Korhonen, J., Nuur, C., Feldmann, A., Birkie, S.E. (2018) Circular economy as an essentially contested concept. *Journal of Cleaner Production*. **175**, 544–552.

Korstjens, I., Moser, A. (2018) Series: Practical guidance to qualitative research. Part 4: Trustworthiness and publishing. *European Journal of General Practice*. **24**(1), 120–124.

Kozlenkova, I. V., Hult, G.T.M., Lund, D.J., Mena, J.A., Kekec, P. (2015) The Role of Marketing Channels in Supply Chain Management. *Journal of Retailing*. **91**(4), 586–609.

Lahti, T., Wincent, J., Parida, V. (2018) A Definition and Theoretical Review of the Circular Economy, Value Creation , and Sustainable Business Models: Where Are We Now and Where Should Research Move in the Future? *Sustainability*. **10**, 1–19.

Lamminmaki, D. (2005) Why do hotels outsource? An investigation using asset specificity. *International Journal of Contemporary Hospitality Management*. **17**(6), 516–528.

Landgraf, L. (2016) Risco de entrada de planta exótica coloca em alerta produtores brasileiros. *Embrapa Soja*, 1–7. [online]. Available from: https://www.embrapa.br/busca-de-noticias/-/noticia/12133083/risco-de-entrada-de-planta-exotica-coloca-em-alerta-produtores-brasileiros.

Lansink, A. (2018) Waste Hierarchy - Lansink's Ladder. *Recycling.com*, 1–8. [online]. Available from: https://www.recycling.com/downloads/waste-hierarchy-lansinks-ladder/ [Accessed August 26, 2018].

Larson, P.D., Halldorsson, A. (2004) Logistics versus supply chain management: an international survey. *Revue du Praticien*. **7**(1), 17–31.

Lazarevic, D., Valve, H. (2017) Narrating expectations for the circular economy: Towards a common and contested European transition. *Energy Research and Social Science*. **31**(October 2016), 60–69.

Lee, H.L., Padmanabhan, V., Whang, S. (1997) The bullwhip effect in supply chains. *Sloan Management Review*. **38**(3), 93–102.

Leube, M., Walcher, D. (2017) Designing for the next (Circular) Economy. An appeal to renew the Curricula of Design Schools. *The Design Journal*. **20**(sup1), S492–S501.

Lincoln, Y.S., Guba, E.G. (1985) *Naturalistic inquiry*. London: Sage.

Liu, C.M., Vasquez-Brust, D.A., Sarkis, J. (2014) The roles of first and second tier suppliers in Greening International Supply Chains. In D. A. Vazquez-Brust, J. Sarkis, & J. Cordeiro, eds. *Collaboration for Sustainability and Innovation: A Role For Sustainability Driven by the Global South? A Cross-Border, Multi-Stakeholder Perspective*. Dordrecht: Springer Netherlands, pp. 63–85.

Lollato, R.P., Marburger, D., Holman, J.D., Tomlinson, P., Presley, D., Edwards, J.T. (2017) *Dual-Purpose wheat: management for forage and gran production*.

Lopes, J.C., Dias, J., Amaral, J.F. (2012) International Review of Applied Economics Assessing economic complexity as interindustry connectedness in nine OECD countries. . **2171**(May).

Lucas, H. (2012) Breakout session P1.1 National Food Security – The Wheat Initiative – an International Research Initiative for Wheat Improvement Context – the problems being addressed. In *GCARD - Second Global Conference on Agricultural Research for Development*. Punta Del Este, Uruguay: GCARD - Global Conference on Agricultural Research Development, pp. 1–3.

Maaß, O., Grundmann, P. (2018) Governing transactions and interdependences between linked value chains in a circular economy: The case of wastewater reuse in Braunschweig (Germany). *Sustainability (Switzerland)*. **10**(4), 1–29.

Mackie, A.E., Coutts, B.A., Barbetti, M.J., Rodoni, B.C., McKirdy, S.J., Jones, R.A.C. (2015) Potato spindle tuber viroid : Stability on Common Surfaces and Inactivation With Disinfectants. *Plant Disease*. **99**(6), 770–775.

Magnan, A. (2011) Bread in the Economy of Qualities: The Creative Reconstitution of the Canada-UK Commodity Chain for Wheat. *Rural Sociology*. **76**(2), 197–228.

Man, N., Kadhim, Z.R., Latif, A., Seng, W.K. (2017) The Role and Importance of the Transactions Costs Theory in Agricultural Contracting Area: an Appraisal of Selected

Empirical Studies. *IOSR Journal of Business and Management*. **19**(1), 79–89.

Mangla, S.K., Luthra, S., Mishra, N., Singh, A., Rana, N., Dora, M., Dwivedi, Y. (2018) Barriers to effective circular supply chain management in a developing country context. *Production Planning and Control*. **29**(6), 551–569.

Marley, K.A., Ward, P.T., Hill, J.A., Marley, K.A., Ward, P.T., Hill, J.A. (2014) Mitigating supply chain disruptions – a normal accident perspective.

Masi, D., Kumar, V., Garza-Reyes, J.A., Godsell, J. (2018) Towards a more circular economy: exploring the awareness, practices, and barriers from a focal firm perspective. *Production Planning and Control*. **29**(6), 539–550.

McBurney, D.H. (1994) *Research Methods*. 3rd ed. Belmont, California: Brooks/Cole Publishing Company.

McDonough, W., Braungart, M. (1992) *The Hannover Principles: design for sustainability*. Charlottesville, Virginia.

McDonough, W. (2018a) Cradle to Cradle: remaking the way we make things (2002). *website*, 1–8. [online]. Available from: http://www.mcdonough.com/writings/cradle-cradle-remaking-way-make-things/ [Accessed May 15, 2018].

McDonough, W. (2018b) The Hannover Principles: Design for Sustainability. *Writings*, 1–5. [online]. Available from: http://www.mcdonough.com/writings/the-hannover-principles/ [Accessed August 15, 2018].

Meixell, M.J., Luoma, P. (2015) Green supply chain management and the circular economy: reviewing theory for advancement of both fields. *International Journal of Physical Distribution & Logistics Management*. **45**(1/2), 69–89.

Ménard, C. (2013) Plural Forms of Organization: Where Do We Stand? *Managerial and Decision Economics*. **34**, 124–139.

Michelini, G., Moraes, R.N., Cunha, R.N., Costa, J.M.H., Ometto, A.R. (2017) From Linear to Circular Economy: PSS Conducting the Transition. *Procedia CIRP*. **64**, 2–6.

Miller, A.D., Umina, P.A., Weeks, A.R., Hoffmann, A.A. (2012) Population genetics of the wheat curl mite (Aceria tosichella Keifer) in Australia: Implications for the management of wheat pathogens. *Bulletin of Entomological Research*. **102**(2), 199–212.

Ministerio da Saude - Brasil (1993) Portaria nº 1428, de 26 de novembro de 1993 ementa. , 1–18.

Ministerio da Saude - Brasil (1997) Portaria svs/ms nº 326, de 30 de julho de 1997. , 1–8.

Ministerio do Meio Ambiente - Brasil (2011) *Manejo de Residuos Solidos Urbanos: destaques da Politica Nacional de Residuos Solidos*. Brasilia.

Mishra, J.L., Hopkinson, P.G., Tidridge, G. (2018) The Management of Operations Value creation from circular economy-led closed loop supply chains : a case study of fast-moving consumer goods. *Production Planning & Control*. **29**(6), 1–13.

Mol, A.P.J., Oosterveer, P. (2015) Certification of markets, markets of certificates:

Tracing sustainability in global agro-food value chains. *Sustainability (Switzerland)*. **7**(9), 12258–12278.

Mollenhauer, M. (2019) Sugar bread a Nigerian favorite. *World-Grain*, 1–3. [online]. Available from: https://www.world-grain.com/articles/11654-sugar-bread-a-nigerian-favorite [Accessed January 8, 2021].

Mondelli, M.P., Klein, P.G. (2014) Private equity and asset characteristics: The case of agricultural production. *Managerial and Decision Economics*. **35**(2), 145–160.

De Mori, C. (2011) *Capacidade Tecnológica em Sistemas Agroindustriais: proposição de índice e aplicação a empresas dos segmentos de trigo e leite*. Federal University of São Carlos.

Mori, C. De, Ignaczak, J.C. (2012) Aspectos Econômicos do complexo agroindustrial do trigo. In J. L. F. Pires, L. Vargas, & G. R. da Cunha, eds. *Trigo no Brasil: bases para produção competitiva e sustentável*. Passo Fundo: Embrapa, pp. 41–76.

Morioka, S.N., Carvalho, M.M. (2016) Measuring sustainability in practice: exploring the inclusion of sustainability into corporate performance systems in Brazilian case studies. *Journal of Cleaner Production*. **136**, 123–133.

Motloch, J. (1995) Regenerative Design for Sustainable Development. . **32**, 198–201.

Mugwagwa, I., Bijman, J., Trienekens, J. (2019) Why do agribusiness firms simultaneously source from different contract farming arrangements? Evidence from the soybean industry in Malawi. *International Food and Agribusiness Management Review*. **22**(1), 79–96.

Murray, A., Skene, K., Haynes, K. (2017) The Circular Economy: An Interdisciplinary Exploration of the Concept and Application in a Global Context. *Journal of Business Ethics*. **140**(3), 369–380.

Murrell, K.D., Djordjevic, M., Cuperlovic, K., Sofronic, L., Savic, M., Djordjevic, M., Damjanovic, S. (2004) Epidemiology of Trichinella infection in the horse: The risk from animal product feeding practices. *Veterinary Parasitology*. **123**(3–4), 223–233.

nabim (2007) *Corporate Social Responsability*. London.

nabim (2017) *UK Flour Milling Industry 2017*. London.

nabim (2018a) *Flour milling in the UK facts and figures 2018*. London.

nabim (2018b) *Wheat Guide 2018*. London.

nabim (2019) *2019 Facts and Figures - Flour milling in the UK*. London.

Nadeem, S.P., Garza-Reyes, J.A., Anosike, A.I., Kumar, V. (2019) Coalescing the lean and circular economy. *Proceedings of the International Conference on Industrial Engineering and Operations Management*. **2019**(MAR), 1082–1093.

Neuman, W.L. (2014) *Social Research Methods: qualitative and quantitative approaches.* 7th ed. Essex: Pearson.

Neves, M.F., Kalaki, R.B., Rodrigues, J.M., Gray, A.W. (2019) Strategic Planning and

Management of Food and Agribusiness Chains: The ChainPlan Method (Framework). *Review of Business Management*. **21**(4), 628–646.

Nozharov, S.S. (2018) Transaction costs in collective waste recovery systems in the EU. *Economic Archive*. **1**, 18–31.

Nozharov, S. (2019) THE INSTITUTIONAL ECONOMICS OF COLLECTIVE WASTE RECOVERY SYSTEMS: AN EMPIRICAL INVESTIGATION. *IDEAS Working Paper Series from RePEc*. **arXiv.org,** 1–10.

OCB (2018) *Agenda Institucional do Cooperativismo*. Brasilia.

OCEPAR (2017) *Relatorio de Atividades e Prestacao de Contas 2016*. Curitiba.

OCEPAR (2020) *Informe agroeconômico*. Curitiba.

OCERGS (2017) *Expressão do Cooperativismo Gaúcho 2017*. Porto Alegre.

Oliveira, G.M. de, Zylbersztajn, D. (2018) Make or buy: the case of harvesting mechanization in coffee crop in Brazil. *International Food and Agribusiness Management Review*. **21**(7), 895–914.

ONS (2017) Expenditure on food and non-alcoholic drinks by place of purchase, UK. , 2.

Pagotto, M., Halog, A. (2016) Towards a Circular Economy in Australian Agri-food Industry: An Application of Input-Output Oriented Approaches for Analyzing Resource Efficiency and Competitiveness Potential. *Journal of Industrial Ecology*. **20**(5), 1176–1186.

Pauli, G. (2016a) The Blue Economy: a report to the club of Rome. *The Blue Economy*, 1–3. [online]. Available from: https://www.theblueeconomy.org/ [Accessed August 16, 2018].

Pauli, G. (2016b) The Blue Economy Book. *The Blue Eco*, 1–3. [online]. Available from: https://www.theblueeconomy.org/the-book.html [Accessed August 16, 2018].

Pearce, D.W., Turner, R.K. (1989) The Circular Economy. In *Economics of Natural Resources and the Environment*. Essex: Johns Hopkins University Press, pp. 29–42.

Perez, C., Castro, R., Furnols, M.F. i (2009) The pork industry: a supply chain perspective. *British Food Journal*. **111**(3), 257–274.

