DIFFUSION OF CIRCULAR ECONOMY PRACTICES IN THE UK WHEAT FOOD SUPPLY CHAIN

Alvaro Augusto Dossa[1] – alvaro.dossa@northampton.ac.uk
University of Northampton
Andrew Gough – andrew.gough@northampton.ac.uk
University of Northampton
Luciano Batista – l.batista@aston.ac.uk
Aston Business School
Kathleen Mortimer – *kathleen.mortimer@northampton.ac.uk*
University of Northampton

Circular Economy (CE) is a framework for sustainability based on restorative and regenerative systems. This paper presents preliminary findings from an ongoing case study of the British wheat food supply chain, using dimensions of Transaction Cost Economics (TCE), to clarify the role of transactions in the diffusion of CE practices. It uses content analysis of semi-structured interviews to elucidate what CE practices and material flow are in operation in the supply chain. While financial considerations are the main factor driving CE adoption, transactions can also function as an indirect driver to CE adoption via assurance/certification schemes requirements that also reduce overall uncertainty. Asset specificity does not play a significant role in the wheat food circular supply chain, except for specific (niche) programs. Verticalized operations and repeated, long-term partnerships between buyers and suppliers facilitate CE-related transactions since high uncertainty act as a barrier to CE operations.

Keywords: Wheat supply chain; Circular Economy; Dimensions of transactions; Sustainable practices diffusion

1. Introduction

The sustainability of food supply chains is a concern for consumers, governments, academia and businesses. In this paper, we consider the definition of sustainability of the Brundtland Commission report (United Nations, 1987) contemplating the balance between social, economic and environmental practices that meet present needs without compromising future ones. The definition implies that the capacity to maintain supply levels without jeopardising food safety and security for current and future generations is a crucial challenge faced by society. Different dimensions of sustainable food systems need discussion to avoid damaging agrifood sustainability (iPES FOOD, 2020).

One of the core products in agrifood production is wheat. It represents approximately 30% of world grain crops, distinguishing itself by both its widespread production and extensive usage in flour, bread and dough manufacturing (Mori and Ignaczak, 2012). Wheat represents approximately 20% of food calorie intake for about 65% of the world population (Lucas, 2012). These considerations support the need to understand sustainability issues relating to the crop as it affects all aspects of the triple bottom line (TBL): Environment, Society and Economy. Additionally, wheat has different characteristics from other foodstuffs, making it a compelling case for investigation: i) it is a long-food supply chain, thus different from fresh produce (Gallaud and Laperche, 2016); ii) it is traded as a commodity, but it has various classes (FAO, 2002) depending on use, market and season of production; iii) it can be both a non-perishable food such as grain, pasta and biscuit or highly perishable such as bread (Bartholomeu *et al.*,

[1] Corresponding author

2016), thus influencing waste potential and concerns. These three characteristics position wheat as a case to be better understood in relation to sustainability.

Wheat is one of the United Kingdom's primary agricultural product, covering approximately 1.8 million hectares of the country (DEFRA, 2018b). Most wheat in the UK is used as feed, but wheat for food (milling) accounts for about 44% of total production. Even though the UK is a net importer of food, it is a net exporter of wheat (Grain Chain, 2016; AHDB Cereals & Oilseeds, 2017; DEFRA, 2018a). Therefore, the British wheat food supply chain is a relevant setting for better understanding food supply chains, benefiting by the increase in knowledge of supply chain's sustainability and providing relevant information on the subject as a whole.

Among the many different approaches to the topic of sustainability, Circular Economy (CE) has gained prominence in the last few years (Ghisellini *et al.*, 2016; Murray *et al.*, 2017), with both a theoretical and a practical framework for supporting research, industry practice and policy implementation. CE is an approach to economic systems that by intention and design, seeks to convert the current linear model (the "make-use-dispose" model) to a restorative and regenerative system (The Ellen MacArthur Foundation, 2013). CE maximises the utility and value of products, components and materials by implementing open- and closed-loops in its flow through the supply chains. CE also encompasses operational practices, business models and governmental policies. Supply chains that adopt CE operations and circular flows of materials are known as circular supply chains (CSC) (Batista *et al*. 2018a; Batista *et al*. 2018b).

The increase of publications on the topic of CSC demonstrates how thoroughly the topic is researched (Geissdoerfer *et al.*, 2017; Kirchherr *et al.*, 2017). However, previous research (Vlajic *et al.*, 2018) showed that only a minority of research in CSC regards the biological cycles of bio-products (namely food), thus demonstrating the need of further exploration of these industries through CE lenses.

Various theoretical frameworks address relationships between actors in supply chains, such as social contagion theory, network theory, resource dependence theory and transaction cost economics (TCE) (Ferguson, 2007; Meixell and Luoma, 2015). From these theoretical perspectives, the one that is particularly important for this study is TCE. Previous works (Maaß and Grundmann, 2018; Nozharov, 2018; Lahti *et al.*, 2018; Neves *et al.*, 2019) have addressed the connections between TCE and CE. They posit that using TCE and CE theories in conjunction have several benefits, such as i) it allows the use of New Institutional Economy perspective in the CE discussion; ii) it facilitates transaction costs measurement within circular transactions also allowing better strategic planning of agrifood supply chains that incorporate CE perspectives; iii) clarifies uncertainties associated with the adoption of circular strategies and business models; iv) helps in the understanding of how organisations can successfully deal with material loops and form partnerships that deal with CE issues.

Despite the benefits, there are gaps in the literature, and the present study aims at addressing two of them: i) none of the previous studies identified were conducted in the wheat food supply chain setting; ii) the role of the relationship between buyers and suppliers in the diffusion of CE practices needs clarification. Therefore, the current research aims at answering the following research question: "How can transactions between organisations in a British wheat food supply chain influence the diffusion of CE practices?"

This paper presents the preliminary findings and the conceptual model developed in ongoing case study research. The model considers explicit deliberation of the main dimensions of

transaction cost economics (TCE) to clarify the role of transactions in the diffusion of CE practices in a wheat food supply chain in the UK. The next section expands upon the theory used in the study as well as in the framework used for the analysis, followed by the methodology, results, analysis and final considerations.

2. Literature Review

Sustainability - environmental, social and economic - of the wheat agrifood supply chain in the UK is a significant issue given the importance of wheat in the food security of the country. Food security is defined by the United Nations' Food and Agriculture Organization (FAO) as food availability, accessibility, stability and use (FAO, 2017). This is also true for the UK, considering the significant consumption of wheat in the British economy. Furthermore, FAO (2020) positions that food safety is a vital part of food security, defining it as "all those hazards, whether chronic or acute, that may make food injurious to the health of the consumer" (FAO; WHO, 2003).

CE is one of the leading theoretical frameworks to study and implement sustainable industrial practices and it is the leading theory used in this research. According to Batista *et al.* (2018), quintessential characteristics of CE include a) Products are kept in use in the economy through reuse, repair, remanufacture and recycle, minimising disposal of waste in open- and closed-loops; b) functionality is preferred over ownership of a product, and; c) collaborative/shared consumption models are prioritised.

A considerable number of works have looked into the adoption of CE practices but fewer investigations so far have focused on agrifood supply chains (Balboa and Domingues Somoente, 2014; Ghisellini *et al.*, 2016; Jesus and Mendonça, 2018; De Angelis *et al.*, 2018; Govindan and Hasanagic, 2018; Masi *et al.*, 2018). Furthermore, despite the relevance of the wheat food supply chain worldwide, no previous study was identified linking the cereal, CE and its diffusion. Additionally, there is a lack of benchmarking references for CE practices executed in the UK wheat food supply chain despite the relevance and need for sustainability in said chain, and the significance of CE as a TBL school of thought (Jawahir and Bradley, 2016; Agrawal and Singh, 2019). As Poore and Nemecek (2018) show, contextual factors can determine the overall environmental impact of agrifood products. Therefore, it is crucial to comprehend the nuances involved in wheat supply chains and their connection to CE. This is especially true to those institutions that want to promote CE adoption.

