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Competitive benefits & incentivisation at internal, supply chain & societal level circular operations in UK agri-food SMEs

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ABSTRACT

Circular operations offer embedded environmental and economic benefits, with promise to tackle ecological degradation. Circular operations also offer competitive benefits for the firm or supply chain, but these have been widely overlooked. Competitive benefits are important, helping to mitigate barriers of cost and risk and incentivise implementation of circular operations. Adopting a qualitative multi-method approach, this study explores implementation of the circular economy at internal, supply chain and societal levels in UK agri-food SMEs. A natural-resource-based view theoretical lens underpins exploitation of competitive benefits at each level and explains their role in incentivisation. Whilst environmental-economic benefits remain embedded, competitive benefits are brought to the fore. This supports the argument that circular operations can be implemented to purposefully seek competitive gain rather than as an environmental obligation. This new competitive perspective promotes appeal and approachability to circular operations, particularly for agri-food SMEs where implementation may be problematic.

1. Introduction

Circular operations are of increasing significance in academia, practice and policy. Circular operations are typically characterised by the recapturing, recycling and reuse of waste and resources. With clear environmental benefits, circular operations are presented as a solution to ecological degradation (Merli et al, 2018). This environmental perspective is prevalent in literature, detracting attention from other benefits. In particular, competitive benefits are often overlooked. An important distinction must be made between *economic* benefits and *competitive* benefits. As is implicated in the superordinate term 'circular economy', *economic* benefits are intrinsic to circular operations and are well noted throughout literature. Economic benefits relate to cost reduction and efficiency improvements which derive from circular capacities in waste reduction and reuse – in other words they are the consequences of environmentally maximised operations. In contrast, *competitive* benefits standalone (Lichtenthaler, 2021) and are purposefully exploited for firm or supply chain gain. For example, circular operations driven by competitive cost–cutting rather than waste reduction; differentiation rather than to alleviate resource depletion; or new revenue streams rather than mitigation of ecological degradation. This presents two key motivations for implementation: circular operations to meet environmental goals with associated economic benefits; or purposeful exploitation of circular operations for competitive benefits. The latter perspective has only recently gained attention in academia and requires further explanation.

To bring the competitive perspective to the fore, there is a need to better understand how firms 'exploit' competitiveness from circular operations. Recent studies have attempted to explain this via application of resource-based theory. From a resource-based theory perspective, competitiveness is purposefully exploited from heterogenous (unique) or immobile (difficult to attain) resources (Peteraf & Barney, 2003). The natural-resource-based view (NRBV) extends this to a sustainability context, presenting environmental operations as resources to be competitively exploited (Hart, 1995). To contextualise for this study, this means that circular operations can manifest as resources to be exploited for competitive benefits. This is discussed to some extent in recent studies (e.g., Mishra et al, 2021; Agyabeng-Mensah et al, 2021; Lichtenthaler, 2021; Schmidt et al., 2021), offering a positive step towards prioritisation of competitiveness. However, two prominent research gaps remain: competitive benefits at different levels of circular operations implementation; and the role of competitiveness in incentivising uptake of circular operations.

Considering different levels of implementation, circular operations

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literature discusses internal, supply chain and societal levels of implementation (Morana & Seuring, 2011; Kristensen & Mosgaard, 2020). This acknowledges that circular operations manifest differently at each level, implying competitive exploitation will also differ at each level. However, existing NRBV-circular operations studies focus on the supply chain level. Additionally, the significance of NRBV's individual resources is overlooked. NRBV resources of pollution prevention, product stewardship and clean technologies exist heterogeneously across different levels, each with distinct competitive benefits (McDougall et al, 2019). Despite this, existing studies tend to apply the NRBV holistically or the supply chain focus encourages application of product stewardship only. As such, the three NRBV resources are yet to be applied to explicate distinct competitive benefits of circular operations at different levels of implementation. This study aims to address this gap via explicit application of NRBV resources to Morana & Seuring's (2011) framework of internal, supply chain and societal levels of circular operations. Specifically, the NRBV's pollution prevention resource exploits competitiveness for the firm from advanced internal waste management and is applied to internal level circular operations. The second resource, product stewardship, exploits competitive benefits for the supply chain via environmentally maximised lifecycle management and is applied to supply chain level circular operations. Clean technologies again exploits competitiveness for the firm but does so on a bigger scale than pollution prevention. More specifically, clean technologies promotes transformation of traditional operations to deliver positive environmental impacts for wider society, supporting its application to societal level circular operations.

This study also aims to address research gaps relating to the role of competitiveness in incentivising uptake of circular operations. Whilst existing studies offer some insight to competitive benefits of circular operations, it remains unclear whether these incentivise uptake. This is important for two reasons: first, implementation of circular operations is subject to considerable barriers that necessitate incentivisation; and second, environmental-economic benefits are limited as an incentive. Academics have long been concerned with the high risk, cost and complexity of transitioning towards a circular approach (Souza, 2013; Coenen et al, 2018). This highlights a need to mitigate concerns and highlight benefits. Whilst this can be achieved to some extent via environmental-economic benefits, this may be limited due to contextual specificities and environmental trade-offs. Recent literature suggests competitive benefits may serve as a more widely applicable incentive for circular operations (Lichtenthaler 2021; Schmidt et al, 2021). This further supports the need for greater understanding of competitive benefits.