Pimbert, M. (2015) Agroecology as an Alternative Vision to Conventional Development and Climate-smart Agriculture. *Development*. **58**(2–3), 286–298.

Pires, A., Martinho, G. (2019) Waste hierarchy index for circular economy in waste management. *Waste Management*. **95**, 298–305.

Pires, J.L.F., Acosta, A. da S., Lemainski, J., Caierão, E., Strieder, M.L., Pereira, P.R. do V. da S., Vargas, L., Consoli, L., Bona, F.D. De, Vieira, V.M., Consoladora, A., Manfron, A., Pires, P.C.V., Feltraco, S.L., Richter, R., Kuntzler, L., Pilecco, M., Zanchet, D. (2017) Validação de sistema de produção para trigo padrão exportação em cooperativas do Rio Grande do Sul. In *Reunião da Comissão Brasileira de Pesquisa de trigo e triticale, 11.; Fórum Nacional de Trigo.* Cascavel - PR: Comissão Brasileira de Pesquisa de trigo e triticale, pp. 358–362.

Pretty, J., Bharucha, Z.P. (2018) *Sustainable intensification of agriculture*. 1sr ed. Abingdon, UK: Earthscn from Routledge.

Rajeev, A., Pati, R.K., Padhi, S.S., Govindan, K. (2017) Evolution of sustainability in supply chain management: A literature review. *Journal of Cleaner Production*. **162**, 299–314.

Reefke, H., Sundaram, D. (2017) Key themes and research opportunities in sustainable supply chain management – identification and evaluation. *Omega (United Kingdom)*. **66**, 195–211.

Reeves, T.G., Thomas, G., Ramsay, G. (2016) *Save and Grow in practice - Maize Rice Wheat: a guide to sustainable cereal production*. T. G. Reeves, G. Thomas, & G. Ramsay, eds. Rome: FAO - Food and Agriculture Organization of the United Nations.

Remenyi, D., Williams, B., Money, A., Swartz, E. (1998) *Doing research in business and management: an introduction to process and method*. 1st ed. London: Sage Publications.

Retail Economic (2018) UK RETAIL STATS & FACTS. *Key stats*, 1. [online]. Available from: https://www.retaileconomics.co.uk/library-retail-stats-and-facts [Accessed October 31, 2018].

Riding, M.J., Herbert, B.M.J., Ricketts, L., Dodd, I., Ostle, N., Semple, K.T. (2015) Harmonising conflicts between science, regulation, perception and environmental impact: The case of soil conditioners from bioenergy. *Environment International*. **75**, 52–67.

Rocha, F.V. da, Péra, T.G., Bartholomeu, D.B., Caixeta Filho, J.V. (2017) Mensuração de perdas de pós-colheita na cadeia de suprimentos de moageiras do trigo no Rio Grande do Sul. *Teoria e Evidência Econômica*. (48), 39–62.

Rogers, D.S., Tibben-Lembke, R.S. (1998) *Going Backwards: Reverse Logistics Trends and Practices*. Reno, Nevada: Reverse Logistics Executive Council.

Rogers, E.M. (1983) *Diffusion of Innovations*. 3rd ed. London: Collier Macmillan Publishers.

Romero, D., Rossi, M. (2017) Towards Circular Lean Product-Service Systems. *Procedia CIRP*. **64**, 13–18.

Rossi, R.M., Neves, M.F. (2004) *Estrategias para o trigo no Brasil*. 1st ed. Sao Paulo: Editora Atlas.

Rural Business Research (2019) Farm Business Survey Datasets. *Farm Business Survey - Gross Margin UK Winter Wheat*, 1. [online]. Available from: https://www2.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/Publications/FASdata [Accessed December 28, 2020].

Sa, H.S. de, Azevedo, D.B. de (2012) Pirataria de Sementes: Influências e Riscos para o Agronegócio Brasileiro. *Revista da ABPI*. **120**(Set/Out), 23–37.

Sa, H.S. de, Castro, T.M. de, Junqueira, A.M.R., SIlva, I.S. da (2013) Pirataria de Sementes : Impactos sobre a Qualidade dos Alimentos e Segurança Alimentar Global. *Revista da ABPI*. **126**(Set/Out), 36–49.

Saunders, M., Lewis, P., Thornhill, A. (2016) *Research methods for business students*. 7th ed. London: Pearson.

Sauvé, S., Bernard, S., Sloan, P. (2016) Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environmental Development*. **17**, 48–56.

Schofield, N.C. (2007) Agricultural Commodities and Biofuels. In N. C. Schofield, ed. *Commodity Derivatives: markets and applications*. Chichester: John Wiley & Sons, Incorporated, p. 11.

SEBRAE (2017) *Estudo de Mercado: industria de panificacao*. Salvador - BA.

Secretary of State (2013) The Food Safety and Hygiene (England) Regulations 2013. , 1–44.

Sekaran, U. (2003) *Research methods for business: a skill building approach*. 4th ed. New York: John Wiley & Sons, Incorporated.

Seuring, S., Müller, M. (2008) From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*. **16**(15), 1699–1710.

Seuring, S., Gold, S. (2012) Conducting content-analysis based literature reviews in supply chain management. *Supply Chain Management: An International Journal*. **17**(5), 544–555.

Sharpe, S., Giurco, D. (2018) From trash to treasure: Australia in a take-make-remake world. *Australian Quarterly*. **89**(1), 19–44.

Shewry, P.R. (2009) Wheat. *Journal of Experimental Botany*. **60**(6), 1537–1553.

Shewry, P.R., Hey, S.J. (2015) The contribution of wheat to human diet and health. *Food and Energy Security*. **4**(3), 178–202.

Shin, H.-D. (2003) *The role of Uncertainty in Transaction Costs and Resource-Based theories of the firm*. Ohio State University.

Simon, H.A. (1972) Theories of Bounded Rationality. In C. B. McGuire & R. Radner, eds. *Decision and Organization*. North-Holland Publishing Company, pp. 161–176.

Smith, J., Barling, D. (2014) *Glamur Project UK Wheat to Bread Supply Chain Case Study*. London.

Sorensen, C.G., Pesonen, L., Fountas, S., Suomi, P., Bochtis, D., Bildsøe, P., Pedersen, S.M. (2010) A user-centric approach for information modelling in arable farming. *Computers and Electronics in Agriculture*. **73**(1), 44–55.

Stahel, W.R. (1982) Product-Life Factor. *Mitchel Prize*, 1–10.

Stahel, W.R. (2016) Circular Economy. *Nature*. **531**, 435–438.

Stake, R.E. (1995) *The Art of Case Study Research*. 1st ed. New York: Sage Publications.

Statista (2018) *Market share of grocery stores in Great Britain from August 2012 to*

*August 2017**. London.

Stock, J.R., Boyer, S.L., Harmon, T. (2010) Research opportunities in supply chain management. *Journal of the Academy Marketing Science*. **38**, 32–41.

Straub, E.T. (2009) Understanding technology adoption: Theory and future directions for informal learning. *Review of Educational Research*. **79**(2), 625–649.

Su, B., Heshmati, A., Geng, Y., Yu, X. (2013) A review of the circular economy in China: Moving from rhetoric to implementation. *Journal of Cleaner Production*. **42**, 215–227.

Teo, T.S.H., Yu, Y. (2005) Online buying behavior: A transaction cost economics perspective. *Omega*. **33**(5), 451–465.

The Ellen MacArthur Foundation (2013a) *Towards a Circular Economy Vol. 1 - Economic and Business rationale for an accelerated transition*. Cowes.

The Ellen MacArthur Foundation (2013b) *Towards a Circular Economy Vol. 2 - Opportunities for the consumer goods sector*. Cowes.

The Ellen MacArthur Foundation (2014) *Towards a Circular Economy Vol. 3 - Accelerating the scale-up across global supply chains*. Cowes.

The Ellen MacArthur Foundation (2015a) *Delivering the circular economy - a toolkit for policymakers*. Isle of Wight.

The Ellen MacArthur Foundation (2015b) *Towards a Circular Economy - Economic and Business: Rationale for an Accelerated Transition*. Isle of Wight.

The Ellen MacArthur Foundation (2019) *Cities and Circular Economy for food*. Cowes.

The European Parliament, Council of the European Union (2002) REGULATION (EC) No 178/2002 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 28 January 2002 laying down the general principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters of food saf. , 1–24.

The Product-Life Institute (2017) About - The Product-Life Institute. *Website*, 1–2. [online]. Available from: http://www.product-life.org/en/about [Accessed August 10, 2018].

The United Nations - General Assembly (2018) Sustainable Development Goals. *Sustainable Development Knowledge Platform*, 1. [online]. Available from: https://sustainabledevelopment.un.org/sdgs [Accessed August 8, 2018].

The United Nations - General Assembly (2015) Transforming our world: the 2030 Agenda for Sustainable Development. , 1–35.

The University of Northampton (2018a) Governance and management: sustainability. *About us*. [online]. Available from: https://www.northampton.ac.uk/about-us/governance-and-management/sustainability/ [Accessed March 16, 2018].

The University of Northampton (2018b) Our achievements. *About us*, 1. [online]. Available from: https://www.northampton.ac.uk/about-us/our-achievements/ [Accessed March 16, 2018].

The World Bank (2015) *World Development Indicators: Electricity production, sources, and access*. Washington.

Tibola, C.S., da Silva, S.A., Dossa, A.A., Patrício, D.I. (2018) Economically Motivated Food Fraud and Adulteration in Brazil: Incidents and Alternatives to Minimize Occurrence. *Journal of Food Science*. **83**(8), 2028–2038.

Toop, T.A., Ward, S., Oldfield, T., Hull, M., Kirby, M.E., Theodorou, M.K. (2017) AgroCycle - Developing a circular economy in agriculture. *Energy Procedia*. **123**, 76–80.

UN.A.F.P.A. (2016a) Estimate of world pasta production (tons). , 1–2.

UN.A.F.P.A. (2016b) Pasta consumption in the E.U. (2006 - 2015). , 1–2.

United Nations (1987) *Report of the World Commission on Environment and Development*. New York.

Urbinati, A., Chiaroni, D., Chiesa, V. (2017) Towards a new taxonomy of circular economy business models. *Journal of Cleaner Production*. **168**, 487–498.

USDA (2017) Brazil wheat usage and imports.

Vasconcelos, D.C. De, Viana, F.L.E., Batista, L. (2018) An Integrative View between Circular Economy and Sustainable Supply Chain Management. In *5th International EurOMA Sustainable Operations and Supply Chains Forum*. Kassel, pp. 1–10.

Venkata Mohan, S., Nikhil, G.N., Chiranjeevi, P., Nagendranatha Reddy, C., Rohit, M. V., Kumar, A.N., Sarkar, O. (2016) Waste biorefinery models towards sustainable circular bioeconomy: Critical review and future perspectives. *Bioresource Technology*. **215**, 2–12.

Vitasek, K. (2013) Supply chain management: Terms and Glossary. *Supply chain management: Terms and Glossary*, 1–222.

Vlajic, J. V., Mijailovic, R., Bogdanova, M. (2018) Creating loops with value recovery: empirical study of fresh food supply chains. *Production Planning and Control*. **29**(6), 522–538.

Wander, A.E. (2013) The importance of transaction costs in agriculture - a review of selected empirical studies. *RBPD – Revista Brasileira de Planejamento e Desenvolvimento*. **2**(2), 118–129.

Weetman, C. (2017) *A Circular Economy Handbook for Business Supply Chains - repair, remake, redesign, rethink*. KoganPage.

Welch, C., Piekkari, R. (2017) How should we (not) judge the ‘quality’ of qualitative research? A re-assessment of current evaluative criteria in International Business. *Journal of World Business*. **52**(5), 714–725.

Wever, M. (2012) *Chain-wide consequences of transaction risks and their contractual solutions: managing interdependencies in differentiated agri-food supply chains*. Wageningen University.

Wever, M., Wognum, P.M., Trienekens, J.H., Omta, S.W.F. (2012) Supply chain-wide consequences of transaction risks and their contractual solutions: Towards an extended transaction cost economics framework. *Journal of Supply Chain Management*. **48**(1), 73–91.

Wheat Foods Council (2015) How flour is milled. *Wheat Basics*. [online]. Available from: http://www.wheatfoods.org/sites/default/files/atachments/how-flour-milled.pdf [Accessed May 23, 2018].

Wheat Initiative (2014) Wheat Facts. , 1. [online]. Available from: http://www.wheatinitiative.org/sites/default/files/attached_file/wheat_facts.pdf.

White, M.A. (2013) Sustainability: I know it when I see it. *Ecological Economics*. **86**, 213–217.

Whiteside, J., Dani, S. (2020) Influence of Organisational Culture on Supply Chain Resilience: A Power and Situational Strength Conceptual Perspective. *Journal of Risk and Financial Management*. **13**(7), 147.