In order to better understand the role of transactions in the diffusion of CE, it is also necessary to comprehend the CE practices in the case studied. Table 1 shows the proposed definitions of CE practices used in the study. Some commonly discussed CE operations such as repair, remanufacture and refurbishment were excluded from the research, since they are logically connected to technical rather than biological cycles (The Ellen MacArthur Foundation, 2013) of materials, especially considering food safety (Secretary of State, 2013).

Table 1. Circular Economy definitions of practices in the wheat agrifood supply chain

Circular Economy practices	
Reduction - considered here in two forms: *Reduction of inputs*: using less resources (capital, energy, land, materials, etc.) to produce and distribute food, e.g. less agrichemical usage; *Reduction of waste*: less waste generated from food production, distribution and consumption, e.g. reduction of surplus production by better inventory control.	**Renewable energy** - the use of renewable energy based on non-fossil fuel energy, e.g. wind and solar powered sources.

Reuse - reusing a product, component or material in the same way and purpose that originally intended, without modification, e.g. reuse of day-old surplus bread as toastie.	**Auditing** - for evaluation of CE operational performance, e.g. semester or annual audits.
Recycle - the extraction (scrap) of raw materials from a product and using said materials in new products. Conversion of food waste to a new product, e.g. production of breadcrumbs from dry bread for stuffing poultry, thickening stews, etc., while another possibility, but less desirable is composting.	Identifying the **correct prices** for CE products - higher prices of CE products reduce the chance of consumers to switch from regular products, e.g. organic and conventional products with the same price.
Redesign - innovation based on a previous design, that allows for more sustainable (less inputs, less waste, greater lifecycle, etc.) and that can have three forms: *products*, *services* and/or *processes,* e.g. new varieties that are more resistant to pests and new production system.	**Green-purchasing** - Implementing pro-environment criteria in purchases: organisational purchases of cleaner products, materials or services not considering just price in the decision, e.g. requiring pro-environment certification.
Redistribute - changing products, components or materials from one market where they were not demanded (i.e. not needed) to another place where there is demand (they are needed), e.g. donation of surplus bread from supermarkets.	**Cooperating** with other organisations to implement and use CE operations, e.g. leasing and cooperating with customers for reverse logistics of packaging.
Recovery - of products for disposal and/or recovery of materials for energy recovery, e.g. return and collection of unwanted products.	Staff and managers **training** with physical or online courses to educate and prepare the staff for the transition towards the CE, e.g. training new processes that use less energy.
Reclassify - the identification of further value in materials, products or components that are approaching the end of its life cycle, thus allowing further use or reuse, e.g. cheaper bread at the end of the day or wheat group 2 to group 3.	**New logistics systems** that are more sustainable, reduce waste and facilitate CE operations (including servitisation), e.g. electric vehicles or AI supported delivery route planning.
Repurpose - the transformation of potentially discarded materials to a new purpose or use, from what it was originally designed or planned. Differs from reclassification because the latter does not require transformation. E.g. Wheat food to wheat feed.	Marketing products to **green customers** with CE-related products, materials and services, e.g. recovered products or materials with less agrichemical use.

Source: the authors[2]

The CE operations that are not 'R' practices were compiled by both Govindan and Hasanagic (2018) and Masi *et al.* (2018). Such operations are connected to an integrated approach to the supply chain, where buyers and suppliers work together to accomplish the transition to a CSC and circular business model. The need for cooperation is highlighted in the **services over ownership** model (Batista *et al.*, 2017; Govindan and Hasanagic, 2018; Masi *et al.*, 2018). However, reverse logistics systems for closed-loops (e.g. recovery), green clients marketing strategies, education of labour force, audits for environmental impact analysis & compliance and price specification, all require considerable levels of cooperation within the supply chain. These practices connect two of the several schools of thought that form CE: **service/performance economy** and **industrial ecology** (Weetman, 2017; The Ellen MacArthur Foundation, 2013).

One of the most relevant works relating to the adoption and diffusion of new practices was produced by Rogers (1983), who stated that adoption is a decision made to use an innovation. Similarly, Kee (2017) defines adoption as the decision to implement, discontinue and/or

[2] Based on Stahel (1982), Ghisellini, Cialani and Ulgiati (2016), Jawahir and Bradley (2016), Kirchher, Reike and Hekkert (2017), Weetman (2017), Govindan and Hasanagic (2018), Kirchher et al. (2018), Masi et al. (2018), Vasconcelos, Viana and Batista (2018).

modify a new object, technology, behaviour, practice, program or idea. This decision is made by a member of a social system, that in turn is defined as "a set of interrelated units that are engaged in joint problem solving to accomplish a common goal" (Rogers, 1983, p.24). In the context of the present research, the wheat supply chain is the social system. Diffusion (Rogers, 1983; Kee, 2017) is the process of communication by which an innovation spreads through certain channels in a social system over time. In summary, adoption relates to a unit of decision-maker changing its operations while diffusion relates to a group of units in a given setting.

The diffusion of CE practices in a supply chain involves a series of organisations adopting new CE-related practices and operations. Adopting new operations and practices is a process that is influenced by drivers (motivators), barriers (bottlenecks, difficulties) and enablers that reduce or overcome the barriers (Dossa *et al.*, 2018). Different works have implemented meta-analyses and systematic reviews of CE literature, including practices and adoption/diffusion influencers (Kirchherr *et al.*, 2017; Batista, Bourlakis, Smart, *et al.*, 2018; Govindan and Hasanagic, 2018; Jesus and Mendonça, 2018). The clusters of Barriers and Drivers identified in Govindan and Hasanagic (2018)'s systematic review were chosen as the categories for this investigation. Two reasons account for this: first, the scope of the work by these authors was considerable; second, the categories proposed in said work were in large part adaptable for the present case study. The work of Kirchherr *et al.* (2018) was originally expected to define the categories of barriers used in the present paper. However, after the initial analysis of the data *vis a vis* the categories, the later were too focused on industrial (technical) products to be of use in the present research. For the enablers, the categories suggested by Mishra, Hopkinson and Tidridge (2018) were chosen. As these authors show, most of the literature on influences of CE adoption/diffusion focuses on drivers (motivators) and barriers (difficulties), with few documents (in comparison) addressing ways to overcome such challenges. The paper also show that the application of such categories is possible in diverse supply chains, thus reinforcing its relevance to the present research. Table 2 summarises the categories used for the current investigation.

Table 2. Drivers, Barriers and Enablers to CE adoption

Drivers	Barriers	Enablers
Policy and economy	Governmental issues	Partnerships and collaboration across the value chain
Health	Economic issues	Digital tools
Environmental protection	Technological issues	New internal incentives
Society	Knowledge and skill issues	Working with regulators and policymakers
Product development	Management issues	Access to finance
	CE framework issues	Existing systems of support
	Culture and social issues	Organisational characteristics
	Market issues	

Source: (Govindan and Hasanagic, 2018; Mishra, Hopkinson and Tidridge, 2018)

The interaction of clients-suppliers can also influence the diffusion process. One of the more prominent theoretical frameworks to evaluate interactions in client-supplier dyads is TCE (Davies and Lam, 2001; Kolmar, 2017). TCE is a core supporting theory in this paper. However, TCE was not used in this research in its entirety (Williamson, 1998; Williamson, 2008). Given the exploratory nature of this research, it was necessary to first understand the characteristics and possible roles of transactions in the diffusion process, before using other elements of TCE in connection to CE. Four attributes of transactions were used as the final operational concepts for the research: a) asset specificity; b) uncertainty; c) frequency (Wever *et al.*, 2012; Klein, 2013); and d) types of contracts.

a) Asset specificity: how much an actor invests to support a transaction, tying it to the other party of the transaction (Wever *et al.*, 2012). The value of the asset is reduced if deployed to a different transaction(s) (Williamson, 1998; Davies and Lam, 2001). Can be: i) site-specificity (location); ii) physical or intellectual specificity; iii) dedicated asset specificity; iv) human capital specificity; v) brand name specificity (Davies and Lam, 2001).
b) Uncertainty: The state of information for a decision-maker where the number of potential outcomes is greater than the number of actual outcomes and probabilities cannot be used to measure the possible outcomes (Davies and Lam, 2001; Shin, 2003; Bannock and Baxter, 2011; Wever *et al.*, 2012). Can occur from human factors or environmental factors (Shin, 2003).
c) Frequency: Number of times a transaction is expected to take place; it can be occasional ('on-off'') or recurrent (Williamson, 1998; Davies and Lam, 2001).
d) Types of contracts: formal (written down) or informal (without 'physical' documentation).