This study seeks explanation of competitive benefits and incentivisation across the three levels of implementation from empirical investigation of circular operations in UK agri-food SMEs. Recent literature highlights the significance of circular operations for SMEs (Dey et al, 2020) and their critical role in driving wider implementation (Katz-Gerro, & López Sintas, 2019). Circular operations' recapturing, recycling and reusing of resources responds to SME resource unavailability (Dey et al, 2020) and high environmental impacts (Dey et al, 2019). The capacity for this is particularly prominent in argi-food (Merli et al, 2018), where SMEs are dominant (Hendry et al, 2019) and high levels of natural and reusable waste welcome a circular approach (Pagotto & Halog, 2016). Therefore, UK agri-food presents an appropriate context to expand understandings of circular operations (Merli et al, 2018). Considering competitive benefits, UK policy presents waste as a source of value (Vision 2020, 2020) and promotes this to drive wider implementation of circular operations across the food sector (DEFRA, 2020). Whilst earlier studies highlight the competitive appeal of circular operations in agri-food (Pagotto & Halog, 2016), specific competitive benefits for agri-food SMEs lack definition and explanation. Stressing the significance of incentivisation, Schmidt et al (2020) find that existing European policy efforts to drive SME engagement with circular operations have limited effect.

The research question guiding this study is: *what competitive benefits are realised from circular operations at internal, supply chain and societal levels and how do these incentivise uptake in UK agri-food SMEs?* Answering the question, the study offers important contributions to theory and practice. Theoretically, this study expands on existing efforts to underpin the competitiveness of circular operations with the NRBV via more distinct application of NRBV resources to levels of circular operations. This permits explanation of the manifestation of circular operations at each level, associated competitive benefits and their role in incentivising uptake. Competitive incentivisation is also important in a practical context, challenging barriers to implementation and supporting efforts to drive uptake of circular operations. This is particularly significant to mitigate resource unavailability and high environmental impacts for SMEs, as well as advancing competitive and environmental performance of the UK agri-food sector.

The rest of this paper is organised as follows. The paper begins by exploring existing understandings of circular operations and associated benefits, emphasising competitive benefits from a NRBV perspective. This is followed by the conceptual study, in which NRBV resources are applied to three levels of circular operations to frame implementation and competitive exploitation. Section four details the qualitative multi-method approach adopted in the empirical study. The findings in section five offer detailed description of agri-food circular operations at internal, supply chain and societal levels. Here competitive benefits at each level are defined and their role in incentivisation explained. Some discussion of emergent findings relating to interconnectivity between levels of implementation is also offered. Finally, the paper concludes with contributions and recommendations for future research in section six.

2. Circular operations

Despite growing academic interest in circular operations, there remains divergence in definition and approaches in literature (Kalmykova et al, 2018). This ranges from circular economy as a business model to be implemented (Geissedoerfer et al, 2017; Confente et al, 2020), to its complete deconstruction as a series of circular strategies (Superti et al, 2021). From the business model perspective, the circular economy exists as an independent entity to be implemented as a well-functioning ecosystem for economic benefits (Murray et al, 2015). This often builds on a linear (traditional – unsustainable) to non-linear (circular – sustainable) debate, presenting circular operations as an idealised state of sustainable operations. However, this offers a restricted and oversimplified perspective (Mishra et al, 2021). Broad comparison to reverse logistics struggle to capture the complexity of transitioning from linear operations towards a circular approach. Whilst circular capacities of recapture, recycle and reuse naturally require some reversal of operations (Jensen, et al, 2013; Garg et al, 2015), reversal alone does not constitute circularity. Rather, circular operations rely on two key principles: restorative and regenerative cycles; and facilitation of a zero-waste economy (Farooque et al, 2019). This requires complete redevelopment of operations (Murray et al, 2015; Lahane et al, 2020) to integrate circular thinking and drive system-wide innovation (Farooque et al, 2019). This is better captured in the circular strategies (or R-Strategies) perspective. Here, the circular economy becomes a superordinate term to encapsulate a vast array of complex circular supply chain strategies (Superti et al, 2021). However, the emphasis on supply chain presents further limitations, undermining the manifestation of circular operations at other levels. Whilst supply chain level operations assume dominance in literature, circular operations exist across internal, supply chain or societal (Morana & Seuring, 2011) or micro, macro and meso levels (Merli et al, 2018). This highlights a need for greater explanation of circular operations at different levels of implementation. Of particular significance to this study, is the need to understand exploitation for competitive benefits at different levels.

However, the benefits of circular operations also lack clear explanation (Agyabeng-Mensah et al, 2021). From both a business model and circular strategies perspective, circular operations are often characterised by the creation of value (Geissedoerfer et al, 2017; Confente et al, 2020). However, the term 'value' is problematic, as it is highly subjective and rarely defined. This is not unlike broader supply chain literature, where the transition towards 'value chain' acknowledges the creation of value in operations (Holweg & Helo, 2014) but often without clear definition. Broadly speaking, value refers to the benefits derived from operations (Ramsay & Wagner, 2009) which in value chain and circular operations literature most commonly relate to waste and cost reduction. This reflects the prevalence of environmental-economic benefits and the term 'circular economy'.