Williamson, O.E. (1998) Transaction cost economics: How it works; where it is headed. *Economist*. **146**(1), 23–58.

Williamson, O.E. (2007) Transaction Cost Economics : An Introduction. *Economics Discussion Papers*. **3**, 1–32.

Williamson, O.E. (2008) Outsourcing: Transaction cost economics and supply chain management. *Journal of Supply Chain Management*. **44**(2), 5–16.

Winfield, M. (2013) Milling. *Wheat, The Big Picture*. [online]. Available from: http://www.cerealsdb.uk.net/cerealgenomics/WheatBP/Documents/DOC_Milling.php [Accessed May 23, 2018].

Wognum, N., Trienekens, J., Omta, O. (2012) Managing transaction risks in interdependent supply chains : An extended transaction cost economics perspective. *Journal on Chain and Network Science*. **12**(3), 243–260.

Wolsink, M. (2010) Contested environmental policy infrastructure: Socio-political acceptance of renewable energy, water, and waste facilities. *Environmental Impact Assessment Review*. **30**(5), 302–311.

WRAP (2013) *Hotspots, opportunities & initiatives: bread & rools*. Banbury.

WRAP (2019) *The Food Waste Reduction Roadmap 2019*. London.

Wulff, B.B.H., Dhugga, K.S. (2018) Wheat - the cereal abandoned by GM. *Science*. **361**(6401), 451–453.

Yang, M., Smart, P., Kumar, M., Jolly, M., Evans, S. (2018) Product-service system business models for circular supply chains. *Production Planning and Control*. **29**(6), 1–31.

Ye, X., Ye, Y., Chai, R., Li, J., Ma, C., Li, H., Xiong, Q. (2019) The influence of a year-round tillage and residue management model on soil N fractions in a wheat-maize cropping system in central China. *Nature Scientific Reports*. (March), 1–10.

Yin, R.K. (2018) *Case study research and applications: design and methods*. 6th ed.

London: Sage Publications.

Yong, R. (2007) The circular economy in China. *Journal of Material Cycles and Waste Management*. **9**(2), 121–129.

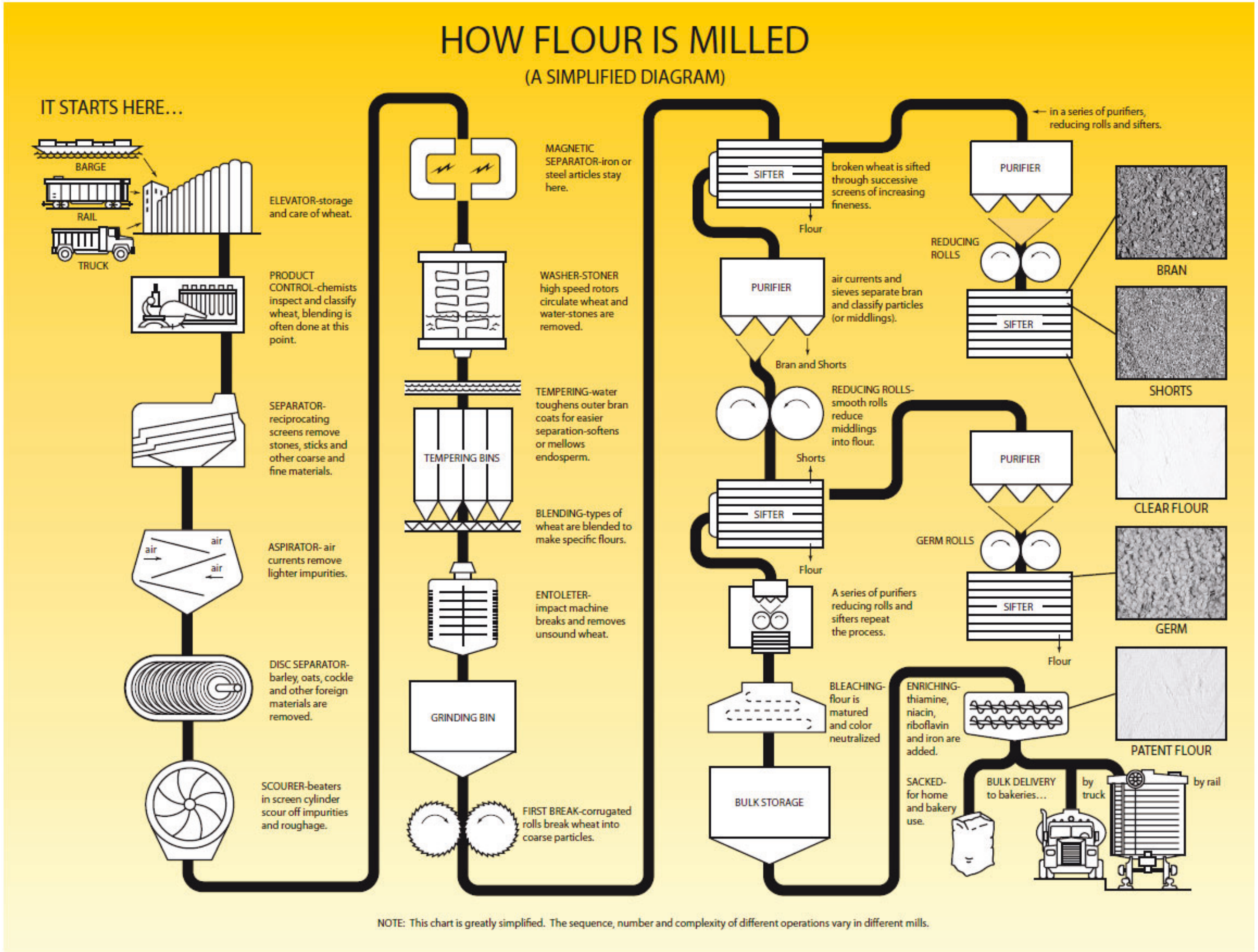
Yu, C., Davis, C., Dijkema, G.P.J. (2014) Understanding the evolution of industrial symbiosis research: A bibliometric and network analysis (1997-2012). *Journal of Industrial Ecology*. **18**(2), 280–293.

Zink, T., Geyer, R. (2017) Circular Economy Rebound. *Journal of Industrial Ecology*. **21**(3), 593–602.

Zipkin, P. (2012) A Reply to Williamson' s 'Outsourcing …'. *Production and Operations Management*. **21**(3), 465–469.

Zschocke, J.C.F.M. (2019) The Argentinian wheat milling industry - characterizing the operations of its two main company types. *International Food and Agribusiness Management Review*. **In press**, 601–620.

**APPENDIX A - HOW FLOUR IS MILLED (A SIMPLIFIED DIAGRAM)**




Source: (Wheat Foods Council, 2015)

## APPENDIX B – EXAMPLES OF CE DEFINITIONS

Examples of definitions from peer-reviewed and not peer-reviewed sources

| Definition | Source |
|---|---|
| "A circular economy is an industrial system that is restorative or regenerative by intention and design" | (The Ellen MacArthur Foundation, 2013a, p.7) |
| "Circular economy is the concept of closing material loops to preserve products, parts, and materials in the industrial system and extract their maximum utility" | (Zink and Geyer, 2017, p.593) |
| "Circular Economy is a system where resources are reused and kept in a loop of production and usage, allowing to generate more value and for a longer period" | (Urbinati *et al.*, 2017, p.487) |
| "(...) Circular Economy [is] a regenerative system in which resource input and waste, emission, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling." | (Geissdoerfer *et al.*, 2017, p.759) |
| "A Circular Economy is an alternative to a traditional linear economy (make, use, dispose), in which we keep resources in use for as long as possible, extract the maximum value from them whilst in use, then recover and regenerate products and materials at the end of each service life." | (Weetman, 2017, p.376 citing WRAP - Waste and Resources Action Programme) |
| "(...) Circular Economy refers to industrial production systems that are restorative and regenerative in purpose, where products, components and materials are kept in the market at their highest utility and value in the long term" | (Batista *et al.*, 2018a, p.438 citing Webster (2015)) |
| "A Circular Economy describes an economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations." | (Kirchherr *et al.*, 2017, pp.224–225) |
| "[Circular Economy is] a generic term for the reducing, reusing and recycling activities conducted in the process of production, circulation and consumption" | (CCICED, 2008 as cited by Ghisellini *et al.*, 2016) |
| "Circular economy is an economy constructed from societal production-consumption systems that maximizes the service produced from the linear nature-society-nature material and energy throughput flow. This is done by using cyclical materials flows, renewable energy sources and cascading-type energy flows. Successful circular economy contributes to all the three dimensions of sustainable development. Circular economy limits the throughput flow to a level that nature tolerates and utilises ecosystem-cycles in economic cycles by respecting their natural reproduction rates." | (Korhonen *et al.,* 2018a, p.39) |

## APPENDIX C – SEMI-STRUCTURED INTERVIEW SCRIPT

**What are the Circular Economy practices in a wheat food supply chain in Brazil and the UK?**

1. In your organisation, what do you consider are practices or operations that are linked to sustainability? *(This is in any form, environment, social, economic, etc.)*

2. Considering this list of practices, which do you think, your organisation pro-actively engage regarding wheat? *(Can you elaborate a little on each one?)*
   - (  ) Reduction of waste ____________________
   - (  ) Reduction of inputs____________________
   - (  ) Reuse____________________
   - (  ) Recycle____________________
   - (  ) Redesign products____________________
   - (  ) Redesign services ____________________
   - (  ) Redesign processes____________________
   - (  ) Redistribution (market substitution) ____________________
   - (  ) Recovery (taking back from consumers for adequate disposal) ________
   - (  ) Recovery (incineration of waste)____________________
   - (  ) Reclassify (identify as lower grade and sell cheaper)________________
   - (  ) Repurpose (change the use e.g., food to feed)____________________
   - (  ) Renewable energy use____________________
   - (  ) Measure sustainable practices (e.g., recycle, reduction of waste, etc.) ____
   - (  ) Maintaining prices of new pro-sustainability products________________
   - (  ) Purchase of inputs and services that are cleaner ____________________
   - (  ) Cooperation with other organisations for sustainability________________
   - (  ) New logistical options that are more sustainable____________________
   - (  ) Education and training of staff and managers for sustainability practices__
   - (  ) Environmental certification (e.g., ISO 14000) ____________________
   - (  ) Targeting the market of "green customers"____________________
   - (  ) Other ____________________

3. How did these practices or operations started here, what were the drivers? *(Examples: legislation, clients demanded, competition demanded….)*

4. What were the barriers and the benefits to implement these practices?

5. Do you think that competitors have different practices, or do you reckon that things are homogeneous throughout the sector?

**What are the main wastes and by-products in a wheat food supply chain in Brazil and the UK?**

6. What do you classify as waste in the wheat products here?

7. What is the percentage of wheat products do you estimate that are wasted in a normal month?

**8.** Where this waste comes from? *(For instance, problem with logistics, with technology, with the operations…?)*

**9.** What do you do with the waste? *(Sell it, donate it, burn it, landfills…?)*

**10.** What about waste from auxiliary practices, like water, plastic, how do you deal with it?

**11.** What about by-products, do you have them? If so, how do they affect your operations?

**12.** Do you think that these practices with the waste are pretty much the same throughout the sector, or there is no homogeneity?

**What are the characteristics of the relationships between the organisations that are part of the wheat food supply chain in Brazil and the UK?**

**13.** Can you tell me who or which are the most important suppliers from your organisation wheat/wheat-based products? If so, which is?

**14.** Can you tell me who or which are the most important buyers from your organisation wheat/wheat-based products? If so, which is?

**15.** Considering your clients and your suppliers, what type of relationships are more common with them? (Formal, informal, temporary, sporadically, long term…?)

**16.** What are the advantages and the disadvantages of this type of relationships with the clients and the suppliers?

**17.** Does the overall sector use the same system of relationships with their clients and their suppliers? If not, what is more common?

**18.** Is it possible to consider your product as a specific or highly different from your competitors? If so, why?

**19.** Do your buyers verify your products and operations to make sure it follows their standards? If so, how?

**20.** Do you have partnerships with other players, like universities, NGOs, etc.? What kind of relationships are these?

**21.** Do financial operations, such as investing in currency fluctuation, or future markets, influence your operations? If so, in what way?

## APPENDIX D – PARTICIPANT INFORMATION SHEET

My name is **Alvaro Dossa**, and I am a Ph.D. student of the **University of Northampton** in its Faculty of Business and Law, and I am an analyst from the Brazilian Agricultural Research Corporation (Embrapa) researching the **wheat food supply chain**. This research is supported (funds, supervision, etc.) by the University of Northampton.