Figure 1 shows the framework used in the investigation to identify the connection between the CE influencers and the dimensions of transactions.

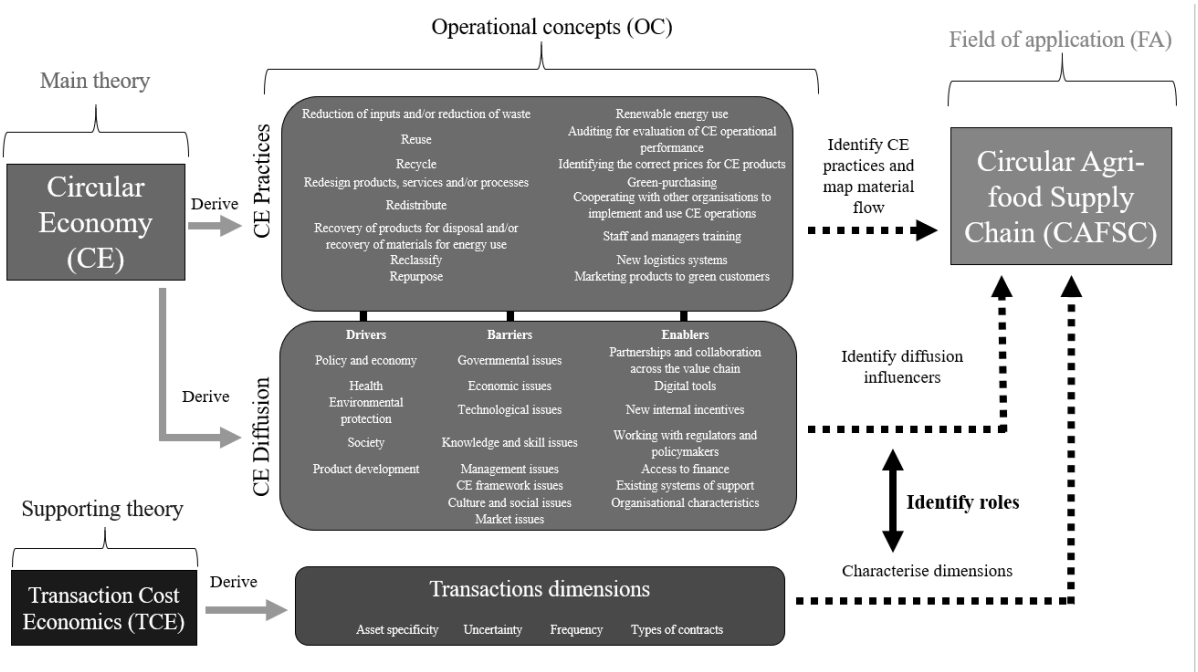

Figure 1. Conceptual framework combining CE and TCE perspectives

The above framework derives its operational concepts (OC) from parts of the central and supporting theories (CE and TCE, respectively), and identifies potentially mutual influences in these OC. Its Field of Application (FA) is the case of a British wheat food supply chain.

3. Methodology

The present research investigated the role of transactions in the diffusion of CE practices in a British wheat food supply chain. An interpretivist qualitative research approach (Cooper and Schindler, 2014; Neuman, 2014) was chosen, which is appropriate for theory development and adaptation (Bryman and Bell, 2015). Three sets of information had to be identified to achieve the research aim: i) the flow of the material in the supply chain; ii) the CE practices in use in

the supply chain and the influencers (drivers, enablers and barriers) of their diffusion in the supply chain; iii) the characteristics of the transactions between the participants.

Considering the need for in-depth exploration of the subject (Bryman and Bell, 2015; Yin, 2018) and the capacity to investigate different stages of a supply chain (Vlajic *et al.*, 2018), a case study approach was selected. The case chosen is of a British wheat food supply chain: such a case brings different advantages to a CE and TCE investigation: i) the UK is one of the biggest producers and consumers of wheat in the world; thus an influential player of the worldwide industry (FAO, 2018); ii) wheat and its products are an essential staple food for the UK, fundamental for the country's food security, with widespread production and consumption and with considerable economic importance (DEFRA, 2018b); iii) wheat food has different characteristics from other foodstuff and commodities in terms of perishability, supply chain characteristics (e.g. number and types of actors from farm to market) and potential uses.

The unit of analysis is the wheat food supply chain. There are two dyads as embedded cases (Easterby-Smith *et al.*, 2015) in it: a) **Farmer A** (supplier) – **Mill A** (buyer) and with **Farmer Cooperative** acting as a supplier agent; b) **Farmer B** (supplier) – **Mill B** (buyer).

Case selection followed two nonprobability sampling methods in sequence: purposive sampling considering accessibly/convenience and volunteer sampling considering the snowball technique, focusing in typical organisations of the wheat food industry, especially in relation to sustainability (Smith and Barling, 2014; Bryman and Bell, 2015; Meixell and Luoma, 2015; Saunders *et al.*, 2016; Babbie, 2018). The participants, therefore, were selected based on the objective of the study, considering who would be most knowledgeable with a comprehensive view of the supply chain and the material flow.

Two major British mills agreed to participate in the study. The particular characteristics of the selected mills offers varying supply chain perspectives, thus enriching the context of analysis. For instance, each mill has different levels of verticalization: Mill A has a simpler business model – just milling wheat purchased from grain-merchants; Mill B is more vertical, with fewer links between farm and retail, also having an industrialisation division.

The investigation followed quality criteria as described by Lincoln and Guba (1985), Welch and Piekkari (2017) and Korstjens and Moser (2018), better suited for qualitative-interpretivist studies. In order to strengthen the research's comprehensiveness and trustworthiness (credibility, transferability, etc.) - quality criteria of qualitative investigations (Lincoln and Guba, 1985), several measures were taken. Three organisations adjacent to the supply chain were interviewed for better comprehension of the supply chain institutional context - Table 3 summarises the participating organisations and their general role. Additionally, trackable information was ascribed to the sources (while maintaining anonymity) with all participants having a grace period of 30 days to request removal from of the research. The information transcribed was submitted (member checked) to the respective informants for review before analysis[3]. Available secondary data like reports, websites, wheat certification requirements and miscellaneous documents were used for data triangulation. Furthermore, one of the authors of the study has experience in the wheat industry, thus allowing familiarity for both data collection and analysis. The data collection had prolonged engagement as they were long semi-structured interviews with *in loco* data collection and thick description. Finally, the authors also ascribe

[3] Only one of the informants – Mill B - required changes in the transcription since the informant felt it did not accurately represent the mill's relationship with the grain merchants.

to data transparency, with analysis available for audit if needed - at the conclusion of the ongoing research. The researchers were also conscious of context and responsive to it, also using the capacity for clarification and summarisation of the data collected (Lincoln and Guba, 1985; Braun and Clarke, 2013).