2.1. Environmental-Economic Benefits: A Triple-Bottom-Line perspective

Advanced waste management is considered the leading environmental benefit of circular operations (Meri et al, 2018). This derives from capacities in waste reduction, reuse and recycling (Kalaitzi et al, 2019) that offer *"practical solutions to reduce the anthropic pressure on natural ecosystems"* (Merli et al, 2018, p712). Accordingly, circular operations are considered noble (Smart et al, 2017), with environmental benefits for the firm, supply chain or wider society (Morana & Seuring, 2011). Highlighting the economic benefits of circular operations are claims that the circular economy *"makes economic and business sense"* (Korhonen et al, 2017, p546). Merli et al (2018) identify enhanced efficiency as the leading benefit in circular economy literature, whilst implications for cost reduction (Miemczyk et al, 2016) and profits from end-of-life recovery (Govindan et al, 2015; Kazemi et al, 2018) are also notable. These economic benefits are inseparable from environmental benefits (Lichtenthaler, 2021), deriving from the reduction, reuse and recycling of waste. Put simply, retaining and reusing waste improves efficiency, avoiding traditional disposal cuts costs and recycling waste as material or energy resources generates end-of-life profits.

Interestingly, this environmental-economic inseparability is typical in sustainable operations literature, commonly underpinned by the triple-bottom-line (Wells & Seitz, 2005; Merli et al, 2018). The triple-bottom-line suggests sustainable operations are driven by interconnection (Geissedoerfer et al, 2017) of environmental, societal and economic pillars (Farooque et al, 2019). From this perspective, *economic* benefits are automatically realised from advanced environmentalism. This should be distinguished from *competitive* benefits, which are purposefully exploited from circular operations. More specifically, economic benefits derive from complex interconnections with environmental and social sustainability, whilst competitiveness can be seen as a 'stand-alone' benefit of environmental operations (Lichtenthaler, 2021). Whilst the prevalence of environmental-economic benefits has long detracted attention from competitive benefits of circular operations (Oh and Jeong, 2014), recent studies have attempted to address this. Specifically, there is a shift away from a triple-bottom line perspective to a resource-based theory perspective (e.g., Mishra et al, 2021; Agyabeng-Mensah et al, 2021; Schmidt et al, 2021).

2.2. Competitive Benefits: A Natural-Resource-Based view perspective

Resource-based theory contends that competitiveness derives from exploitation of heterogonous or immobile resources (Wernerfelt, 1984). Heterogeneity offers uniqueness to establish competitive advantage, whilst resource immobility means resources cannot be easily attainted (Peteraf & Barney, 2003). Offering further clarity, Barney (1991) describes competitive resources are those that are be valuable, rare, inimitable or non-substitutable. Lockett et al (2009) explains: valuable resources exploit external opportunities of threats; rare resources are in limited supply; inimitable resources are complex or ambiguous, making them difficult to replicate; and non-substitutable resources cannot easily be replaced by another resource. Circular operations with these qualities can be purposefully exploited for competitive benefits. This is reinforced by application of the natural-resource-based view (NRBV), which supports exploitation of environmental – in this case circular – operations that are considered both unique and difficult to attain. Firms can systematically examine existing or potential circular operations for opportunities for competitiveness (Lichtenthaler, 2021).

There is some support for this in recent literature. Both Lichtenthaler (2021) and Schmidt et al (2021) apply the NRBV to consider circular operations as strategic capacities to achieve and sustain competitiveness in circular operations. Mishra et al (2021) apply the NRBV to explain implementation of circular operations to advance collaboration and innovation. Similarly, Agyabeng-Mensah et al (2021) use the NRBV to underpin implementation of circular operations to enhance organisational reputation and identity. However, whilst such studies do offer valuable insights to the competitive benefits of circular operations, they overlook different levels of circular operations implementation and distinct NRBV resources.

That is, just as circular operations manifest across multiple levels (internal, supply chain, societal), the NRBV comprises multiple resources (pollution prevention, product stewardship, clean technologies). NRBV-circular operations links often overlook this, offering broad comparisons based on shared dependencies on reverse logistics (Jensen, et al, 2013; Garg et al, 2015) and embedded environmentalism (Kalaitzi et al, 2019). This reflects the outdated view of circular operations that undermines the complexities of different levels of implementation. Moreover, holistic application of the NRBV to underpin competitiveness disregards important distinctions between each resource. Where individual resources are applied, product stewardship is prevalent (e.g., Miemczyk et al, 2016). Product stewardship drives advanced environmentalism throughout the lifecycle, welcoming comparisons with circular economy at the dominant supply chain level of implementation. Supporting this, Schmidt et al (2021) suggest that circular operations reflect product stewardship, whilst Jensen & Remmen (2017, p381) describe product stewardship as a *"concept that relates to the realm of the circular economy"*. However, clear links can also be made with the other two resources: pollution prevention seeks advanced waste management for competitive benefits within the firm (Hart, 1995), aligning with internal level circular operations (Schmidt et al, 2021); clean technologies seek competitiveness from positive environmental impacts for society, aligning with societal circular operations (McDougall et al, 2019). Despite this, pollution prevention and clean technologies are yet to be applied to circular operations literature to delineate competitive benefits at internal or societal levels. Pollution prevention is implicated in some recent studies, largely presented as a necessary precondition for the more dominant product stewardship (Miemczyk et al, 2016; Schmidt et al, 2021). More importantly, clean technologies is disregarded entirely in favour of the NRBV's older 'sustainable development' resource (Schmidt et al, 2021), overlooking the important reconceptualization of NRBV resources (McDougall et al, 2021).