The aim of my PhD is to investigate the role that the interactions between organisations in a long-food supply chain, in this case, the British and the Brazilian wheat food supply chain, have in the diffusion of Circular Economy practices.

I would like to request your participation, answering a set of questions regarding your **company sustainability (circular economy)** practices and the **relationships** with other organisations. This interview should take more than 30 minutes. The questions do not involve any company secrets or sensitive topics. Circular Economy is the economic system that by intention and design, moves past the make-use-dispose of materials and products, in favour of a loop of these elements, maximizing utility and/or value, and that through operational practices, business models and governmental policies, increases the chance of a sustainable, restorative and regenerative triple bottom line.

I assure you that the research will be anonymous, and you and your company will not be named. All the data will be kept in the University of Northampton online servers for at least 2 years. If you have any questions or suggestions, feel free to contact me at any moment.

Also, I understand that you have a busy schedule, and might be receiving several of such requests, and because of this, I will endeavour to give you the following results after the research:
a) A digital copy of the completed research thesis for your analysis;
b) Suggestions for improvements for your operations if encountered;
c) A report of each of the circular economy practices that we identify in the companies studied in each country.

Alvaro Augusto Dossa
University of Northampton

## APPENDIX E – CONSENT FORM

**Title of Project:** ***Wheat food supply chain: a comparative study of sustainability issues concerning Brazil and the United Kingdom through Circular Economy lenses.***

Thank you for taking part in this research.

If you have any questions regarding the aims and objectives of the research, the confidentiality of the research, why it is being undertaken, the duration of the research, etc., please find the information provided on the Participants Information Sheet or ask the researcher any questions.

You will be given a copy of this Consent Form to keep and refer to at any time.

Important Note:
a. If you do not understand any aspect or would like further information please do ask.
b. If you **do not consent** to the numbered statements below, please mark it and we can discussed further.
c. Sign the bottom of the sheet if you agreed with the consent form.

| | I **agree** | I **disagree** | |
|---|---|---|---|
| 1. | ( ) | ( ) | I have read and understood the Participant Information Sheet dated ___________and know what the research involves. |
| 2. | ( ) | ( ) | I have been given the opportunity to ask questions about the research and my participation. |
| 3. | ( ) | ( ) | I voluntarily agree to participate in the research and understand that I can withdraw my participation at any time during the interview. |
| 4. | ( ) | ( ) | I understand that if criminal activity is clearly identified during the research, it will be reported to the proper authorities. |
| 5. | ( ) | ( ) | I understand that I may be contacted at a later date of this interview for further clarification. |
| 6. | ( ) | ( ) | I understand that I have the right to erasure up to 30 days after this interview, without having to explain my reasoning, and my record of participation will be destroyed. After the 30 days period, I will be unable to withdrawal from the research. |
| 7. | ( ) | ( ) | The procedures regarding confidentiality have been clearly explained to me I understand that my identity will be kept as anonymous in all the outputs of this research. |
| 8. | ( ) | ( ) | I understand and agree that my participation involves taking part in the interviews being audio recorded. |
| 9. | ( ) | ( ) | The use of the data in the research, publications, sharing and archiving has been explained to me. |
| 10. | ( ) | ( ) | I understand that this data will be kept at the University of Northampton and its online systems and may be used for articles or reports as an output of this research thesis, but my confidentiality and anonymity will be maintained. |
| 11. | ( ) | ( ) | I agree to participate in this data collection as outlined to me above. |

| ________________________________ | ____/____/____ | _______________________ |
|---|---|---|
| **Name of Participant** | **Date** | **Signature** |

If you have any questions, please contact the researcher at the following:
Name of researcher: Alvaro Augusto Dossa
Email: alvaro.dossa@northampton.ac.uk or alvaroaugusto@gmail.com
Tel: +44 (0)737 902 6661 (the UK) or +55 (54) 9 8141 6110 (Brazil)

## APPENDIX F – SAMPLE OF TRANSCRIPTS' TRANSLATION

| Original transcript (Portuguese) | Translated transcript (English) |
|---|---|
| Interview: Supermarket chain 1 | |
| Alvaro 00:25:10 – É, então temos um conjunto de práticas que vem, a grosso modo, da teoria da indústria técnica, e nós estamos tentando ver quais delas existem realmente na cadeia do trigo. Se puder marcar algumas, se quiser falar alguma coisa sobre cada uma delas e que sejam realizadas por aqui, especialmente a questão 2 (Alvaro entrega o questionário).<br><br>Participante 00:25:26 – (Participante está lendo o formulário) Listas de práticas que você considera... realizar... relativas a trigo. Redução de desperdício é com relação a tudo, a trigo também, então eu vou considerar. Redução de insumos e reuso propriamente não. Reciclagem.... Com relação a tudo, nas mais variadas formas, mas quando eu falo especificamente sobre trigo, talvez não seja o caso porque eu não tenho, por exemplo, eu não pego pão duro e moo, que seria uma forma de reciclar o trigo nesse caso, né, então acho que não seria passível de ser marcado. Redesign de produtos, o que significaria esse redesign de produtos? | Alvaro 00:25:10 - Yes, so we have a set of practices that comes, roughly speaking, from theory on technical industry, and we are trying to see which ones really exist in the wheat chain. If you can check some, if you want to say something about each of them and that are practiced here, especially question 2 (Alvaro gives the questionnaire).<br><br>Participant 00:25:26 - (Participant is reading the form) Lists of practices that you consider ... carrying out ... relating to wheat. Waste reduction is about everything, wheat too, so I will consider it. Reduction of inputs and reuse not exactly. Recycling .... Regarding everything, in the most varied forms, but when I talk specifically about wheat, it may not be the case because I don't have it, for example, I don't take hardened bread and grind it, which would be a way to recycle wheat in this case, right, so I think it would not be possible to be checked. Product redesign, what would this product redesign mean? |

## Appendix G – CE practices in the Brazilian wheat food supply chain

| Practices | Farmer 1 | Farmer 2 | Farmer 3 | Extensionist | Grain merchant | Cooperative 1 | Mill 1 | Mill 2 | Mill 3 | Cooperative 2 - mill 4 | Mill association | Agri-food industry | Industrial bakery | Supermarket chain 1 | Cooperative 2 - supermarket 2 | Supermarket chain 3 - in-store | Craft bakery | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduction of waste | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 16 |
| Reduction of inputs | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 14 |
| Reuse | 1 | | 1 | 1 | 1 | | | | | 1 | | 1 | 1 | | 1 | 1 | 1 | 10 |
| Recycle | | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 1 | 1 | 12 |
| Redesign products | | 1 | | | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 12 |
| Redesign services | 1 | 1 | | | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | | 1 | | 1 | 11 |
| Redesign processes | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 14 |
| Redistribution (market substitution) | | 1 | 1 | | 1 | 1 | | 1 | | 1 | | 1 | 1 | 1 | 1 | | | 10 |
| Recovery (taking back from consumers for adequate disposal) | | | | | 1 | 1 | | | | 1 | | | 1 | | 1 | | 1 | 6 |
| Recovery (incineration of waste) | | | | | | | 1 | | 1 | | | 1 | 1 | | 1 | | 1 | 6 |
| Reclassify (identify as lower grade and sell cheaper) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | 15 |
| Repurpose (change the use e.g. food to feed) | | | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | | 1 | 1 | | | | 9 |
| Renewable energy use | | | | | 1 | 1 | | | 1 | | | 1 | 1 | | | | | 5 |
| Measure sustainable practices (e.g. recycle, reduction of waste, etc.) | | 1 | | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 12 |
| Maintaining prices of new pro-sustainability products | | | 1 | | 1 | 1 | | | 1 | 1 | | | 1 | 1 | 1 | | 1 | 9 |
| Purchase of inputs and services that are cleaner | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 14 |
| Cooperation with other organisations for sustainability | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 16 |
| New logistical options that are more sustainable | | | 1 | | 1 | | | | 1 | 1 | | | | 1 | 1 | | | 6 |
| Education and training of staff and managers for sustainability practices | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 16 |
| Environmental certification (e.g. ISO 14000) | | | | | 1 | 1 | | 1 | 1 | | 1 | 1 | | | 1 | | | 7 |
| Targeting the market of "green customers" | | 1 | | | | | | | 1 | | 1 | | | 1 | 1 | 1 | | 6 |
| Other | | | | | | | | | | | | | | | | | | 0 |
| Total | 9 | 12 | 13 | 9 | 18 | 16 | 10 | 10 | 13 | 17 | 11 | 15 | 18 | 10 | 19 | 11 | 15 | |

## Appendix H – Diffusion of CE practices in the Brazilian wheat food supply chain

### a) <u>Barriers:</u>

Market issues:

"In general, Alvaro, in Brazil, we are still guided by the economic issue, profitability. It is what moves the producer the most. And then, I exemplify this, we already have this soya bean sequence, in the main area, the main summer cultivation, 95%, 90/95% of the area with soya beans repeating, this is 6, 7, maybe 10 years ago . This is a problematic practice, from the point of view of diseases, pests and soil management. Soil management, this has already been pointed out, is the return of erosion, in a very expressive way. For you to convince the producer to change this system at any time, at some point, it is only if he has some economic loss. Then you start to show the problem of erosion, he started to have problems with falling productivity in periods of drought, because he is losing soil, he is losing fertility, then he starts to have a slightly different posture. The fear of the producer, when we talk about integrated management of pests and diseases, the great fear of the producer is to lose productivity and profitability. This scares the producer a lot about this: "If you don't apply it, your crops will be eaten, then you will lose.", So he is very afraid in this economic part. There are rare exceptions, there are rare exceptions that the producer has a positioning a little more in this line of sustainability, like: "I adopt soil conservation management, because I have had experience there in the past, I have lived it, I I already experienced that and I know the importance of doing this type of practice. ", so it is a lot of moments. In Paraná, we have already had several moments in history, here, that REDACTED <Rural Extension Company>, REDACTED <Public Research Company 2> invested heavily in good practices, soil management, pest management in soya beans , this is a program back in the 80s. From the moment we left this scenario, thinking that this was already resolved and, farmers, cooperatives were going to play this, we left, and the problem returned. So, the motivator is economical. Today, unfortunately, we are still in this, only in this bias_." <u>BR Extensionist</u>.

"In the pasta factories in Brazil today, they are almost all familiar. So, it evolved very little (the request for more sustainable products). And for domestic (flour) and bakery, zero. The domestic, I would say that today, there are people looking at the label, but it is still a population, it is a very low percentage of the population. So, there is already this, people wanting to use wholegrain, wanting to know where the wheat came from, it exists, but it is still very little. So, where do I have the demand for sustainability? In multinationals. Why? Because they are companies that have a world view. They already come here with the vision of other countries." <u>BR Mill 2</u>.

"For us here, it's just trucks. For them there, I think it's all a truck too, because these wheats, they sell everything in the area here, you know, to make bread or pasta, if it's pasta. Because, wheat, most of the wheat is imported. So, the imported wheat sometimes stays more in the region closer to the ports and such, right. Here it is well consumed. What jeopardizes the wheat a little for us, and that has always been so, is that the government facilitates the importation of wheat. They subsidize interest, and sometimes the mills pay a little more, it's not because it's better, no, they pay a little more on imported wheat than our wheat, you understand. When we have wheat to sell, if you count imported wheat, put in the port, from the port up here, it's much more expensive, but they don't pay the same price. Only when some of the wheat is needed, then our price even out with the price of imported wheat. We started with wheat up to R$ 51,00 reais, right, today what? R$ 40,00 reais?" <u>BR Farmer 1</u>.

Economic issues:

"It's lowering the price, because technology is also becoming more and more accessible, you know, and it's becoming people's agenda. Gradually it turns. These days I used to say, here inside I said, "Wow, I'm going, I'm doing a renovation of my house and I'm going to put a photovoltaic panel. "" Wow, but is it worth it? ". I said:

"At least it will make me happy to know that I did something within my reach on the planet", "Ah, you are very nice", but a nice executive appears and tomorrow the other one arrives and says "How much did it cost? ", understood. Then slowly you will have people getting involved with this." Supermarket chain 1.

"It will influence. It will always influence. I will be giving you the option of taking less home instead of consuming more. Suddenly, I'm being nice to you, but I'm not being good with the business. I think that we all start from adding value, not the other way around. If I need to sell two to be profitable, suddenly, than I would have in one. You, today, in our region, our regional population is not increasing. Consumption is not increasing, people are wanting to eat better. You see here, in the purchasing sector, an increase in product options, and my, yerba mate I think we have more than 50, 100 brands in the region. Some that come and go. It's too much. Flour, how many brands do you have in the state of Rio Grande do Sul. And that goes in other products. The cleaning line, perfumery. New industries forming, small industries. And all seeking market." BR Cooperative 2 – supermarket.