Table 3. Summary of participating organisations

Organisation	Org. focus	Size	Quantity of wheat (grain)
Farmer A	Wheat production and storage	280 hectares	2,000 - 2,400 t/year
Farmer B	Wheat production and storage	255 hectares	2,000 - 2,400 t/year
Farmer Cooperative	Wheat storage and marketing support	600 members	150,000 tonnes (storage)
Mill A	Wheat processing	10 mills	> 1,300,000 t/year
Mill B	Wheat processing and flour industrialisation	4 mills	> 500,000 t/year
Millers association	Trade association	31 members in 50 sites	~ 5 million t/year
Farmer's assurance organisation	Certification of farmers' operations	Almost all UK wheat food farmers	~ 5 million t/year
Extensionist agent	Farmers' technical support and technology transfer	2,000 farmers in the region	N/A

The research adopted a **semi-structured interview** approach as the main form of data collection (Braun and Clarke, 2013). This allowed on the spot adaptations if required. Such a decision, aligned with the interpretivist paradigm of the research, was necessary considering that different participants gave different perspectives of the phenomenon. The interview script was constructed based on the literature review presented in Section 2 and summarised in the conceptual framework. Data collection protocol had four sections: i) interviewee and organisational context; ii) CE practices and diffusion questions – with the CE practices of Table 1 presented as a guide for discussion; iii) waste of wheat and related material and material flow; iv) transactions and material flow. All interviewees worked with operations, purchases and/or sustainability in their respective organisations. Each interview lasted, on average, 1 hour, with subsequent non-structured exchanges whenever needed to clarify information, totalling 9 formal interviews (2 participants were interviewed in Farm B) – not counting non-structured interactions with the participants via email, telephone or in-person.

The interviews were audio-recorded, except for Farmer Cooperative, where permission to record was not given, so notes were taken. All interviews recorded were transcribed and submitted to participants for evaluation. Data was analysed through content analysis (Cooper and Schindler, 2014), looking for the pre-determined patterns. Coding procedures followed Braun and Clarke (2013) guidance. The pre-determined patterns were the categories and subcategories shown in the conceptual framework. Preliminary coding focused on mapping the flow of the material, thus allowing the CSC to be diagrammed, alongside CE practices and diffusion. The second cycle of coding concentrated on the transactions and the relationship with diffusion influencers. The software Nvivo 12 was used to code the information and the software Bizagi was used to design the supply chain. To facilitate the understanding, henceforth considerations relating to CE are in bold, and for TCE they are underlined.

4. Results/analysis

4.1 Linear and Circular supply chain perspectives

Figure 2 shows the linear perspective of the supply chain as a baseline for the overall study. The white circles represent the start of the wheat supply, while the black circles represent the end regarding the wheat flows in the supply chain. It is a traditional wheat food supply chain in terms of roles executed by the organisations (Smith and Barling, 2014). Farmers produce the grain using different varieties aimed at different industrial uses based on wheat characteristics such as colour and protein content. Most British farmers are able to store a considerable amount of grain in their own farms (in sheds). Other farmers use services of central grain storages, storing in collective silos in exchange for a fee. Such organisations can also function as agents for farmers' grain sales in partnerships with traditional grain-merchants.

Grain-merchants function as agents to connect farmers to mills, who in turn can sell flour to industrial bakeries or to retail such as craft bakeries and supermarket chains. They can also provide transportation services. Grain imports are also part of the supply in order to achieve specific flour characteristics (e.g. for bagel manufacture) and grain exports are also possible, especially post-seasons with surplus production.

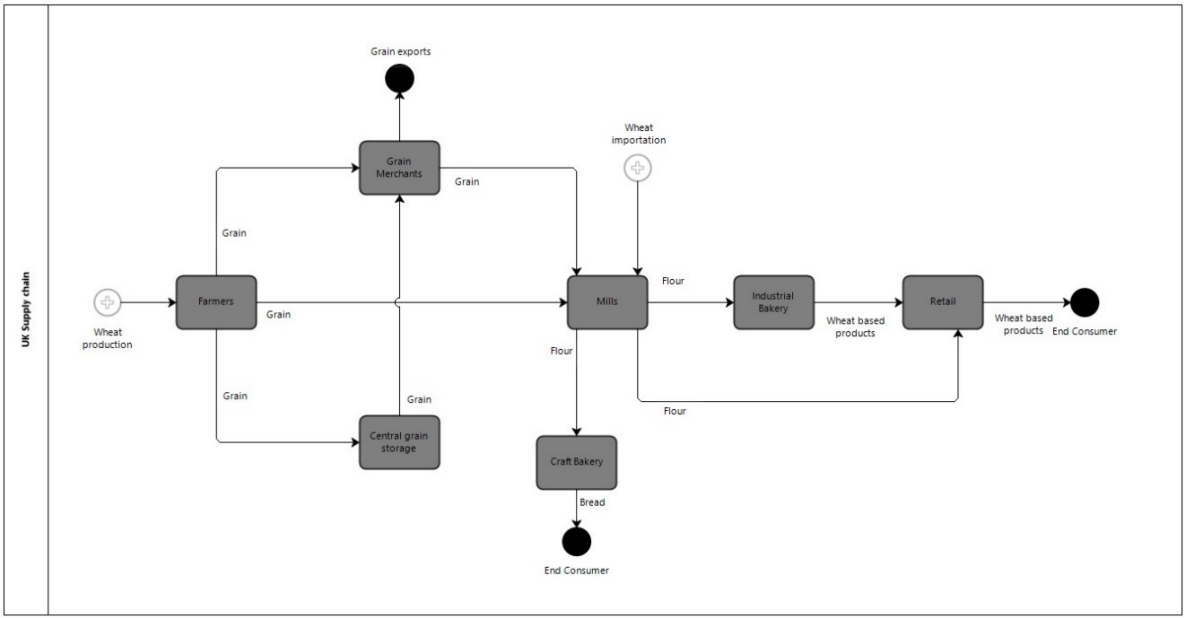

Figure 2. UK linear wheat food supply chain representation

Several CE practices (Table 1) are present even in the linear perspective of the supply chain, such as **reduction of waste** and **inputs** and **redesign** of processes. Section 4.2 identifies them more thoroughly. Figure 3 shows the British wheat food supply chain mapped with CE considerations. The material (wheat and wheat-based products) flows both in the forward sense (represented by the black arrows) and the **open-** and **closed-loops** that return wheat, its **by-products** and **potential wastes** (light grey arrows).

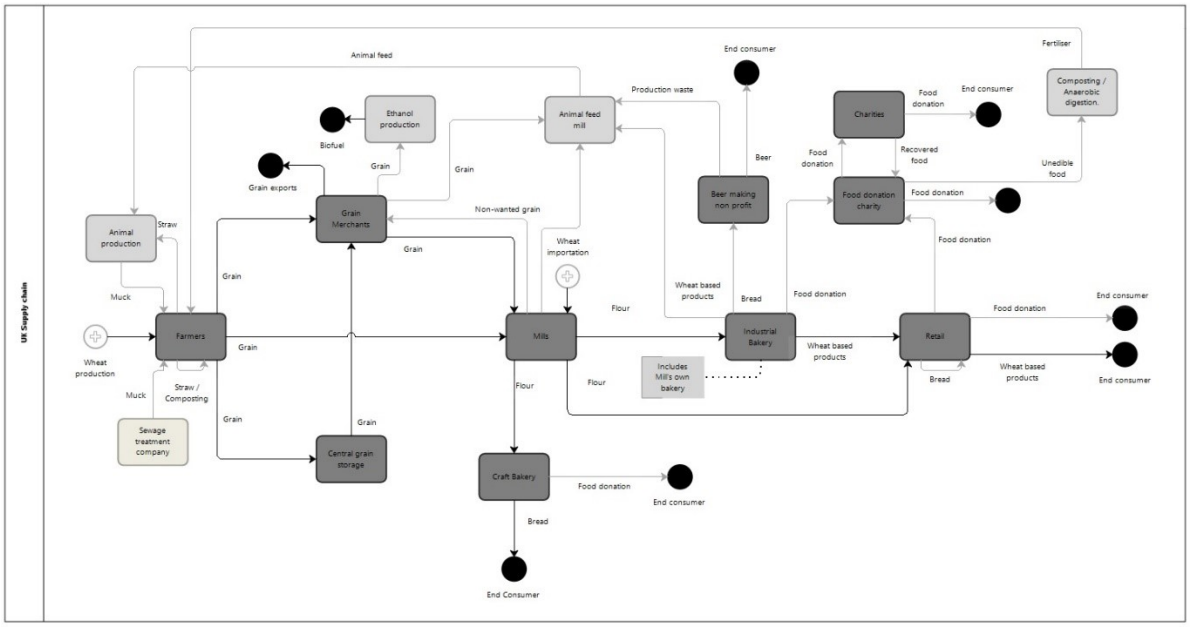

Figure 3. UK circular wheat food supply chain representation

The organisations represented in a darker background are connected to wheat food while the organisations presented in a lighter background still use wheat and wheat-related products as raw material, but not necessarily for human consumption. While early CE documents (Yong, 2007; Chertow, 2008) mainly discussed closed-loops supply chains, newer literature on CSC shows that open-loops should also be considered in the CE discussion (Batista et al. 2018c; De Angelis, Howard and Miemczyk, 2018; Vlajic, Mijailovic and Bogdanova, 2018). The material flow mapped in Figure 3 strengthens the need for open-loop consideration in CSC analysis and underpins the need for attention to open-loops as part of waste reduction strategies in the CE discussion.