2.3. Competitive incentivisation

The transition from triple-bottom-line to resource-based theory also renders implications for incentivisation. High complexity, costs and risk (Souza, 2013; Coenen et al, 2018) deter implementation of circular operations (Mishra et al, 2021). This presents a need for increase appeal (Schmidt et al, 2021) as practitioners struggle to value *"future benefits against current costs, knowledge needs, and market pull-and-push factors"* (Rizos et al, 2016, p2). Incentivisation mitigates concerns and highlights benefits, driving operational change towards circularity (Katz-Gerro, & López Sintas, 2019). From a triple-bottom-line perspective, intrinsically linked environmental-economic are drivers for implementation. More specifically, the presentation of circular operations as a noble concept (Smart et al, 2017) or solution to ecological degradation (Merli et al, 2018) suggests environmental goals encourage implementation, whilst economic benefits are automatically realised. There is some support for this in recent literature, with Schmidt et al (2021) suggesting that obligations to environmentally advance operations encourage a circular approach. However, environmental benefits are highly subjective, as geographic and sector specifics influence their relevance and appeal. Environmental-economic benefits are further complicated by environmental trade-offs which can limit measurability and return. In contrast, from a NRBV perspective, competitive benefits are the driver for implementation, whilst environmental-economic benefits are embedded. Competitive benefits promote measurability and a more widely applicable incentive of circular operations. Lichtenthaler (2021) offers some support for this, suggesting circular operations are traditionally obligated and lack incentive, but growing awareness of their competitiveness can be expected to advance uptake. This indicates a change of mindset: companies no longer just accept environmental-economic benefits from circular operations but implement circular operations to exploit competitive opportunities. Or returning to value, *"successful companies do not just add value, they re-invent it"* (Bititci et al, 2004, p252).

2.4. Circular operations in Agri-Food SMEs

Schmidt et al (2021) suggest SMEs may be well equipped to lead wider uptake of circular operations. The prevalence of SMEs in industry permits their presentation as key to widespread implementation (Katz-Gerro, & López Sintas, 2019). This is despite capacity and resource limitations of SMEs which exacerbate barriers to implementation (Dey et al, 2020). Considering capacity limitations, whilst the cost and complexity of circular operations are intimidating, SME capacities such as flexibility and collaboration are complimentary to circular operations (Schmidt et al, 2021). Meanwhile, circular operations' recapture and reuse presents an opportunity to mitigate SME resource unavailability (Dey et al, 2020) and environmental impact (Dey et al, 2019). In spite of this, promotion of environmental benefits has had limited effect in stimulating uptake of circular operations (Schmidt et al, 2021). Rather, promotion of benefits such as competitive cost cutting responds to financial resource unavailability and SMEs' heightened need for competitive advantage (Hendry et al, 2019).

This can be demonstrated in UK agri-food, where SMEs are prevalent (Hendry et al, 2019) and operations are well suited to circularity (Jensen et al, 2013; Pandey et al, 2016). Agri-food operations are both reliant on and detrimental to ecological economies (Aznar-Sánchez et al, 2020) and are considered more complicated than supply chains in other sectors (Mehmood et al, 2021). In response UK agri-food has developed expertise in the development and management of environmental operations (Tassou et al, 2014). Waste in agri-food is presented as *"a valuable resource"* (Vision 2020, 2020), as high levels of food and animal wastes facilitate the production of rich landspreads, stockfeed or anaerobic digestion. This offers a more natural reuse of waste than in other manufacturing sectors, presenting agri-food as *"a natural circulation system in which biological material in a symbiotic relationship moves within the ecosystem"* (Mehmood et al, 2021, p2).

In spite of this, waste remains a prevalent issue throughout the sector (Vision 2020, 2020), highlighting a need to increase uptake of circular operations (Aznar-Sánchez et al, 2020). Existing UK policy promotes *"extracting maximum value"* to drive wider implementation of circular operations in food firms and the wider sector (DEFRA 2020). However, returning to the problematic terminology of value, the need for greater definition of competitive benefits is once again highlighted. That is, whilst the environmental benefits of circular operations in agri-food are well documented (Aznar-Sánchez et al, 2020), competitive benefits lack clear explanation and thus struggle to incentivise uptake. According to Mehmood et al (2021), circular operations in agri-food is driven by policy, environmental, social or health concerns, financial (economic) benefits and product development, suggesting the role of competitiveness in incentivisation is limited. Miranda et al (2021) highlight the need to increase appeal of circular operations in agri-food to overcome the dominant linear approach in the sector. Competitive incentivisation is also expected to appeal to SMEs (Schmidt et al, 2021).

3. Conceptual framing of competitive circular operations across three levels

This study aims to explain competitive benefits and incentivisation of circular operations across different levels of implementation in UK agri-food SMEs. Morana & Seuring's (2011) framework of three 'action levels' of circular operations is used to distinguish between levels of implementation. The framework comprises the individual or actor, the supply chain and the societal or political. Each level manifests differently, meaning environmental-economic and competitive benefits differ at each level. To bring the competitive benefits to the fore, the three NRBV resources are applied to each level of implementation: pollution prevention to internal circular operations; product stewardship to supply chain circular operations; and clean technologies to societal circular operations. This study is the first to apply three distinct NRBV resources to delineate competitive benefits across three levels. Conceptualisation of these three levels of competitive circular operations is offered below and depicted in Table 1.