"So, there are things that are cost, really cost, like what I can tell you, it is cost, let's say, we don't have enough staff to do more, because we work very lean like that. So, I'm procurement, but I do several things in addition. Quality people too, yes, they are loaded with work, so to seek more, we don't have another development-only department, so we add functions. So, it also makes it a little harder, it takes longer for us to look for new alternatives, you know, then. But we always follow the law." BR Industrial Bakery.

## Culture and social issues:

"Yes, but then, in question, the question is, do you improve his time, the product's useful life, the customer, the customer doesn't want that." BR Craft Bakery.

"I would say that we (BR Mill 3) are well ahead. Right in front. And whether you like it or not, we still are, we are a little bit away from this culture of, there in Europe, Asia, it depends on Asia and the United States, right, with regard to sustainability, right." BR Mill 3.

"As you become aware, you have a layer of the population that prefers this product, you know. You still have a layer that, in addition to being poor, is ignorant, right. But as you can, and there are both scenarios, you know, when people evolve economically, until they don't understand so much of the impacts of it, but they accept it more easily. When the guy is still in the poverty streak, so to speak, there it is, it becomes more difficult for you to convince them of anything, because it is that expensive thing, "hey, I ate the last Bem-te-vi (common bird from Brazil) from the face of the earth, but I didn't die of hunger, fuck the Bem-te-vi ", he understood." Supermarket chain 1.

## Management issues:

"Information, information, you know. Information, there has to be a lot of information, we, the Brazilian, he, he is doubtful, you know. He does not believe. We are unbelievers, right? For example, the person, if I reach a person: 'Look, this bread is made, it is made with wheat like this, like this, like this, baked', you know? Yeah, 99% of people don't want to know about it." (…) "Price, right? Even more, if I reach out to him, it's almost easier for me to be dishonest, I reach out and increase and don't say anything, right. And that if I arrive and say to him: 'Look, I'm going to have to charge you 2 cents more, like this, like this, roasted', that we talk about a large number of people, 90% of people do not want." BR Craft Bakery.

"A little difficult, Alvaro, because when you enter this environment of integrated pest management, there are few cooperatives that have this from a commercial perspective. From the point of view of, of philosophy, they even mention this, but when it goes to practice, you have the need to make a cooperative cash viable, the commercial strategy, it ends up being stronger. And there is a very strong race here, in Paraná, which is like this: the summer harvest is over, companies, almost all of them, are already selling for the next harvest. They are already negotiating the next one, the inputs for the next harvest. And then, in this, in this sale, we have not been able to make much interference with the cooperatives." BR Extensionist 1.

## Governmental issues:

"There's nothing to do, right. Brazilian law is very strict on this issue of food reuse." BR Mill 1.

"But if it were to pay the price you pay in the city (for electricity), then we would have already put it (solar panels). We already took a look at this, even with 50%, is almost, we are almost doing it. We have been researching here, here this year there will be people from a company coming here, doing a demonstration, here at REDACTED <local technical fair 1>. It's very likely we'll do yes." BR Farmer 1.

"Today, today if you are going to make any product, for example, with wheat, imported wheat, right, good wheat, pure wheat, strong wheat, your production cost is very high. It is not viable, you cannot sell your product. Your product will be very expensive on the shelf, right. So, we are, we are obliged, you know, obliged to defend yourself here, you know, to seek knowledge of, of, between the best product or the least worst, with price. Because our tax burden is huge. Our tax burden here is, it almost makes you unfeasible for you to work and produce, you know. Every day, you know. Every time you go, you go to a meeting, you go to a lecture, you come back discouraged that you know, how things work, how laws work, you know. What the law protects, who the law protects, is complicated" BR Craft Bakery.

## Technological issues:

"Everyone tries, tries to sell. Everyone tries to sell and I tried to sell for a long time, it is difficult for you to find a buyer, right. I make commit myself, in breadcrumbs, not to mix anything. For example, I cannot mix sweet bread. I cannot mix any other type of bread except French bread. Only French bread. In my breadcrumbs there is only French bread. Why? Because the guy will use it in his coxinhas (Brazilian pastry) there, right. And if it is, if there is sweet flour in the middle, when the guy's client, who bought his product, put it in the oil, this one, this coxinha is going to get dark. You will try the flour because of the sugar. So the guy will have a problem in the future too. So, I have to be true to what I do too." BR Craft Bakery.

## Knowledge and skills issues:

"In some cases, we advise the producer on the possibilities. But in the case of wheat, in particular, as it takes a long time to make a decision as to whether it will grow next year or not, we have not been very active. Because in Paraná, Brazil, you have the possibility to register, for example, a seed field, it is not a seed field, you will register a field of grains, so you can reserve a part of that grain for you to cultivate, with the right to access PROAGRO, financing, within the legal framework. So this, this kind of attitude we have with farmers, we guide them, but in wheat, specifically, as he hardly makes a decision for 2 or 3 years, if he is going to farm, sometimes he gives up, right , he ends up, practically, every year acquiring the inputs, seed, for example, takes new seed". BR Extensionist.

"Internally, too, you have the challenge of, for example, staff turnover, you always keep your team engaged and trained with the objectives of REDACTED <BR Cooperative 1>. So, you have people recycling, there are changes in collaborators, you have to be constantly doing this training and improvement." BR Cooperative 1.

"Training, I think. Training and technical support, because, it turns out, most of the technicians who serve here in the region, are salespeople for the companies." (...) "But I think this issue, our biggest difficulty, is with assistance. Just like now, a gentleman started talking to us about on-farm multiplication, biological stuff, and then we're going to take part in a course, a training about it in REDACTED <city in western Paraná> (about 5 hours away from the farm, only accessible by car).” BR Farmer 1.

**b) Drivers:**

## Society – Consumer demands

“No, no, I think the big driver is society's behaviour. Society is moving towards that, understood. So, I believe that in the future, the crowd there with the media there, really, are getting faster, this diffuses very quickly, so it's another behaviour, right, and our consumer is really going for this line. We can't really refuse or close our eyes to it. So, it is really through a consumption trend, you know, that you see value in all this. So we believe that, because our client is also believing.” BR Mill 3.

“Yeah, what I told you about, glyphosate, this issue of, this issue of falling number, let's put some very specific things like that, now that I like, I have been doing a management project here, management for certified seeds, it's something that, saved seed, here it must be about 50% of the region, or more, 70, 80%, that's a lot. And I'm looking for certification, that I really have a better final product. What happens is that the saved seeds have efficiency problems, right? The first year has passed, the second year, the third year, you no longer have a quality seed. So I demand from the group, there are farmers that I make this requirement, and it is something that the industry is taking, I have to pay a little more for this, but I am interested in this operation.” BR Mill 1.

“We are also bringing fruit, get everything inside it ... In fact, we started with eggs. When I joined the company 1 year and 4 months ago, the first time that someone in the sustainability area came to me, 3 or 4 months later it was to say: “I need to talk to you about a problem that we are having. We are being contacted by several international organisations, there are several NGOs to talk about the creation of eggs production is with cage free. Then I said: “ok, this is an agenda that for me is very important, it is very interesting” (…) “Cage free. I said: "this is an important issue for me, let's sit down and talk". And then from there we started talking about eggs, you know. So, for example, I'm ready, I'm just depending today on our presidency to agree to the terms, I'm ready to sign an agreement with REDACTED <environmental NGO 2> committing us that, in 3 years, 100% of our production of own brand eggs comes from cage free farms, and in a space of up to 10 years, that is, we are talking about 2029, probably 100% of the eggs sold, of all brands come from this same type of supplier.” Supermarket chain 1.

## Product development – Increase product efficiency

“If you can produce something by reducing input, you know, getting one, increasing the volume, right, lowering the cost, is all you can. If you can reuse some energy or product, transform it.” Cooperative 2 - supermarket.

## Policy and economy - Compliance to regulation

“Yeah, so this already had a problem, the Public Ministry (Brazilian prosecutors office) acted, so much so that it is being created a… there is one today, an operation they are creating, what they call green curtains, they would be the surroundings of, of the cities for you to have zero pesticide use, create a green curtain with, with an arboreal species that would prevent drift from reaching the urban environment, right.” BR Extensionist.

## Health - Concern with public health

“Mycotoxins, the DOM, all that stuff. He needs this and he needs this flour to be good, that is, to be suitable for the product he is going to manufacture. They are very demanding, for example, large biscuit factories.” BR Mill Association.

## Product development – increase in product value

"No, no, because here's the thing, here if you speak, you want to add. In reality, it is the following: we, the market in general, want to add value to things. Understood? So, he usually says: "No, it's sustainability, organic.", Whatever it is, the title you want to put on, it really has its bias of adding value, at first, you know. That's why I say it is, it is controversial in the sense of wanting to use that fashion word or something, okay, to generate value or generate margin, understand? This is the detail of the controversial that I told you about." BR Mill 3.

"Yeah, what I told you about, glyphosate, this issue of, this issue of falling number, let's put some very specific things like that, now that I like, I have been doing a management project here, management for certified seeds, it's something that, saved seed, here it must be about 50% of the region, or more, 70, 80%, that's a lot. And I'm looking for certification, that I really have a better final product. What happens is that the saved seeds have efficiency problems, right? The first year has passed, the second year, the third year, you no longer have a quality seed. So I demand from the group, there are farmers that I make this requirement, and it is something that the industry is taking, I have to pay a little more for this, but I am interested in this operation." BR Mill 1.

"Productive potential decreases even more. So we are like this, in a region very suitable for wheat blast (fungal disease caused by *Pyricularia grisea*). The wheat blast, about 2 or 3 years ago, decimated our productivity right here, above 80%. And when it's not the blast, we've been unlucky for dry years. So there is, there is a little side to the wheat producer. It is our challenge. It was even one of the reasons I met REDACTED <researcher from a public research firm 1>, we created a pilot project here, just like REDACTED <BR Cooperative 2> has in the South, to segregate wheat. By type, by quality. So we segregated last year, we dedicated whitener wheat, whitener breeder, we did it with REDACTED <Wheat variety 1> from REDACTED <wheat breeding company 1>, we managed to segregate. The volume was small, the forecast was to segregate 3 thousand tons, with the drought and with the break we reached 550 tons. Of stored and approved wheat. Only we add 7.5% of the value of the price of wheat bread. So, this wheat that went all in a common grave, with the same currency, we managed to separate it and pay 7.5% more to the grower. It is a way to stimulate the producer." BR Cooperative 1.

## Environmental protection - Reduce environmental impact

"So, the following, the question of interconnecting with nature, I think it is very ideological, for you to take care of it." BR Grain-merchant.

"All of them, all of them. And even the others, you spoke of REDACTED <competitor supermarket chain 6> from Curitiba, for example, the theme of, of egg, cage-free chicken, REDACTED <competitor supermarket chain 6> signed an agreement with, I don't remember what the institution was now, but anyway, it signed, committing itself until 2023, if I remember correctly, not to sell more and such, and it's a small company, a company with 7, 8 stores, you know , but they are people concerned with the environment, concerned, today they are under pressure from opinion-forming bodies, not yet, you see. REDACTED <BR Supermarket 1> is subscribing now. REDACTED <competing supermarket chain 2> signed 1 month ago, REDACTED <competing supermarket chain 3> signed last week. You see? So the guys did a lot more for believing. In REDACTED <competitor supermarket chain 4> in Rio de Janeiro the same thing, you know. So even smaller companies are adopting this awareness. But among the big ones, they are already very widespread practices." Supermarket chain 1.

## Environmental protection - Adapt agriculture

"It depends on how deep you want to go. When I talk about work, I am evaluating whether the guy, when the employee lives on the property, in what condition he is sleeping, in what condition he is eating, in what condition he is drinking. If he has a child, if school transportation is being made available for that child to study, if he has a wife, what condition is this wife living in. They charged him for rent, and that in relation to salary, pro-labore, or how it is. So this whole evaluation, in the smallest details to understand if the question of labour is sustainable. When you go to the environment, I'm evaluating whether the guy, as he stores an oil that he uses to supply a machine on the property, a harvesting equipment. If he changes the oil on a tractor, where does the old oil go? It is stored as and how it is intended. The property's garbage, what destination does it give? Does it separate? It separates garbage with metal, plastic, paper and sends it for recycling, collects everything and delivers how?" Agri-food industry.

## Environmental protection - Concern with sustainable development

"It is part of the company's philosophy. Exactly. I think in cooperativism as a whole. I think that if you take, separate, cooperatives from private companies, from private companies, the private company is very aggressive with, with profitability and profit, right. Not that REDACTED <BR Cooperative 1> is not, profitability is in our vision, to grow profitably, but this growth with profitability is so that the organisation remains active and returns benefits to the associated." BR Cooperative 1.