The connection of animal production with the wheat supply chain also needs to be highlighted. By providing material for composting/fertiliser production, and using by-products and wheat that did not reach milling specs for animal feed, the animal production industry, both for meat (beef, poultry and pork) and milk - has a close link with the CSC: one provides the capacity of circularity for the other: grain/straw/food waste as feed material, compost/muck as input for wheat production. The connection can be identified in Figure 3 in the left (e.g. animal production), in the middle (e.g. animal feed mill) and in the right side of the map (e.g. composting/anaerobic digestion).

Circular processes executed at the farm level include the use of waste for fertilising purposes (**recycling** and **recovery**). Farm B is also using no-tillage agriculture, a form of straw-reuse for soil protection - a restorative and regenerative agricultural practice. Furthermore, even when considering more commonly discussed food-related CE practices such as donation (**reuse**) (The Ellen MacArthur Foundation, 2019) to food charities or other industrial processes (like beer making with surplus bread), **repurposing** waste and by-products for animal feed is also a CE alternative. This reinforces the need to factor open-loops and repurposed materials at all stages of the supply chain as CE operations for CSC and CE business models. In summary, even though the wheat food linear supply chain view has CE practices in it, it is only by using CE lenses in the analysis of the material flow that it is possible to notice the various forms of material use and reuse, in the chain itself or by flowing to and from other supply chains.

4.2 CE practices in the UK wheat food supply chain

Appendix 1 shows all the CE practices listed in Table 1 and those selected by the interviewees as being executed in their organisation. For the Extension Agent and for the Farmer Assurance Organisation, the options were related to practices that they promoted, while the Millers association represented an overall view of the milling industry operations according to the participant's experience.

The findings show that the organisations interviewed have some variations of CE practices, but all have the following CE-related operations: pro-active **reduction of waste** and **inputs**, **redesign of processes, reclassification** and **repurpose** of products**, certifications** that include environmental concerns and **recycling** efforts connected to supplementary materials (e.g. packages, plastic containers, papers, etc.). When discussing wheat food supply chain, there is a natural overlap between two CE practices described in Table 1: **reclassify** and **repurpose**. Wheat has different uses, and this is highly connected to protein content in the grain. For example, as a general rule, wheat for bread flour requires typically higher levels of protein. If the amount of protein is reduced, the wheat flour can be used for making biscuits, pasta and so forth. At a particular gluten level, wheat will be 'naturally' classified as feed, as the use for food becomes impractical, meaning that the CE practices of 'reclassify' and 'repurpose' (Table 1), become indistinguishable. The CSC actors explained that the most significant drivers to implement CE operations are linked to **cost reduction** and **financial gains**.

According to the organisations that support the actors in the wheat food industry, legislation (**Policy and Economy drivers** – Table 2) also plays a major role in **driving** the adoption of sustainability practices, both by punishing problematic practices (e.g. excess Nitrogen use) or by fomenting desired operations (e.g. environmental services payment). At the same time, safety requirements (e.g. soil contamination from the use of waste compost) are also monitored by the government and other entities so not to jeopardise food safety downstream in the supply chain. This means that the government can play a role as **both driver and barrier** of CE practices adoption (Governmental issues barrier – Table 2).

Although not all of the participants selected **renewable energy** use (Table 1), all mentioned that they are at least looking into its implementation. For instance, Mill B studied the use of solar panels, but air particles around the mill reduce the effectivity of such energy source (thus pointing to a **Technological** barrier). At the time of the interview, Mill B was studying alternatives for renewable energy in their operations. Other options of renewable energy sources varied from water-powered mills to wind, solar and other forms of on-site energy production. Energy production is crucial for millers since energy consumption is a significant part of their costs in the UK.

Some CE practices identified in the literature and presented in Table 1 like **redesign** (of products, services or processes) for CE, **redistribution** for different markets and **maintaining prices** of new pro-sustainability products, were not immediately understood by the farmers interviewed. It is unlikely that farmers will adopt or even discuss an operation without the understanding of what it comprises. Although they could have a different word or terminology for something, this can fall outside common CE terminology (especially the 'R' practices), thus resulting in different interpretations that can affect research, legislation, CE promotion efforts, etc. Traditional CE terminology, therefore, was not well suited for parts of the research.

Alternatively, some activities undertaken by farmers are not present in the CE literature reviewed. **Crop rotation** and **soil management** are two forms of operation that can reduce

both risk and waste (of water, agrochemicals, operations and biomatter) and the presence of pests (weed, insects, diseases). Neither is commonly discussed in the CE-literature regarding food supply chains. Grain storage practices as a form of **reducing waste** and filters in the mills to reduce air particles for the flour and that is later **repurposed** as animal feed, also fall within the CE paradigm but are not commonly discussed in the CE literature.

4.3 Transaction dimensions and CE in UK wheat food supply chain

Three of the categories of transaction dimensions investigated in the research need to be highlighted: types of contracts, frequency and uncertainty. In terms of the kinds of contracts and frequency, the relationships of both dyads of farmers-mills varied: farmers have recurrent transactions with the same small group of organisations (e.g. one or two grain-merchants and the regional mill) for several years. To reduce uncertainty, farmers tend to sell their grain in spot-markets and future contracts at the same time (e.g. 30% spot market, 30% in future winter pool and 40% in future summer pool). They do not have, however, a formal agreement of supply for many seasons. Contracts, generally in the industry, do not make pro-sustainability requirements, with the exception of assurance certification. Partnerships among neighbouring farmers were also identified but were informal, although recurrent.

Although the dyadic relationship does not have formal agreements of supply, as a general rule, there is an element of informality in the negotiation of wheat, considering long-term relationships. If the farmer has a good enough history with the buyer, it will make it easier for the buyer to purchase the grain even if it is a little below spec. The farmers' cooperative commented that most of its relationships with clients and suppliers (farmers) were informal. Still, they were moving to have more formal contract agreements. On the other hand, mills tend to work with a long-term recurrent formal relationship with large corporations (e.g. industrial bakeries and supermarket chains), and recurrent long-term informal[4] relationships with local craft-bakeries.

Asset specificity was not a dimension highlighted by the participants. The main reason for this is that most wheat grain and flour produced are not connected to specific assets and are traded mostly as commodities. The exception is the program that the dyad Farmer A-Mill A is a part of, that pays a premium for the **reduced use of input**. Location was also specificity mentioned, but it did not impede sales or purchases from/by others, only made it more expensive. This is because of logistics costs and the narrow profit margin of the products. Site specificity allowed the sale of wheat grain to the local mill, but there was no investment for the transaction, these organisations just happened to be close.

On the other hand, uncertainty plays a vital role in the way that wheat is commercialised in all the links of the supply chain, especially in terms of risk[5]. Uncertainty sources include weather issues, international commodity prices, industry requirements for safety and homogeneity for products and processes and capacity of suppliers to provide the expected raw material. These elements are linked to the transactions chosen by the organisations interviewed. Examples cited include marketing strategies by the farmers (mentioned above), the use of assurance organisations and wheat varieties planted. The considerable use of spot-market suggests the need for adaptability to uncertain environments.