3.1. Internal circular operations & pollution prevention

Internal circular operations manifest in firm processes and systems. According to Wells & Seitz (2005, p250), this *"occurs at the point of manufacture and is confined to the re-use of materials collected as waste from manufacturing"*. Internal acquisition (Miemczyk et al, 2016) allows the firm to retain and reuse waste for as long as possible (Korhonen et al, 2017), reducing waste and boosting environmental performance (Rizos et al, 2017). In an agri-food chain, this may be the capturing of animal waste for reuse as landspread. Following exhaustion of reuse, waste is recycled to avoid harmful disposal such as landfill and facilitate material utilization or energy combustion. Internal circular operations therefore offer an environmentally maximised manufacturing system (Garg et al, 2015) with greater capacity for value creation (Schmidt et al, 2021). Such environmental maximisation also delivers economic benefits. Korhonen et al (2017) suggest internal circular operations support improved efficiency, whilst costs associated with raw material procurement, energy use and disposal may be reduced. This is essentially a direct output of internal reduction, reuse and recycle (Kristensen & Mosgaard, 2020), inseparable to environmental benefits.

From a resource-based theory lens, complex internal acquisition of natural resources renders implications for rarity and non-substitutability. More specifically, comparisons can be drawn to the NRBV's pollution prevention resource, which seeks enhanced efficiency and competitive cost cutting through advanced waste management in internal operations (Hart, 1995). Pollution prevention seeks to purposefully exploit such operations for competitive benefits. This means recapturing, recycling and reuse of waste is driven by competitive cost cutting rather than to alleviate environmental impacts. Whilst existing studies note links between pollution prevention and internal circular operations (Schmidt et al, 2021), specific competitive benefits at this level are yet to be defined. As a result, there are calls for greater definition of the competitive perspective in academia (Lichtenthaler, 2021), and for practitioners to take greater advantage of circular 'value' (Geissedoerfer et al, 2017) at internal levels. Considering SMEs specifically, adoption of an environmentally maximised system for resource recapture and reuse alleviates their high environmental impacts, energy use and waste (Dey et al, 2019). However, as financial resources are also restricted (Dey et al, 2020), competitive benefits offer more effective incentivisation for implementation than environmental benefits. This is particularly true for UK agri-food SMEs, where the need for competitiveness is increasing (Hendry et al, 2019) alongside the need for better solutions for waste management (Aznar-Sánchez et al, 2020).

3.2. Supply chain circular operations

Supply chain, or lifecycle, circular operations are prevalent in

Table 1
Application of NRBV resources to levels of circular operations.

	Circular Operations	Supporting Resource	Competitive Benefits	Embedded Environmental-Economic Benefits
Internal	Retaining, reusing and recycling wastes and effluents throughout internal manufacturing	Pollution Prevention	Competitive cost cutting	Advanced minimisation of waste and emissions in internal operations; associated cost reduction; maximised efficiency
Supply Chain	Recovery, reuse and recycling of shared wastes and effluents throughout supply chain.	Product Stewardship	Cost & efficiency benefits; access to scare resources; competitive differentiation	Reducing negative environmental impacts and promotion of conservation throughout the lifecycle; associated cost reduction; maximised efficiency
Societal	Development of new circular technologies and systems to reduce emissions, drive conservation & protect global ecologies	Clean Technologies	Cost benefits; commercialisation opportunities; new revenue streams.	Development and promotion of new technologies and systems in pursuit of positive-impact environmental operations; associated cost reduction; maximised efficiency

literature, developing into their own concept of circular supply chain management (Lahane et al, 2020). This level requires dynamic recovery (Govindan et al, 2015) of by-products, unsold products and effluents throughout the lifecycle (Garg et al, 2015). Product acquisition, inspection and disposition, remanufacturing, repair and remarketing allow reincorporation of waste in the supply chain (Jensen et al, 2013). This offers environmental benefits that extend beyond internal circular operations (Korhonen et al, 2017): waste is still retained and reused for as long as possible, but throughout the supply chain as opposed to being limited to the firm. For example, at this level recaptured animal wastes are not only reused on-site but may be shared with supply chain partners for reuse in multiple contexts – expanding scope for reuse. Benefits in lifecycle waste reduction and conservation (Kalaitzi et al, 2019) support links with sustainability (Smart et al, 2017) and industrial symbiosis (Merli et al, 2018). Like internal circular operations, economic benefits relating to cost and efficiency are embedded within environmental benefits but are shared between supply chain actors.