## Health - Concern with animal health

"There are a lot of birds here, I really like this bird around. But when they eat treated wheat, some birds can die. So, I pick all this wheat, it's about 2 or 3 sacks, I have, I have an equipment that I make a hole, sometimes there in same place, and I bury it. I burry. There are times when the cooperative receives, it has a receiving process. Now, some time ago, REDACTED <BR Cooperative 1> is not receiving, REDACTED <Cooperative that no longer exists 1> started receiving, you know. When they had that problem, then they started guiding: "When you have a sack of treated seed, for God's sake, don't put it in, it's happened like this, like this. Bring us that, we have a place." BR Farmer 1.

NGO, through the media there, is an impressive business. (asked if they had a problem with activists). There are invariably one or the other that we really have to go to court to defend ourselves and then ... Because the gang is fast too, right. Something happens there and now. (…) They already know and speak, so they have to defend themselves. And sometimes, most of the time, it is unfounded. Supermarket chain 1.

## Policy and economy - Governmental incentives

"Exactly. We do these reference units, for example, for the integrated management of pests... How do we work: we established a technical protocol, in common agreement between research and extension. So, you bring all the knowledge that the research has on pest and disease management and turn it into a protocol. Protocol is a two-page walkthrough that tells us what needs to be done. And the basic premise is monitoring. So, in this case, weekly monitoring. That's what we can do, we can do this type of monitoring. Take, for example, soya bean, we established this in the last year, a REDACTED <Project name 3>, REDACTED <Project name 3>, for monitoring Asian rust, is the big problem in soya bean, right, so people established a REDACTED <Project name 3>. There were 212 collectors. Except that this information, today, in the form of a network, it ended up circulating throughout the state of Paraná, so when the rust arrived in the state of Paraná, we warned the producer: "Now you have favourable conditions for the development of rust. It is the time to apply (fungicide)", or " It is not the time to apply", So this is something that is difficult, that is why we speak, it is difficult to quantify, because this information circulates very fast today, through digital tools, right, people make it circulate very, very fast." BR Extensionist.

## Society - Organisations expansion

"It has been, more or less, about 8 years or so, that we left, right, to make that link between the field and the table, right? Then there is the raw material, goes through the supermarket and turns it back, right, to the farmer, in this case." BR Cooperative 2 – supermarket.

### Society - Urbanisation and its influences

"Yes, it is. That's right, it's more, in fact, for us to remain active in society, right. In society, you can't say no to everything, you know. You, turn and move, you have to, you have to, you have to be active, right. You can't just say no to people." BR Craft Bakery.

(asked about the importance of the consumer visualising the product) "For sure. I have no doubt. It is very important for the consumer... because in an economic chain, you know, if there is no value for the consumer, there is no market. If you don't have a market, who will you produce for? Or why, right? It needs to have value for the consumer, so for you to reach a sustainable practice in the field, you need, leaving the guy's table to feel good about it all, right. When you talk about agricultural production, be it wheat, whatever, sometimes the way of perceiving it is a little different than it is when it comes to an animal product. Some institutions, some NGOs around the world have drawn attention to the theme of eggs, for example, because they spread chicken blood in the nets, throw rotten eggs in the nets, make a damned fuss and it moves the public a lot more, right, it alerts. You will do this with a wheat, it does not cause half the suffering, which people do not understand, whether it is wheat or any other agricultural product, poorly produced, it can cause damage to the environment, the environment as we know it passes by transformation. It is less palpable, the most that people perceive from the environment on a daily basis is: heat, it can still be attributed to the casuistry or when it passes in front of a river, like Tietê and say; "Oh, because in the countryside, looking at Tietê is so clean", he takes a shower there and I get here in São Paulo, and then the guy doesn't even realize it. Otherwise, the environment for him or sustainable practices (participant gestures with the hands of: screw it) and etc. they spend a bit on television and the guy sits with the possibility of having a remote control in his hand and if the subject is not pleasant he changes the channel." Supermarket chain 1.

## c) **Enablers:**

### Partnerships and collaboration across the value chain

"Yes, here I can mention one, maybe in Europe it is even more developed. We use a tool, cooperation with other organisations for sustainability, we have a model that was developed, in fact it was leveraged initially by REDACTED <Multinational food company 2> in Europe and today it is already in Brazil too, which is SAI platform which is sustainable agriculture, sustainable agriculture, I will not remember I what it is but it is a platform (…) SAI platform, which is a platform that works in parallel with the FSA, which is a model for evaluating rural property and we have it, was developed by REDACTED <Multinational food company 2>, initially funded by REDACTED <Multinational food company 2> but today it is available to all companies that want to participate, including you cited REDACTED <BR Cooperative 1> participates, REDACTED <Multinational food company 3>, REDACTED <Mixed multinational company 1>, REDACTED <Multinational food company 4> then, and cooperatives such as REDACTED <BR Cooperative 1>, so several players in the market who were interested or if they come to have can participate. Unique, there is no royalty, there is nothing for that, there is only a contribution amount to keep the tool working and the physical structure of it all." Agri-food industry.

"So if you don't think about the entire chain, you can't survive. You just can't see yourself as your isolated business, you have to look at your customer and your supplier. If this is not integrated, you will not survive in agribusiness. Because,

because the margin is very low. And wheat, being a product, a very new open market, it took a while for this to happen.” BR Mill 2.

## Organisational characteristics

“Yeah. We would even have a facility in asking the question of solar energy because we have one, I don't know if you got to observe it there, but we have a very, very wide terrain that we could use the plates there and it is also close of the substation, so I wouldn't have so much trouble with that. But then, as it is a cooperative issue, we also have to work on this issue, you know...” BR Cooperative 2 – mill 4.

## Existing systems of support

“So, we don't, we don't have it that way. It is hard to do with them. Sometimes they come to see our crops, such and such. But we have a big friendship with these people here, because we make some parcels, right? Look there, look, see, look (Participant points to farm area). The parcels, REDACTED <rural extension company> comes, and this year should have about 25 parcels from there. Each company has 1 or 2 varieties. From REDACTED <public research firm 1> included. All varieties. Sometimes there are varieties of wheat that weren't even released to the public yet, you know. It's there, for us to see, there is a demonstration, we accompany it, which is inside here, right? Then there's a day of REDACTED <local technical fair 1>, REDACTED <rural extension company>, the company itself comes, put a little stand near their wheat there, and then ... The advantages of the variety, what this variety produces. Today, there is a lot of bread making wheat, right, they say that is the right wheat, because there is variety of wheat that sometimes produces well, but not very good for bread. Sometimes he's good for cookie, he's good for, for...” BR Farmer 1.

## Digital tools

“Yes, this, this is demanding. Only this way, I'll tell you, Alvaro, a perception. The farmer, he has not, he has not participated so much. I don't know if, if it is a social media issue, he has a lot of contact, right? If you take it there, the farmer today, with his smartphone, he researches a technology that he is interested in, he finds videos, tutorials, in short. The farmer participates, but he is no longer participating so actively in these types of collective activities. Today, what he has used a lot is a question of digital tools, he has, he has demanded a lot, right.” BR Extensionist.

## New internal incentives

“It also starts to be part of our agenda. It wasn't, but it starts to be part now. Yes, things like slave labour, child labour and etc., social welfare in the region where the company is located. It all starts to come to our agenda now. But other networks already have this more developed, including.” Supermarket chain 1.

“What I see is that the cooperative has an important link in the sustainable part: our agronomists, our technicians are not commissioned. So, you know that, mainly resellers (term used in Brazil to describe retailers of agricultural inputs), right, private ones, the guy earns on commission. The guy's fixed salary is a little lower salary and the more he sells, it is X reais per litre. So REDACTED <BR Cooperative 1> doesn't have that, in REDACTED <BR Cooperative 1> the employee earns a fixed salary, and all employees of the company, if the company reaches the trigger at the end of the year have a share of the results. So, we do not charge for... of course, everyone has a goal, there is a goal to achieve, there is a sales target, there is a target for receipt, everyone has to have a goal to have a north, but within REDACTED <BR Cooperative 1> the agronomist will sell what the producer needs, so if the producer is in need of a fungicide application now, he will position it, now if that crop is already close to harvest he will not have to do a fungicide application.” BR Cooperative 1.

## Working with regulators and policy makers

“Productive potential decreases even more. So we are like this, in a region very suitable for wheat blast (fungal disease caused by *Pyricularia grisea*). The wheat blast, about 2 or 3 years ago, decimated our productivity right here, above 80%. And when it's not the blast, we've been unlucky for dry years. So there is, there is a little side to the wheat producer. It is our challenge. It was even one of the reasons I met REDACTED <researcher from a public research firm 1>, we created a pilot project here, just like REDACTED <BR Cooperative 2> has in the South, to segregate wheat. By type, by quality. So we segregated last year, we dedicated whitener wheat, whitener breeder, we did it with REDACTED <Wheat variety 1> from REDACTED <wheat breeding company 1>, we managed to segregate. The volume was small, the forecast was to segregate 3 thousand tons, with the drought and with the break we reached 550 tons. Of stored and approved wheat. Only we add 7.5% of the value of the price of wheat bread. So, this wheat that went all in a common grave, with the same currency, we managed to separate it and pay 7.5% more to the grower. It is a way to stimulate the producer." BR Cooperative 1.

## Access to finance

"(Regarding acquiring solar panels) We have done research and it is expensive. And also, as it is, is something that is coming very fast, in an evolution, it is cheapening very fast. Our credit cooperative, now, they are offering a very low interest financing line of credit, payment in up to 8 years, if I'm not mistaken..." BR Farmer 1.

## Appendix I – CE practices in the UK´s wheat food supply chain

| Practices | Farmer 1 | Farmer 2 | Extensionist | Assurance scheme | Farmer cooperative | Grain merchant 1 | Grain merchant 2 | Mill 1 | Mill 2 | Mill association | Industrial bakery | Craft bakery | Food distribution charity | Beer-making charity | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reduction of waste | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 13 |
| Reduction of inputs | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | | 1 | 11 |
| Reuse | 1 | 1 | | 1 | | 1 | | | 1 | | 1 | 1 | 1 | 1 | 9 |
| Recycle | 1 | 1 | | 1 | | 1 | | | 1 | | 1 | 1 | 1 | 1 | 9 |
| Redesign products | | 1 | 1 | | | 1 | 1 | | 1 | | 1 | 1 | | 1 | 8 |
| Redesign services | | | 1 | | | 1 | 1 | | | | 1 | 1 | 1 | | 6 |
| Redesign processes | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | | | 1 | 1 | 1 | 1 | 11 |
| Redistribution (market substitution) | 1 | 1 | | | | 1 | | | | | 1 | 1 | 1 | | 6 |
| Recovery (taking back from consumers for adequate disposal) | | | | | | 1 | | | | | | | | | 1 |
| Recovery (incineration of waste) | | | | | | 1 | | | | | 1 | | | | 2 |
| Reclassify (identify as lower grade and sell cheaper) | 1 | 1 | | | 1 | 1 | 1 | 1 | 1 | | 1 | | | | 8 |
| Repurpose (change the use e.g. food to feed) | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | | 1 | 10 |
| Renewable energy use | 1 | 1 | | 1 | 1 | 1 | | | | | 1 | 1 | | 1 | 8 |
| Measure sustainable practices (e.g. recycle, reduction of waste, etc.) | | | 1 | 1 | 1 | 1 | 1 | | | | 1 | 1 | 1 | 1 | 9 |
| Maintaining prices of new pro-sustainability products | 1 | | | | | 1 | | | | | | | | 1 | 3 |
| Purchase of inputs and services that are cleaner | 1 | | | 1 | 1 | 1 | | | | | 1 | | | 1 | 6 |
| Cooperation with other organisations for sustainability | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 13 |
| New logistical options that are more sustainable | 1 | 1 | | 1 | 1 | 1 | | 1 | | | 1 | 1 | 1 | 1 | 10 |
| Education and training of staff and managers for sustainability practices | | 1 | 1 | 1 | 1 | 1 | | 1 | | 1 | 1 | 1 | 1 | 1 | 11 |
| Environmental certification (e.g. ISO 14000) | 1 | | | | 1 | 1 | | | | | | | | 1 | 4 |
| Targeting the market of "green customers" | | | | 1 | | 1 | | | | | 1 | 1 | | 1 | 5 |
| Other | | | | | | | | | | | | | | | 0 |
| Total | 14 | 13 | 8 | 12 | 11 | 21 | 8 | 6 | 8 | 4 | 17 | 15 | 10 | 16 | |

## Appendix J – Diffusion of CE practices in the UK´s wheat food supply chain quotes

### a) **<u>Barriers:</u>**

#### Market issues:

"Me personally, okay, so, so my barriers are very much location based. So, when I say a barrier, it's almost an opportunity, but you have to develop that relationship to have that opportunity. But the barriers are, well, where we are. So, we don't have many livestock farms in the, in the area. Whereas if you went down in the Southwest, you have more muck than you do arable land. It's a totally different dynamic. Whereas around here, yes, I have a relationship with, with a livestock farmer, but if REDACTED <other farmer name>'s farming next door suddenly wants to get some muck, he can't get it." UK Farmer 1.