---

[4] For the sake of clarity, informal here does not mean that there is zero written document. The sale is still formal, with invoices and receipt. But there is no contract to maintain the mill as the supplier

[5] Although uncertainty and risk are not the same thing (Kolmar, 2017) since risk can be measured, this discussion falls outside the scope of this research as the participants have not differentiated both concepts in their responses.

Mill B operations are somewhat different from those at Mill A: while Mill A only purchases wheat through grain-merchants, Mill B buys a non-insignificant percentage of its wheat directly from farmers in its region of operation (UK-East Midlands). Since farmers have a narrow profit margin for grain and logistical costs to transport grain to its destination tend to be high, only farmers near mills can do that. This can be considered an example of physical asset specificity, although the investment was not made for the contract, as it is the geographical location allowing it (Jraisat, 2010; Ito and Zylbersztajn, 2018).

Mill B verticalization was connected to uncertainty-reduction since the participant identifies it as a highly risk-averse company. However, the participant did not view the reduction of transaction costs (e.g. search and bargaining costs) as connected to it. The result of this was an increase in its transaction costs by its directive of direct purchase of wheat from farmers (reducing purchase from grain merchants if possible) and the downstream verticalization of its operations.

4.4 Transaction dimensions and CE diffusion influencers

Grain transactions have few contractual demands: wheat quality, price, date and location of delivery, quantity and assurance scheme requirements. The forms of wheat commercialisation can vary from the spot-market, hedged future contracts or pool of farmers. As stated, the high uncertainty part of the wheat grain industry requires considerable flexibility from farmers and grain-merchants. If, by any reason, the wheat does not meet quality requirements, it will be reclassified as lower grade and can be moved to animal feed instead of remaining in the food (milling) supply chain, thus leading to a reduction in premium pay. This leads farmers to adopt wheat varieties that reduce their uncertainty by being not only more productive but also more resistant to pests and more stable in quality (especially protein content). In other words, transactions with high uncertainty are connected to the **driver** '**product development**' as both subcategories apply here: increase in product value and increase in product efficiency. It is also possible to argue that high uncertainty transactions drive the adoption of **reclassification** and **repurpose** CE practices as these practices are connected to flexibility.

Many British food supply chains – including wheat – have certification requirements in their trading schemes. Although commodity contracts do not have the sustainability requirements explicitly, they do have certification conditions. These certifications encompass a series of required practices at all levels of the supply chain, such as input application control, storage operation and infrastructure, waste disposal, among others. There is a considerable number of these practices that can be connected to CE, and are **driven** by different concerns, such as **environmental protection** and **health** (Table 2). Therefore, certification is an indirect **driver** of CE diffusion in the wheat food supply chain in formal contracts.

Another connection between driver and transaction was identified concerning the unique purchasing program that Farmer A and Mill A are a part of. The program requires wheat production with **reduced input use** (in this case, the use of foliar nitrogen). The reduction of inputs is one of the CE practices identified in Table 1 and traditionally discussed as one of the 3 'R' practices (reuse, reduce, recycle) (Kirchherr *et al.*, 2017). The change in standard farm operation that focuses on increasing protein content in the grain is fomented by a big industrial bakery and structured with the support of one of the UK largest grain-merchants. 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. The use of more nitrogen in wheat crops aims at increasing protein (especially gluten), which is a common goal for farmers and mills

because of the type of flour generated from it. 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. The program (including its relationships and requisition) was the only example of dedicated asset specificity identified in the research so far. It is also an example of a **driver**: **society** as it is done by consumer demands (Govindan and Hasanagic, 2018), in this case, the bakery leading the program. In summary, the **driver** 'consumer demands' increased asset specificity by requiring the adoption of a **reduction of inputs**.

The most direct connection between Transactions and CE **enablers** relates to **partnerships/collaboration** (Table 2). Participants identified this in two forms, both relating to High Frequency (repeated occurrences, over a long period) through informal and formal partnerships. Collaboration between farmers was informal and included barter of muck for straw deals and the donation of waste from other activities like tree pruning and turf. Although not directly connected to the suppliers, these relationships are essential to supply farmers with material to increase soil fertility and organic matter. Another source of these inputs was through formal partnerships with water and sewage companies for treated waste, occurring in both interviewed farms. It is also important to note that the beforementioned program for reduced input use in wheat and flour sourcing is also a **formal**, **long term** contract.

There were two instances of the CE practice '**cooperation** with other organisations to implement and use CE' (Table 1, based on (Masi *et al.*, 2018)) that are enabled by formal contracts: the formation of Farmer Cooperative (and use of its assets), and the expressed desire of Farm B to formalise an agreement with a few neighbouring farms for sharing machinery. Both examples fall within the CE paradigm of sharing/services over ownership, as discussed by Batista *et al.* (2018a). In summary, both 'formal' and 'informal' contracts are connected to the **enabler** 'partnerships and collaboration across the value chain', especially in repeated, long-term transactions (high frequency).

Regarding verticalization, it was identified that it enables the **repurposing** of grain, by-products and waste. Mill B also has an industrial bakery division that industrialises the flour for supermarket's in-store bakeries and their brands. It also has an animal feed industry that absorbs (**repurposes**) the low-quality wheat (not used in their bakery or by their flour clients), wheat bran and other waste. **Repurposing** of material for other uses was also anticipated in Table 1. The fact that Mill B is more vertical was not mentioned as a factor influencing CE practices adoption, but it is possible that it **enables** it.

Mills' formal transactions with their larger clients (i.e. industrial bakeries and supermarkets) do have pro-sustainability conditions for the mills to comply. These elements go beyond certification requirements and are sources of audits and costs for the companies. However, the mills are not yet passing these requirements to their suppliers as a general rule, thus not clearly visualised in the dyads discussed in this paper. This means that market pressure from **end-consumers** for the adoption of CE practices is not yet directly affecting the supply chain actors interviewed so far. According to the interviewees, the amount of transformation that wheat goes through to become food makes it harder for end-consumer pressure to reach farmers and other upstream actors. This is especially true considering the substantial percentage of spot-market transactions occurring. In other words, before it becomes flour, the transactions of the wheat grain are – as a general rule – not yet influenced by **market issues** and **culture issues** considering end-consumers and the forms of transactions happening with wheat grain.

The high volume / low value of wheat grain and flour makes logistics costs an important issue for the organisations interviewed. The most common form of flour transport is through pressurised lorries. Mill A's fleet of lorries is leased, as they aim to reduce costs and to maintain the newest fleet possible (thus reducing environmental impact with more modern trucks). Leasing is considered a CE practice (Korhonen *et al.*, 2018; The Ellen MacArthur Foundation, 2014) as it relates to new business models of service over ownership (Table 1). However, due to food safety requirements, the tanker lorries used to transport flour will travel empty once the flour is delivered. This means that, although formal contracts (leasing) function as an **enabler** of CE, they can also connect to a barrier of CE adoption, specifically, **Market Issues**, since the need to travel empty goes against CE principles.

5. Discussion

Considering the research framework discussed in Section 2, as well as the research question – "How can transactions between organisations in a British wheat food supply chain influence the diffusion of CE practices?" – the following section discusses the findings of the research so far.

5.1 OC practices and diffusion:

The preliminary results of this research suggest that the research participants consider financial costs and gains as the **main driver** to adopt CE practices (OC of practices diffusion). The literature regarding the adoption of CE practices (The Ellen MacArthur Foundation, 2013; Govindan and Hasanagic, 2018) has the pro-economic/financial dimension as one of the main drivers for its implementation in supply chains, thus supporting the current findings. However, other important points made in CE-related theory need to be addressed carefully. Relating to CE practices (OC derived from the main theory), for instance, soil as a resource that needs to be protected for a sustainable farming system was highlighted by the farmers and the extension agency. This shows that soil, in its various dimensions (structure, fertility, organic matter, etc.), has a fundamental role in CE-related to agrifood systems and should be more prominently discussed in CE theory relating to CE practices. Crop rotation as a tool for reducing operations and agrichemical usage can also be included in the CE practices relating to food systems. It can be argued that the **driver** '**adapting modern agriculture'** (environmental protection cluster) (Govindan and Hasanagic, 2018) of Table 2 - already encompasses both issues. However, the prominence of soil discussion and the fact that soil protection and crop rotation are not new to the agricultural field, suggests it might be better to separate the issue in the literature relating to CE in the agrifood context.