Applying a NRBV product stewardship lens, benefits beyond environmental benefits are brought to the fore. Product stewardship seeks access to scare resources (Hart, 1995) and competitive differentiation from environmentally maximised lifecycle management. Supply chain circular operations' recapturing, recycling and reuse promotes the sharing of waste to create value between supply chain actors – or product stewardship's access to scare resources (Hart, 1995; Schmidt et al, 2021). This mitigates resource unavailability of SMEs (Dey et al, 2019) and realises the 'value' of agri-food's highly reusable waste (Jensen et al, 2013). Considering competitive differentiation, established circular operations distinguish the supply chain, resulting in a unique organisational identity (Agyabeng-Mensah et al, 2021). In part, this derives from the social complexity of supply chain circular operations, that relies on interactions between all supply chain actors (Merli et al, 2018; Misra et al, 2021), particularly in agri-food (Miranda et al, 2021). This creates inimitability and rarity for competitiveness – or product stewardships differentiation. Pagotto & Halog (2016) also present opportunities for differentiation from advanced environmentalism of the food chain, which appeals to agri-food consumers. Considering incentivisation, Miranda et al (2021) suggest that interdependencies in the agri-food chain heighten the need for clarity of how and where actors benefit from circular operations. Moreover, Katz-Gerro, & López Sintas (2019) suggest that SMEs are fundamental in establishing circularity in supply chain. Greater explanation of competitive incentivisation therefore stands to drive SME engagement and their promotion throughout the supply chain.

3.3. Societal circular operations

The societal circular economy goes beyond the confines of the firm or supply chain to address environmental issues on a societal or political level (Morana & Seuring, 2011). 'Societal' takes on two meanings here. First, enhanced environmentalism is intended to benefit society rather than the firm or supply chain (Morana & Seuring, 2011): the retaining and reuse of waste is intended to reduce harmful emissions and support conservation to protect global ecologies (Rizos et al, 2018). Second, this requires engagement with wider society: implementation involves collaboration with external actors such as government or NGO bodies (Lieder & Rashid, 2016; Kazemi et al, 2018) and drives the development of new technologies and systems (Jensen et al, 2013). This presents circular operations as powerful environmental innovations (Szekely & Strebel, 2013; Kalmykova et al, 2018). Demonstrating this in agri-food, Miranda et al (2021) claim that technological change drives circularity. Returning to the agri-food animal waste example, this may be development of a circular treatment system reuse of animal wastes to support soil restoration or ecological regeneration beyond the confines of the firm or supply chain. Thus, from the environmental perspective, implementation of circular operations and realisation of benefits occur at different points in the agri-food chain (Miranda et al, 2021).

This societal focus can also be recognised in the NRBV's clean technologies resource, which shifts the focus away from mitigating negative environmental impacts to instead seek societal-wide positive environmental benefits for competitive gain (Hart & Dowell, 2010). Like pollution prevention, benefits are once again aimed at the firm, but expand beyond cost to include competitive pre-emption and commercialisation via patenting and licensing of systems and sale of outputs (McDougall et al, 2019). In a circular context, this means circular systems can be patented and sold, creating new revenue streams. The development of circular systems and technologies on a societal level is unique and difficult, creating demand and rendering implications for resource-based theory's value, rarity and immobility (Lockett et al, 2009). Clean technologies competitive pre-emption (Hart, 1997) adds to this, driving firms to develop circular systems and technologies ahead of competitors, thus incentivising speedy implementation. Therefore, firm engagement in the societal circular economy is driven by firm benefits, rather than wider societal environmental goals, which remain embedded. As well as competitive appeal, implementation for firm benefits rather than societal wide environmental impact improves approachability. More specifically, the expectation to deliver environmental benefits for society is intimidating for SMEs with resource and capacity constraints, whilst firm level goals are more likely to stimulate response. Accordingly, societal-wide benefits are an ineffective incentive in comparison to firm-level commercialisation and new revenue streams that attach tangible value for SMEs. Nonetheless, like the internal and supply chain levels, explicit application of competitive resources is yet to be applied to delineate competitive benefits specific to the societal level.

4. Empirical study

The conceptual framing was useful in highlighting alignments between each level of circular operations literature and NRBV resources. This offers some insight for potential competitive benefits and consideration of their role in UK agri-food SMEs. However, given existing gaps in understanding of circular operations at different levels and lack of application of specific NRBV resources, empirical investigation was necessary. A qualitative multi-method study was undertaken in the context of UK agri-food SMEs to explain implementation of circular operations across three levels for competitive exploitation. This comprised in-depth interviews and participant observations.

Existing literature suggests circular operations have *'almost exclusively been developed and led by practitioners'* (Korhonen et al., 2017, p45). Such practitioners can be considered experts and so direct access to their experience supports explanation of phenomena. This is facilitated by in-depth interviews which seek rich, discursive data to explain complex operations (Goffin et al, 2006). In-depth interviews rely on an open and conversational dialogue, guided by key questions and interview prompts (Bryman & Bell, 2011). Specifically, in this study, this provided access to the experiences of practitioners in SMEs that have exploited competitive benefits from circular operations. Interviews began with a key question tailored for the relevant level: '*tell me how circular operations have been implemented in the firm*'; '*tell me how circular operations have been implemented throughout the supply chain*'; '*tell me how your company is engaged with circular operations on a sector, national or global level*'. Whilst questions were inspired by earlier conceptual framing, theoretical terminology was avoided and where possible the researchers mirrored practitioner terms. This was intended to minimise bias and put interviewees at ease. In the most part, environmental, economic and competitive benefits emerged naturally in interviewee explanation of circular operations, but environmental, economic and competitive prompts were used where appropriate. However, in line with the research question, interviewees were asked more explicitly to define competitive benefits of specific circular operations under discussion. Again, to minimise bias or leading, such questions remained open (e.g., '*can you tell me what the competitive benefits of this are?*') as opposed to directly referencing a competitive benefit (e.g., *how does this contribute to competitive differentiation?*). Interviewees were also asked to discuss drivers for implementation to permit exploration of incentivisation. Interviews were conducted face to face, lasted between 60 and 90 min and provided rich, discursive data explaining the manifestation of circular operations and competitive benefits across three levels of implementation.