"So, so a greater interest in supply chain, given that wheat is relatively low risk, you don't get, sort of health issues caused by... well, there was no health issue caused by the meat, it was more about being misleading in terms of what was happening, but... So, there is a greater focus and emphasis now on this revamp in the supply chain but when it comes to milk and things like what's perishable, then clearly those practices and issues have always been more prevalent than they are with wheat. You can store for quite a few years, it's not going to go off particularly, unless it's kept badly. And so it doesn't really present, you know, too many issues in the supply chain." UK Grain-merchant 2 – cooperative.

"And, as you know, so it's sort of like a very difficult cycle because the retailer's say: "well, the consumer demands variety, the consumer demands full shelves, the consumer demands choices, the consumer demands long dates and for us to be able to do those things, for us to have a variety of different breads, for us to have full shelves of breads" because, you know, when you go to the supermarket at the end of the day, you see half of the empty shelves, things not there, the retailers don't like that. So in order for them to maintain full shelves with variety, with in-day bread, they need to have a lot of bread, as we use that as the example, they need to have a lot available to put out onto the shelves, otherwise the consumers are going to go to somewhere else, go somewhere else. But the consumers, we say: "Well, you know, we don't really care if the onions don't look perfect, you know, you're the ones... the retailers buy the onions, and you say: 'consumers won't like these onions', so we're not going to buy them". And that makes... so it's this cycle of retailers saying: "no, no, we do it because it's what the consumer wants". And the consumer saying: "Well, you know, I buy from the retailer, what, what choice do I have", you know, and so it's this sort of circle, when, of course, the individuals food waste and food surpluses is small compared to the... but I would also say, as well, that it's not just the retailers, it's also the manufacturers who supply the retailers. A lot of these retailers, they keep their suppliers on very short contracts, you know, that they can cancel last minute if things don't go to plan. And so that, like you were saying with the farmers that leaves the manufacturers in a position where they say: "Well, look, we need to overproduce, we need to overproduce because they might not want everything that we've got and we need to recoup some of our losses, you know, we need to do something, so we need to overproduce to try and sell"..." UK Food distribution charity.

#### Economic issues:

"I think for us some of the stuff like, that's only like, for instance, turning things into fuel... sustain, you know, it's just we, we just don't have the volumes to kind of look into, you know, for a lot of that kind of stuff our volumes are so small in the bigger picture that some of that stuff is just... doesn't really feature kind of thing you know, so we do, with the size operation, we have, we do what we can, but some of that stuff is like more for like big, big players type of stuff. You know, if we've got that big, we'd definitely look at it, whereas it's not that we don't do it because we just think:

"can't be bothered". It's just we're not, not that size. So, it's mainly the size." BR Craft bakery.

"Profit is, is part of it, because of, there's lot of farmer customers, but some milling customers as well. It's a, it's a dog-eat-dog business, is the milling industry, as you've seen with REDACTED <name of a milling company> recently, folding effectively. But, but from a farmer's perspective, our customers are not making a lot of money at the moment. So, profit would, would be the biggest break, to them making that sort of change. Coming back to what I've just said, you need to be making money to have the luxury to make some decisions that aren't necessarily purely financial. And our customers at the moment are in a situation where they're having to make purely financial decisions. So, to persuade them to behave differently, it's not always easy." UK Grain-merchant 1 – private.

"There's, it's, there's, there's two sides to that: yes, it is, in a company structure, sometimes it's easier, because you have to justify everything, your job is purely growing crops. That's your, that's your job. Whereas I've got lots of other things going on, so there's always something else going on in my head. But on the flip side, I have the ability to say: "well I'll, I'll establish a relationship with a local shepherd, and we'll get some, will get some sheep in, because I feel it is the right thing to do and I know it's good long term". Whereas if, particularly if there's any expense to that, again, organic, putting in organic manures back on, without having to buy them... I know of a local farm manager that he's not allowed to do that, because his boss says: "well, if I'm going to spend 50 pounds a hectare, what I'm going to get back for it"? So, there is a... there is... it's both, it's both." UK Farmer 2.

## Culture and social issues:

"Our customers tell us the most important things about In-Store Bakery are… Freshness, Seeing the baker top up products regularly, Quality, Look & Feel of the product is KEY, Availability, Product throughout the day." UK Supermarket chain 5. Presentation given at British Society of Baking – 2018.

"We're trying to raise awareness of the causes of, and solutions to food waste, and creating a more sustainable future in general. And that is not... that widespread. That's not, that... we're trying to do that on a global scale, we're not trying to do that, just to the minority percentage of the population that are extremely sustainably minded. Or that will make their... or just the part of the population that will make their, their purchasing choices based on factors such as "how sustainable is the product"? Because there are... there is a large, a large percentage of the population does do that now thankfully. But not all of them. And you know, we want all of them to be doing that, so, REDACTED <name of non-profit> is one way of switching that model to, you know, making more sustainable choices with their purchases." UK Beer making charity.

## Management issues:

"Yeah, yeah, it's all to do the culture. Yeah. And its still very family orientated. And cost is hugely important, because the margin of flour is so small. So if you do mix that into it, it's... it wouldn't be worth their time to invest in, to buy all the solar power panels, if we could really be doing with another milling, those kind of things. So we've got to be selective about how we use funds as well, because, you know, we aren't a multinational, which is still... we're big, but we're not huge". UK Mill 2.

"So REDACTED <mill/industrial bakery> that are a part of associated REDACTED <large food company> quite a large business, they probably have more, it's more effective for them to have someone in their company who is kind of focusing on sustainability. And they will have very close contact with retailers. I think if I'm being honest, I don't believe that at the moment, there is a significant push from milling industry customers to demonstrate sustainability credentials. For us to be showing with, you know, improving sustainability in our supply chain. I think the focus is really on food safety and things like traceability. So ensuring that your flour conforms with mycotoxins and agrochemical low residue laws, everything's under the maximum levels and making sure your supply chain is behaving appropriately. That's not to say that we aren't working on projects that have sustainability built in. I suppose you heard a lot about nitrogen at the milling wheat conference. So milling wheat, so to get that protein level higher... so you have the stronger gluten that we need for UK bread making. You need to add more nitrogen than if you would just grow for animal feed and that has an environmental implication, as has been identified in the DEFRA clean air strategy, which was launched, I don't know if it was launched this year, but it's certainly was certainly being consulted on the second half of 2018. So there's an implication there as to how those new rules of nitrogen fertiliser that can affect the milling wheat supply chain. I don't know if the strategy is gone to the, you know, it's gone to a detailed level yet in terms of saying 'you can't put on more than this' or whatever. But there is... that could potentially restrict what farmers do in terms of nitrogen fertiliser application." UK Mills association.

## Governmental issues:

"Yeah, the same day, the same day, so we wouldn't even be able to necessarily do anything with it. You know, if if, if REDACTED <supermarket chain 2> or REDACTED <supermarket chain> turned around and said: "we've got 10 cages of, like you said, the tiger loaves or the French sticks". I'd say to them: "well, what's the date on it?" And they say: "Oh, well, it's best before tomorrow". And I say: "well..."" UK Food distribution charity.

"They're reducing the cost. However, a lot of the time, a lot... the reason why there is this slight disparity, is that a lot of the surplus goes to, as you said, animal feed and also anaerobic digestion, and that's subsidised by the government. Because... and then so, if a supplier has a load of surplus, then the government or whoever, it's cheap for them to send in a vehicle, collect it all, take it for anaerobic digestion, turn it into energy, turn it into animal food, animal feed. And so what REDACTED <food distribution charity> has done is, we've turned around and we've gone: before you make energy, before you feed the animals, don't you think that maybe the… some of humans should…?" UK Food distribution charity.

"Yeah, the bees. So, in parts of the country, the fact that they don't have neonicotinoids now to control Cabbage stem flea beetle, has decimated oilseed rape crops. So, in that particular scenario, you're gonna see a situation where it's going to be a lot less oilseed rape grown. So does that lead to a situation where you go into contract grown? Now it's not that somebody's can't go into contract grown... normally, normally contract grown products start out of a... because of scarcity." UK Grain-merchant 2 – cooperative.

## Technological issues:

"(issues with straw for muck deals) Yes, a bit. There is, yes. Some farms use their own, so they produce straw and on their own farm and use that for their livestock enterprise and then muck from the livestock enterprise goes into the arable enterprise. And that often happens. The problem comes when you get the ones that are only arable and the others are, perhaps, only livestock, and some've got too much manure because of Nitrate Vulnerable Zone regulation. Do you know about those? Yeah. They've got more manure than they can use for their land. They are glad to get rid of it. Livestock farmers, sorry, the arable farmers pick the manure for their land. So, if they can match up, it can work very well. The big problem with that is introducing weeds, particularly black grass. And this means that some farmers have been a bit hesitant about doing that. Because they don't want to bring a load of straw in from just anywhere, because they might be just importing a load of trouble. Black grass in particular, that's the one everybody is frightened of, so while... you tend to find that if people are doing the so called straw for muck deal..." UK Extensionist.

"Oh yeah, sure. So we have our own fleet here we have around a hundred lorries here... and we still have to take in contractors to do our work because we just... we're just that busy that we need to have extra people coming in and it is a concern of ours I suppose, but we'll... still always have fossil fuel vehicles, because there's not an electric vehicle at an affordable price, that will do what a fossil fuel vehicle can do. We need to go up to Manchester and back every day so we don't have an electric vehicle that could do that and... but we've got, you know, eighty lorries on site that could do that and so it's... it is a concern of ours but at the moment there is nothing we can do except, I don't know, buy a mill beside the bakery... or, you know, that's the only thing we can really do is... our big bakery at Manchester and buy a mill up there but I mean that's something that's not really a sensible way to deal with the problem, is just something that happens in our industry when you carry such a specialised product, you just come in take other stuff back." UK Mill 2.

### Knowledge and skills issues:

"(regarding knowledge of the agricultural levy) No. So I work with REDACTED <agriculture board> as well, I sit on the main board. So it's not on the main board, I sit on the oilseeds board and there's... I can't remember exactly what the categories are called, but there's four types of farmers: some engaged, some don't, some have an understanding, some don't. Most farmers, if you ask them, they wouldn't know where their levy was, because it's too insignificant for them... £0.46p a tonne, it's nothing. And they don't have to collect it. So... whereas in the potato industry, they have to write a check out to REDACTED <agriculture board>. It's much more... they can see that money physically going out. Whereas when, when it's taken... REDACTED <cooperative grain merchant> collect it on behalf of me, and it's just a, it's just a bit on the bottom of the, of the invoice." UK Farmer 1.

"Yeah, yeah. I think that there's, there's... because, we're not... we don't have a great food culture in the UK. Its getting better but we don't have a fantastic food culture. I think people lose sight of the fact that bread comes from flour, comes from wheat. Hence why we have the education program in place, to kind of go with and get the younger people get them to understand end-to-end what happens throughout the supply chain so they can, so we can kind of build up the next generation of consumers that get it and understand it. But I think from a perception and you know, reputational risk point of view, people don't tend to look at the bakery aisle as problematic, which is obviously be quite beneficial for REDACTED <industrial bakery> as a business." UK Industrial Bakery.

## b) Drivers:

### Society – Consumer demands

"When we started up our Everyday Experts panel in 2011, we did so to better understand our customers. What mattered to them? What did they want to change? How did they really feel about the issues of sustainability and being green?" UK Supermarket chain 5 - green report.

"We are committed to ensuring sustainable supply in accordance with clearly defined and monitored ethical standards. Our approach to supply chain ethics is set out in our Ethical Principles . To help with our supplier due diligence, we utilise the globally recognised platform SEDEX with our ingredient and packaging suppliers." UK Industrial Bakery website.

"One of the, one of the things that I can say that, that we were talking about before (the Participant showed the installations to Alvaro and they've talked about the research before the interview) is about that sort of whip effects, about how the supplier and it affects... one of our, one of the big retailers put a lot of pressure on one of the main bread organisations and said: "you need to start working with REDACTED <food distribution charity>. Otherwise, there might… it might affect our relationship", because the main retailer really loves what REDACTED <food distribution charity> does, really loves who we are, how we operate. And so if their individual suppliers don't want to play ball, cooperate, then the main retailer might turn around and say: "Well, you know, maybe we don't want to stock your bread or your product or whatever, because you're not sticking to the sort of conditions or the ethics that we like as this retailer" UK Food distribution charity.