The amount of transformation required for the wheat grain, as a commodity, to become something perceived by the end-consumer as food (e.g. bread, pasta, biscuit and cakes) reduces the pressure felt by the upstream supply chain actors according to the participants. However, this does not mean that CE practices are not required by clients in any form; only that **consumer pressure** – one of the drivers in the Society cluster of Table 2 - can act as a motivator differently depending on the supply chain. Most research in circular food supply chains is build based on short-supply chains (one intermediary at the most, between farm and market), with little processing (e.g. fresh fruits, meat, coffee, etc.) (Gallaud and Laperche, 2016; Weetman, 2017; Vlajic *et al.*, 2018). The present research, on the other hand, is being developed in a long supply chain with the considerable transformation (grain to flour to food product), and this can influence how the end-consumer market acts as a driver for CE adoption affects the supply chain. In other words, drivers, barriers and enablers need to be investigated in a case by case analysis of circular agrifood supply chains, as different products can respond differently from similar influences – in this case, consumer demand.

The assurance organisations play an essential role both in the transactions for wheat flour purchase, and the adoption of practices linked to CE. This points to an **indirect** connection between transactions and CE operations adoption by organisations: although the contracts do not mention CE-operations requirements, the assurance requirement can act as a CE adoption driver. In other words, assurance schemes function as an indirect driver to CE practices diffusion via transactions. It needs to be pointed out, however, that although these operations (e.g. traceability, contamination prevention, etc.) are not explicitly acknowledged as CE, these practices **reduce waste** and **inputs**, and are connected to sustainability as they relate to food safety and security, and therefore there is a direct connection between CE and food assurance schemes, as both a driver and an enabler.

Govindan and Hasanagic (2018) listed a significant number of **barriers** in their systematic review. However, most of these barriers were found to be unsuitable for the agrifood context. On the other hand, the clusters of said barriers were broad enough to be of use. Additionally, the clusters '**market issues'** and **'culture issues'** could sometimes overlay each other, since culture plays an essential role in the way markets consume food and what external requirements are possible within the agrifood industry. This suggests that research and policies for CE diffusion need to be context-specific (field of application).

5.1 OC Dimensions of transactions:

Among the different dimensions of transactions investigated in this research, uncertainty was the most cited dimension of the transactions in the supply chain. Third-party assurance schemes play a role in mitigating it. Both as grain and as flour, wheat did not require investments in specific assets for selling to clients. However, the current program aiming for the elimination of liquid (foliar) nitrogen to increase protein in the grain in exchange for a premium on grain price, can be connected to CE, since it can lead to a reduction of input use. Eliminating the application of nitrogen also reduces the need for other machinery operations.

The difference in complexity between the linear representation of the wheat food supply chain and the **circular** representation, reinforces the difficulty in managing a circular supply chain compared to a linear one. As Barbier (2011) expresses, the more complex a system is, the more difficult it is to change, and the higher the transaction costs expected. In other words, circular supply chains, as a whole, should have considerable higher transaction costs than linear ones. Having said that, the formation of such circular supply chains is not necessarily planned and organised, as the formation of the circular wheat food supply chain shows. The arrangement of those organisations has formed naturally over time. This means that it is possible to have circularity in supply chains without being necessarily designed for that. The verticalization of activities can function as an enabler of CE practice diffusion in wheat and should be considered an alternative for frameworks and strategies of CE business models in the industry.

6. Final Considerations

The worldwide concern of food sustainability fosters the need to understand better the mechanisms in which CE can be promoted and adopted in agrifood supply chains. The research objective was to clarify the role of transactions between organisations in the adoption of CE practices in the wheat food supply chains. Transactions can play an indirect role as a driver to adoption via requirements for certification for farmers, a direct role as a barrier given quality standards for mills, and as enablers since transactions happen with partners in the supply chain. Transactions can also have no role at all, such as by the lack of CE-requirements in purchases of commodities.

The current data supports that transactions with high asset specificity function as a driver to the diffusion of CE practices (e.g. reduction of inputs to fulfil a specific program and location that reduces logistics operations). In transactions with high uncertainty, transactions can act as a barrier, since flexibility is required. Therefore, CE-requirements should not reduce the flexibility of organisations to adapt to change if circularity is a goal. In transactions with high frequency (continually repeated) as the defining characteristic such as the formation of cooperatives or sharing machinery, the contracts serve as an enabler, facilitating such interactions. It is also important to point out that other links in the supply chain, further downstream, can have a different perspective, such as a direct requirement for CE-related practices in contracts (both for purchase and overall commitment). Supermarket chains pressuring their suppliers for waste reduction and donation of overproduction (both highly connected to CE) are well known and public.

The case studied – a British wheat food supply chain, shows that food commodities are also part of CSC. Even though commodity contracts are standardised by definition (Batalha, 2001), assurance schemes can function as guarantors of CE-related production processes. Furthermore, the case shows that, with the exclusion of specific (limited) purchasing programs, there is no premium payment for CE-related products (e.g. reduced input use) in the wheat food supply chain. Institutions that desire to foster CE should take this into consideration as it can serve as a barrier to implement CE on a large scale for wheat products.

By mapping the material flow, the case also demonstrates that the CE perspective in food supply chains makes planning and designing CSC much more complicated, especially in supply chains with many actors between farm and market and through the loops. Frameworks such as those proposed by Neves *et al.* (2019) need to consider this when discussing CE strategies for supply chains. With the identification of the dimensions of transactions in wheat food CSC, future research can better identify transaction costs and have a clearer picture of overall costs to implement CE. It also allows the identification of best contractual types in circular agrifood supply chains, given the potential to have different forms of contracts in various stages of the supply chain for circularity.

The fact that some of the organisations interviewed did not recognise some of the practices linked to CE in the literature (Kirchherr *et al.*, 2017; Weetman, 2017; Jesus and Mendonça, 2018), suggesting that there is still need to develop CE theory for the food context further. It is also necessary to recognise that several practices in farming can already be classified as connected to CE (e.g. no-tillage production, reduction of inputs, etc.), without the need for a complete revamp of current agriculture systems toward new systems as some authors have suggested (Jun and Xiang, 2011; Borrello *et al.*, 2016).

As a contribution to managerial practices, the paper presents CE practices already in operation in the UK wheat industry. Decision-makers in the industry who want to embrace CE can use the practices discussed here as a guideline of potential operations to be used. Additionally, the results demonstrate that transactions with Assets Specificity as the dominant dimension are better for CE diffusion than transactions with Uncertainty as to the most relevant dimension. Therefore, managers working in the wheat industry who want to develop a circular business model should consider formal transactions that aim at reducing such uncertainties, even though they might require more specific investments.

By understanding the possible variations of the role of transactions, transaction costs can be reduced. Organisations that want to promote CE can benefit from the present research since it clarifies details regarding the nature of costs in CE implementation related to clients-buyers. CE cost implementation cannot be calculated based only on capital investment and operational costs; transaction costs must also be included.

Through the use of a new institutional economy theory (TCE), the present research brings a different perspective from the most commonly applied Ecological Economics used in CE research (Nozharov, 2019). Additionally, the results demonstrate that the theory of CE needs to be better adapted to the practices of agrifood supply chains: nomenclature of operations, differentiation between practices and recognition of sustainable farm operations that fall within the CE paradigm need to be better discussed by theory. Finally, the argument that supply chains need to be intended and designed as circular to fall within the CE paradigm (as the most notable definition of CE proposes (Geissdoerfer *et al.*, 2017)) shows that the theory is not aligned with the reality. The circular flow of materials mapped (Figure 3) was not intended or planned with CE in mind but evolved as such, nonetheless.