Importantly, circular operations are complex, multi-dimensional entities (Coenen et al, 2018) and as such it is fair to assume that some aspects may exist out with interviewee understanding or be difficult to verbalise. Divergent understandings and approaches to circular operations (Kalmykova et al, 2018) limits capacity for their comprehensive explanation. In such instances, observational data can provide access to tacit knowledge, expanding on discursive data to provide deeper understandings (Kaluwich, 2005). This study used *participant observation* to physically observe circular systems and technologies in their real-life setting. Bryman & Bell (2011) describe participant observation as the researcher's physical observation of phenomena of interest and detailed descriptions of activities observed. This meant that researchers 'toured' the agri-food SME under study, observing circular systems or technologies without interaction or participation. At the internal level, circular operations such as recapturing and reuse of water were observed in their entirety. Observing supply chain level circular operations was more complex as access to supply chain partners was unavailable. However, observation of supply chain circular operations, such as the grading of crops for sale, reuse as stockfeed or redistribution for landspread, was possible. Similarly, it was infeasible to observe circular operations in society, however circular systems and technologies which delivered societal out-puts, such as biodiversity sites, were observed. During observations, interviewees were invited to explain observed operations and were questioned about associated benefits. This allowed the researcher to add tangibility and verification to discursive data, as well as stimulating discussion of circular operations and benefits that may otherwise have been overlooked. Therefore, observations provided another data set to expand and support explanation of competitive benefits and incentivisation across three levels of circular operations.

4.1. Sampling & recruitment

As discussed, this study is set in the context of UK agri-food, which is considered particularly relevant for empirical exploration of circular operations (Merli et al, 2018). The sector's expertise implies access to relevant data to inform the study, whilst the findings of the study respond to the need to increase SME implementation of circular operations at all three levels. The sampling frame consisted of UK companies with fewer than 250 employees and experience of circular operations. In circular operations research, defining and accessing the relevant unit of analysis is challenging (Korhonen et al, 2017). Synonymous terms of 'circular economy', 'closed-loop', 'zero-waste' and 'cradle-to-cradle' (Kalmykova et al, 2018) were included in search criteria, but experience of circular operations alone was not enough. Competitive exploitation and levels of implementation also had to be considered. Accordingly, parameters from the earlier conceptual framing provided further sampling criteria to direct a non-probability sampling approach. This meant that selected firms required operations that aligned with internal, supply chain or societal level circular operations (although many represented more than one level). Sampling criteria for the internal level included internal recovery and reuse of waste, often indicated by water recapturing technologies or anaerobic digestion systems. For the supply chain level, recapturing and sharing of waste products throughout the supply chain and joint circular technologies or systems was sought. The societal level required the development and patenting, selling or sharing of circular technologies and systems with positive environmental impact. Selected firms must also demonstrate competitive exploitation of such operations, demonstrated by strong financial associations (competitive cost cutting), promotion of circularity (differentiation), and sale of outputs (new revenue streams) or patented circular technologies (commercialisation). Resource-based theory implications of value, rarity, inimitability and non-substitutability were also taken into consideration in selection criteria.

Sampling criteria was used to direct online searches and review secondary material from publicly available industry documents and company websites. An existing database of contacts from broader research of competitive operations in agri-food was also searched. Relevant companies were contacted by email and invited to participate in the study. Where possible, specific managers or employees were targeted based on their proximity to or experience of circular operations. Whilst the supply chain and societal circular economies manifest externally, managers and employees still assume responsibility for adoption and operation of circular systems and technologies. In total, 36 SMEs were contacted and 18 agreed to participate. This strong response rate was supported to some extent by the use of contacts known to the researchers via previous investigation of competitive operations in agri-food. The 18 agri-food firms comprise eight firms operating at the internal level, seven at the supply chain level and nine at the societal level (Table 2), thus providing 24 empirical examples of competitive circular operations. This sample was considered sufficient in providing rich, discursive data to explain the implementation of circular operations across three levels, associated competitive benefits and competitive incentivisation.

Of the 18 agri-food SMEs, eight consented to participant observation: three represent internal circular operations, three for supply chain circular operations and two for societal circular operations (Table 3). Observing each firm was impossible due to access issues and scope. Often the location of interviews, timing and on-site regulations meant researchers were not able to tour premises. However, as observation primarily served to expand upon discursive findings, participation from every company was not necessary. Importantly, feasibility and access are common issues in observational research, necessitating a flexible approach (Zikmund et al, 2010).

Table 2
Sample.