## Product development – Increase product efficiency

"Everything here is do to cost. There is not really a... there's not really a focus on sustainable, renewable energies for the sake of the environment or anything. It's not environmental, it's to do with cost or back towards grain and feed loss continuously been sending out... and then we will be... we will sell... poor quality flour on to an animal food compounder. Because, at least then we still get 50 pound a tonne back, you know, we don't do it for environment, if I'm honest, it's done for cost." UK Mill 2.

## Policy and economy - Compliance to regulation

"The problem comes when you get the ones that are only arable and the others are, perhaps, only livestock, and some've got too much manure because of Nitrate Vulnerable Zone regulation. Do you know about those? Yeah. They've got more manure than they can use for their land. They are glad to get rid of it. Livestock farmers, sorry, the arable farmers pick the manure for their land. So, if they can match up, it can work very well. (…) Or, probably... some people rent an extra land, but the best option is to find an arable farmer who wants it. I think some arable farmers now, increasingly, will be prepared to pay for it. Well they pay quite a bit for poultry litter, don't they? Poultry manure. And farmyard manure has a value. Slurry has a value" UK Extensionist.

## Health - Concern with public health

"Pre-delivery Storage: The Seller must ensure that Goods sold for delivery against this contract are at all times stored in clean and hygienic conditions. Sellers shall allow Buyers, their agents or sub-buyers, access to any store containing the contract goods and, if required, shall produce evidence of a thorough, methodical and effective inspection and cleaning system of the store and any equipment used to handle the goods." UK Grain-merchant 2 – cooperative's contract.

"(asked about mad-cow disease as motivator for having certification in the grain). Yeah. So, effectively this crop assurance came about it, it was the arable section, sectors, answer to mad cow disease and to avoiding a mad cow disease. So, so yes, you're correct. UK Grain-merchant 1 – private.

## Product development – increase in product value

"REDACTED <name of founder>'s first priority therefore was to brew great beer, since nobody will buy the beer if it doesn't taste good. Number two was this must be brewed using surplus bread. He didn't want to just buy bread from a bakery and brew beer with it." UK Beer making charity – presentation at the 2019 British Society of Baking.

"Yeah, yeah, yeah, just, just because that's the way that we've set the protocol. That's the way we've set the relationship up. And it gives us... it's probably something we'll come on to later, but I may as well talk about it. The number one overriding concern for REDACTED <UK industrial bakery> is the quality of the end product. So in essence by having that relationship all the way back, and not just to the, to the farmer and the growers, but actually we have a relationship with the cooperative, in terms of seed development as well." UK Industrial bakery.

## Environmental protection - Reduce environmental impact

"That's a really good question. I think it could be a mixture. And I think that, probably the trigger, that makes people do more of that sort of 'integrated approach', the trigger is different for different farmers. Some, some farmers are driven by the whole sustainability idea, they hate to see soil blowing away, they want soil to be sustainable, brought in good health and so on. So that it continues being productive for generations to come. Some... change might be... because they've been advised to." <u>UK Extensionist</u>.

## Environmental protection - Adapt agriculture

"Number two is, it goes back to sustainability, wanting to, wanted to be there for the, for the longer term and understand that unless we change our practices, unless we do things differently, then we might not be here, and therefore not in business, therefore not making money. So that is a desire to, to farm for the longer term and there's the saying, you know, 'live as if you're going to die tomorrow, farm as if you're going to live forever', you know, it's just... you hear say. So, but that is, that is what we sort of try to practice." <u>UK Farmer 1</u>.

## Environmental protection - Concern with sustainable development

"One is being able to remain a viable business without direct support, government support that is. The other one is more... whole-farm way of looking at it. Soil sustainability, increasing soil health to create a resilient business. So that the farm will continue for the next generation and the next generation and so on." <u>UK Extensionist</u>.

## Health - Concern with animal health

"Cereals - The Company requires that ALL cereals including feed grain are below the EU limits for mycotoxins set for unprocessed cereals, unless it is agreed by the Company that for a specific contract these limits do not apply. For certain end uses lower limits apply and these will be specified if applicable." <u>UK Grain-merchant 1 – private</u>'s grain contract.

"As part of our commitment to a competitive and productive agriculture sector, we've set-up REDACTED <UK Supermarket chain 1> REDACTED <sustainable farming program>. The Groups, led by our suppliers, farmers and REDACTED <Supermarket chain 1> colleagues, are central to our work of building long-term relationships with our farmers and becoming British agriculture's most trusted partner. REDACTED <sustainable farming program> drive improvements in quality, consistency and taste, as well as supply chain efficiency and farm animal welfare." <u>UK Supermarket chain 1 – website</u>.

## Environmental protection – Fight climate change

"But you can mitigate... So we're now trying to, through direct drilling, we're trying to build up organic, soil organic matter levels... We're introducing biosolid, which is human waste, human sewage... Also, sort of, I've got a small herd of cattle which I've got on a wood chip corral with straw so I'm going to try compost that with old turf from my brother's business. So I'm trying to increase organic matter levels on certain parts, so it can help reduce our... the effect of drought possibly, so the soil can have a better hold...availability to hold the soil moisture." <u>UK Farmer 2</u>.

"Yeah, I mean, I think... I think it's the FAO that categorises wheat as the most at-risk crop. So, from climate change, which I think is something like 60% yield globally reduction that they're expecting between now and 2050. So, you know, us really having those long-term agreements in place, understanding what impacts and what risks and mitigation is going on at farm is really gonna be the thing that helps protect our supply chain all the time." <u>UK Industrial bakery</u>.

## Policy and economy - Governmental incentives

"Do we promote it? Some... it could come in.. that... environment certification... we don't pro-actively cover that, but there is some... it is looking as is if it might go that way and we might become more involved, I think we might have to. Because of the changes that are ahead, because it looks as though the payment schemes... if there are payment schemes, they are going to be linked more to the environment. Environmental benefits, nobody yet knows what they are, it could come in via environmental certifications, but at the moment we don't." UK Extensionist.

Society - Organisations expansion

"25 years, yeah. We started off as, maybe you know, the charity, the REDACTED <name of a homeless support charity>. Basically one year they were doing a Christmas party for all of the workers, for all of the homeless people, and a lot of the food was donated by a major retailer and the boss of REDACTED <name homeless support charity>, he turned over to the to the boss of this retailer and said: "well, thank you so much for providing us all with this food, you know, this is an amazing Christmas lunch. Thank you so much". And the guy said: "Don't worry about it, all this food was going to go in the bin". And so the person at the homeless shelter sort of had this idea, had this thinking: all this food is going to go in the bin, is there something we can do? And then that's how REDACTED <food distribution charity> grew off the back of that, and it became an independent organisation." UK Food distribution charity.

Society - Urbanisation and its influences

"Is just to support local industries, the main thing... so that's not so much... I'll just put local, we try to use as many local suppliers and then, in our menu we... we'll always put like REDACTED <name of local suppliers> or whatever. So that we can support them." UK Craft bakery.

"Yeah, it looks like it. It's become a little bit of a problem because too many people don't understand farms agriculture, they're not even interested. They want the food. Some people don't care where it comes from. Fortunately, a lot do. So it's a bit different. And I think, there would be some interest in, where your bread comes from. But we're not usually able to tell them, are we? So..." UK Extensionist.

c) **Enablers:**

Partnerships and collaboration across the value chain

"We also support our suppliers when they've produced a bit too much by providing our network to deliver this extra food to REDACTED <UK Food distribution charity>". UK Supermarket chain 5 – website regarding Food Waste.

"Yeah, so, so effectively, they do lots of research and development around different strains of wheat that we might want to use. We then test that, to see whether it meets our quality standards and you know, and that could be anywhere, you know, 5 to 10 years in production before that actually ends up in the bread. But if, if that seed doesn't produce flour that produces the quality of product that we want, then we won't allow our farmers to use it. So it is, it's a real long-term collaborative relationship between us, the millers, the overarching cooperative and farmers supplying to us." UK Industrial bakery.

"Cooperation with other organisations, definitely. We work with other food banks, we work with other charities, we work with a lot of groups. So, if we've got too much things, I might contact with the REDACTED <name of different food donation organisations>, "we've got a lot of this, would you guys like some?" That certainly is okay." UK Food donation charity.

"Me personally, okay, so, so my barriers are very much location based. So, when I say a barrier, it's almost an opportunity, but you have to develop that relationship to have that opportunity. But the barriers are, well, where we are. So, we don't have many livestock farms in the, in the area. Whereas if you went down in the Southwest, you have more muck than you do arable land. It's a totally different dynamic. Whereas around here, yes, I have a relationship with, with a livestock farmer, but if REDACTED <other farmer name>'s farming next door suddenly wants to get some muck, he can't get it." UK Farmer 1.

## Organisational characteristics

"As for waste, we are quite lucky here. So we have a feed mill attached to our designer flour mill. So if we, for example, dropped some flour on the floor, or there was poor quality grain that came in, we keep all on site, and it'll go into the feed mill. And that will go round and round until that's all part of animal feed. So I mean, there's nothing bad in it. And it's just you know, it might not be the high quality expected for human consumption, but it's more than fit for animal consumption. So that's what we have for in terms of that. But I mean, general waste, unless you talk about the people in the building, in which case, recycling doesn't exist in the building, if I am straight with you. There are bins, but there's just not a mentality towards recycling at all. I don't know why that is. I'm not from around here, and I don't know why that is. Maybe it's because it's much older generation of people at work here. But there's very limited recycling that goes on here. To be honest." UK Mill 2.

## Existing systems of support

"We are now focused on finding new innovative ways to deal with waste. We support the Courtauld Commitment 2025 Waste and Resource Action Plan (WRAP) on specific waste reduction projects. We also work closely with WRAPs Love Food Hate Waste programme through our School Visitors programme, to encourage the next generation to understand the importance of reducing food waste." UK Industrial bakery – website.

## Digital tools

"In the UK we work with REDACTED <UK Food distribution charity> to donate surplus food from our stores to those in need. Through REDACTED <name of food donation program>, REDACTED <UK Supermarket chain 1> colleagues can inform local charities how much surplus food they have at the end of each day by using the REDACTED <UK Food distribution charity> app. The charity picks it up free of charge and turns it into meals for those in need. Through REDACTED <name of food donation program> we have donated 48 million meals to over 7,000 charities and organisations since launch in 2016." UK Supermarket chain 1 – website.

## New internal incentives

"No, no, no, sorry. Well, we'll look at individual things based on what, on what we need, what we need to do with that. So for instance, REDACTED <UK Supermarket chain 1>, they do, they do an annual Climate Disclosure Project. They look at, in terms of carbon footprint, it's got an 1, 2, and 3, and if it's gone to 3, its your supply chain. So what we do is, we declare our carbon footprint to them on an annual basis, so that they know, across all the products that they're sourcing, what's their total carbon footprint is." UK Industrial bakery.

## Working with regulators and policy makers

"But to go even further we have developed this Sustainable Livelihoods Strategy. It recognises that, in some supply chains, wages and incomes are too low and demonstrates our commitment to supporting workers and small-scale farmers in our supply chains to increase their resilience and prosperity. Only by working together with suppliers, NGOs, Governments, unions and the wider industry can we increase incomes and reduce poverty on a sustainable basis." UK Supermarket chain 1 – website.

## Access to finance

"Renewable energy use, yes, so we've got a biomass boiler on farm here that we are, we're burning wood pellets and solar as well, so we've got both of those involved the business, you know, that comes off the backups of government grants to do it. Are we using that within actual, with, with, in terms of producing our crops? Not really, you know, the electricity does go into part of, you know, the workshop and the heat, obviously, heats in here where we're working, but we're not using to dry the crops or anything." UK Farmer 1.

"(asked about contact with suppliers) Most of the time they contact us. They've seen our social media campaigns, they're aware of us from other people within the food industry. We've been around for so long, we're very present. We're sort of in the back of everyone's head, we've recently been given quite a large sum of funding, which will allow... which is allowing us to sort of help. So, there might be some sort of cost barriers that stop suppliers from giving us food. They might say: "Well, we'd love to, but we haven't got the time, we have the staff in the warehouse to organise it for you", or "we'd love to but we can't afford the transport" or "we'd love to but it's in packaging that we don't want to give to you" or whatever. So with the funding that we've been given from our funders, we can say: "all right, look, if it's going to cost you 'this much', or if it's going to cost 'you this much', we can assist with that to make it cost-neutral for you so that we can access your surplus, which is fantastic." UK Food distribution charity.