Regarding limitations, while case studies are instrumental in exploratory research such as this, and are useful to clarify details in particular settings, there is a limit to its capacity for generalisation. Qualitative research, including single case studies such as this one, do not have statistical generalisation power. Another limitation of the present research is its small number of participants, considering that the investigation is focused upstream of the mills. However, the wheat food supply chain also encompasses bakeries (craft and industrial), various forms of industries, retail – especially supermarkets - and various forms of food reuse/donation of potential food waste. Additionally, the present research is localised in the UK context. Still, a comparison to other countries might be in order, as different institutional settings and culture can influence practices, influencers and consumption patterns. For further discussion of food CSC and TCE, other crops such as barley should be investigated. Future research can use quantitative methods to verify how the findings of this study apply to other transactions and dyads (buyers-suppliers) in the wheat industry setting. Finally, other theoretical frameworks relating to relationships between organisations can be used in the discussion of diffusion of CE, with social contagion theory and institutional theory as relevant candidates for future research on the topic.

7. Acknowledgments

The authors of this paper would like to acknowledge the University of Northampton for funding this research and the participating organisations.

8. Disclosure statement

This paper is part of the first author's PhD thesis and was initially presented at the 2019 LRN Conference. Although the first author works in the wheat research unit for the Brazilian Agricultural Research Corporation (Embrapa), there was no conflict of interest as it is part of a governmental body of a different country where the research took place.

9. References

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) Exports and the UK market. *Exports*, 1–3. [online]. Available from:

http://www.hgca.com/content.output/5165/5165/Exports/Exports/Exports and the UK market.mspx [Accessed October 29, 2018].
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.
Babbie, E. (2018) *The practice of social research*. 14th ed. Boston: Cengage.
Balboa, C.H., Domingues Somoente, M. (2014) Circular economy as an ecodesign framework: the ECO III model. *Informador Técnico*. **78**(1), 82–91.
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.
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.
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., Gong, Y., Pereira, S., Jia, F., Bittar, A. (2018b) Circular supply chains in emerging economies–a comparative study of packaging recovery ecosystems in China and Brazil. *International Journal of Production Research*. **7543**.
Batista, L., Bourlakis, M., Liu, Y., Smart, P., Sohal, A. (2018c) Supply chain operations for a circular economy. *Production Planning & Control*. **29**(Special), 419–424.
Borrello, M., Lombardi, A., Pascucci, S., Cembalo, L. (2016) The Seven Challenges for Transitioning into a Bio-based Circular Economy in the Agri-food Sector. *Recent Patents on Food, Nutrition & Agriculture*. **8**(1), 39–47.
Braun, V., Clarke, V. (2013) *Successful qualitative research: a practical guide for begginers*. 1st ed. London: Sage Publications.
Bryman, A., Bell, E. (2015) *Business Research Methods*. 4th ed. Oxford: Oxford University Press.
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.
Cooper, D.R., Schindler, P.S. (2014) *Business research methods.* 12th ed. London: McGraw-Hill.
Davies, H., Lam, P.-L. (2001) *Managerial Economics: an analysis of business issues*. 3rd ed. Essex: Pearson.
DEFRA (2018a) *Agriculture in the United Kingdom 2017*. London.
DEFRA (2018b) Key Crop Areas and Livestock Numbers - UK and Country Level Data - 1866 - 2017. , 1.
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.
Easterby-Smith, M., Thorpe, R., Jackson, P.R. (2015) *Management & Business Research*. 5th ed. London: Sage Publications.

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 (2020) *Climate change: unpacking the burden on food safety*. Rome: FAO - Food and Agriculture Organization of the United Nations.
FAO (2017) Food Balance Sheets.
FAO (2018) Wheat Worldwide import and export - by country - 2009-2013. *FAOstat*. [online]. Available from: http://www.fao.org/faostat/en/#data/TP [Accessed May 16, 2018].
Ferguson, M.J. (2007) *A Social contagion model of organizational misbehaviour*. Vanderbilt University.
Gallaud, D., Laperche, B. (2016) *Circular Economy, Industrial Ecology and Short Supply Chain : Towards Sustainable Territories*. John Wiley & Sons, Incorporated.
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.
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.
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.
Grain Chain (2016) Wheat farming in the UK. , 1–18.
iPES FOOD (2020) *COVID-19 and the crisis in food systems : Symptoms , causes , and potential solutions*. Brussels.
Ito, N.C., Zylbersztajn, D. (2018) Vertical integration in the Brazilian orange juice sector: power and transaction costs. *International Food and Agribusiness Management Review*. **21**(1), 1–16.
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.
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.
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.
Klein, P.G. (2013) Transaction Cost Theory. In E. H. Kessler, ed. *Encyclopedia of management theory*. Thousand Oaks: Sage Publications, pp. 889–892.

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.
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.
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.
Lincoln, Y.S., Guba, E.G. (1985) *Naturalistic inquiry*. London: Sage.
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.
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.
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.
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.
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.
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.
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. (2019) THE INSTITUTIONAL ECONOMICS OF COLLECTIVE WASTE RECOVERY SYSTEMS: AN EMPIRICAL INVESTIGATION. *IDEAS Working Paper Series from RePEc*. **arXiv.org,** 1–10.
Nozharov, S.S. (2018) Transaction costs in collective waste recovery systems in the EU. *Economic Archive*. **1**, 18–31.
Poore, J., Nemecek, T. (2018) Reducing food's environmental impacts through producers and consumers. *Science*. **360**(6392), 987–992.
Rogers, E.M. (1983) *Diffusion of Innovations*. 3rd ed. London: Collier Macmillan Publishers.
Saunders, M., Lewis, P., Thornhill, A. (2016) *Research methods for business students*. 7th ed. London: Pearson.
Secretary of State (2013) The Food Safety and Hygiene (England) Regulations 2013. , 1–44.
Shin, H.-D. (2003) *The role of Uncertainty in Transaction Costs and Resource-Based*

theories of the firm. Ohio State University.
Smith, J., Barling, D. (2014) *Glamur Project UK Wheat to Bread Supply Chain Case Study*. London.
Stahel, W.R. (1982) Product-Life Factor. *Mitchel Prize*, 1–10.
The Ellen MacArthur Foundation (2019) *Cities and Circular Economy for food*. Cowes.
The Ellen MacArthur Foundation (2013) *Towards a Circular Economy Vol. 1 - Economic and Business rationale for an accelerated transition*. Cowes.
The Ellen MacArthur Foundation (2014) *Towards a Circular Economy Vol. 3 - Accelerating the scale-up across global supply chains*. Cowes.
United Nations (1987) *Report of the World Commission on Environment and Development*. New York.
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.
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.
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., 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.
Williamson, O.E. (1998) Transaction cost economics: How it works; where it is headed. *Economist*. **146**(1), 23–58.
Williamson, O.E. (2008) Outsourcing: Transaction cost economics and supply chain management. *Journal of Supply Chain Management*. **44**(2), 5–16.
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.

Appendix 1

Practices	Farmer A	Farmer B	Farmer Cooperative	Mill A	Mill B	Mill Association	Farmer's assurance	Extensionist
Reduction of waste	X	X	X	X	X	X	X	X
Reduction of inputs	X	X	X		X	X	X	X
Reuse	X	X			X		X	
Recycle	X	X			X		X	
Redesign products		X			X			X
Redesign services								X
Redesign processes	X	X	X	X				X
Redistribution (market substitution)	X	X						
Recovery (taking back from consumers for adequate disposal)								
Recovery (incineration of waste)								
Reclassify (identify as lower grade and sell cheaper)	X	X	X	X	X			
Repurpose (change the use e.g. food to feed)	X	X		X	X		X	
Renewable energy use	X	X	X				X	
Measure sustainable practices (e.g. recycle, reduction of waste, etc.)			X				X	X
Maintaining prices of new pro-sustainability products	X							
Purchase of inputs and services that are cleaner	X		X				X	
Cooperation with other organisations for sustainability	X	X	X		X	X	X	X
New logistical options that are more sustainable	X	X	X	X			X	
Education and training of staff and managers for sustainability practices		X	X	X		X	X	X
Environmental certification (e.g. ISO 14000)	X		X					
Targeting the market of "green customers"							X	