FC*	Description	Circular Operations Experience	Interviewee
FC1	Fruit & Veg Firm	Internal; Supply Chain; Societal	Environment & Energy Efficiency Officer
FC2	Fruit & Veg firm	Internal; Supply Chain; Societal	Head of Agronomy
FC3	Fruit & Veg firm	Internal	CEO; Health, Safety & Environmental Officer
FC4	Dairy and Fruit firm	Internal	Director
FC5	Baked goods firm	Internal	Agricultural & Sustainability Manager
FC6	Fruit & veg firm	Internal	Commercial Director
FC7	Meat firm	Internal	Environmental & Sustainability Manager
FC8	Seafood firm	Internal; Societal	Co-founder
FC9	Animal Breeder & Fruit & Veg Firm	Supply Chain	Chief Executive
FC10	Cereal Producer	Supply Chain; Societal	CEO
FC11	Dairy Firm	Supply Chain	Head of Corporate Communications
FC12	Stock Feed Supplier	Supply Chain	Development Manager
FC13	Baked Goods Firm	Supply Chain	Corporate Responsibility Director
FC14	Fruit & Veg & Cereal Firm	Societal	Farm Director
FC15	UK Meat Firm	Societal	Sustainability Director
FC16	UK Fruit & Veg Firm	Societal	Sustainability Officers
FC17	UK Fruit & Veg Firm	Societal	Head of Environment
FC18	UK Dairy Firm	Societal	Marketing Director & Finance Director

Table 3
Observation Sample.

	FC	Observed Operations	Observed Circularity
Internal Circular Operations	FC1	Internal water treatment facility; internal operations; storage systems	Recapturing and reuse of water; resource recapturing
	FC2	Tour of farm machinery; back-of-house operations;	Specialised machinery to collect spillage; waste segregation for reuse and/or recycling
	FC3	Back-of-house operations; retail process	Waste segregation for reuse and/or recycling
Supply Chain Circular Operations	FC1	Packing & distribution process	Reuse of packaging and distribution materials between supply chain partners
	FC2	Harvesting prior to export	Crop grading for reuse, resale, redistribution or recycling with supply chain partners
	FC9	Crop treatment processes; tasting processes prior to export	Crop grading for reuse, resale, redistribution or recycling with supply chain partners
Societal Circular Operations	FC1	Biodiversity site	Use of recaptured waste waters to facilitate biodiversity pond, with measurable ecologies.
	FC18	Renewable energy site; Biodiversity site	On-site water, wind and solar recapture for on-site energy generation and resale to the grid; Use of recaptured waste waters to facilitate biodiversity pond, with measurable ecologies.

4.2. Data analysis

Interview transcripts and observational notes were analysed via qualitative content analysis, which offers a systematic approach to extract meaning from qualitative data sets (Elo et al, 2014). In the first instance, qualitative content analysis encouraged categorization of the two data sets according to level of implementation. The earlier conceptual framing or circular operations literature and corresponding NRBV resources served as a guide. This also provided codes (*see* Table 1*)* for environmental-economic benefits and competitive benefits, which were used to code the categorized data. Three researchers independently coded categorised data according to environmental-economic and competitive benefits. Cross-tabulation of findings highlighted disparities which were resolved via further discussion between the three researchers and, where necessary, further consultation of literature. This is referred to as inter-coder reliability and promotes robustness and validity in qualitative content analysis (Elo et al, 2014).

5. Findings & discussion

The findings offer empirical explanation of circular operations across internal, supply chain and societal levels in UK agri-food SMEs. Whilst environmental-economic benefits are embedded at each level, competitive benefits are brought to the fore. This supports empirical definition of the competitive benefits as well as explanation of how and where such benefits are captured (Figs. 1-3). The role of competitive benefits in incentivising uptake of circular operations is also explained. Emergent findings surrounding interconnectivity between levels of implementation are also presented.

5.1. Internal circular operations

Circularity manifests at multiple stages at the internal level *(see* Fig. 1 *for example)*. Examples in agri-food include the recapturing and reuse of cow slurry as fertiliser, the use of unviable crop as landspread and the collection of food waste from production and on-site facilities for reuse as compost. Circular purpose-built water systems are particularly prevalent, facilitating the recapturing of excess water from production and rainwater harvesting to *"manage water in a sustainable way [….] before it flows off and is lost' (FC6)*. Such examples evidence agri-food's embedded capacities in circularity: *"because being on a farm nothing is wasted and there is a use for everything"* (FC3). This also evidences internal acquisition (Miemczyk et al, 2016) and reuse of waste materials (Korhonen et al, 2017) expected of internal circular operations. Circular operations' retain, reuse and recycle (Kalaitzi et al, 2019) is central here. From a NRBV perspective, there is clear correspondence with pollution prevention's advanced waste management (Hart, 1995).

Environmental-economic benefits are embedded in internal circular operations and remain inseparable, aligning with existing literature (Kristensen & Mosgaard, 2020). Such benefits principally derive from waste management capacities. In agri-food waste typically includes product-based waste and effluents from internal operations. In circular operations, such wastes become a source of value (Farooque et al, 2019): *"the output of one process might be normally considered waste but if you can use it in another process, you stop it from being waste"* (FC8). This is particularly significant for SMEs, where energy use and waste are high and resources often scarce (Dey et al, 2019). From an environmental perspective, internal circular operations promote conservation, whilst from the economic perspective efficiency is maximised and costs reduced. For example, reuse of waste wood generates heat to *"reduce dependency on grid supply energy"* (FC4), minimising costs associated with procurement and disposal. Similarly, water recapture and reuse align with the growing focus on water conservation in agri-food manufacturing and diminishes effluent charges. The longer such wastes are retained and reused, the greater the environmental-economic value: *"it's an obvious win–win, it's an easy idea to sell, so our facility is*

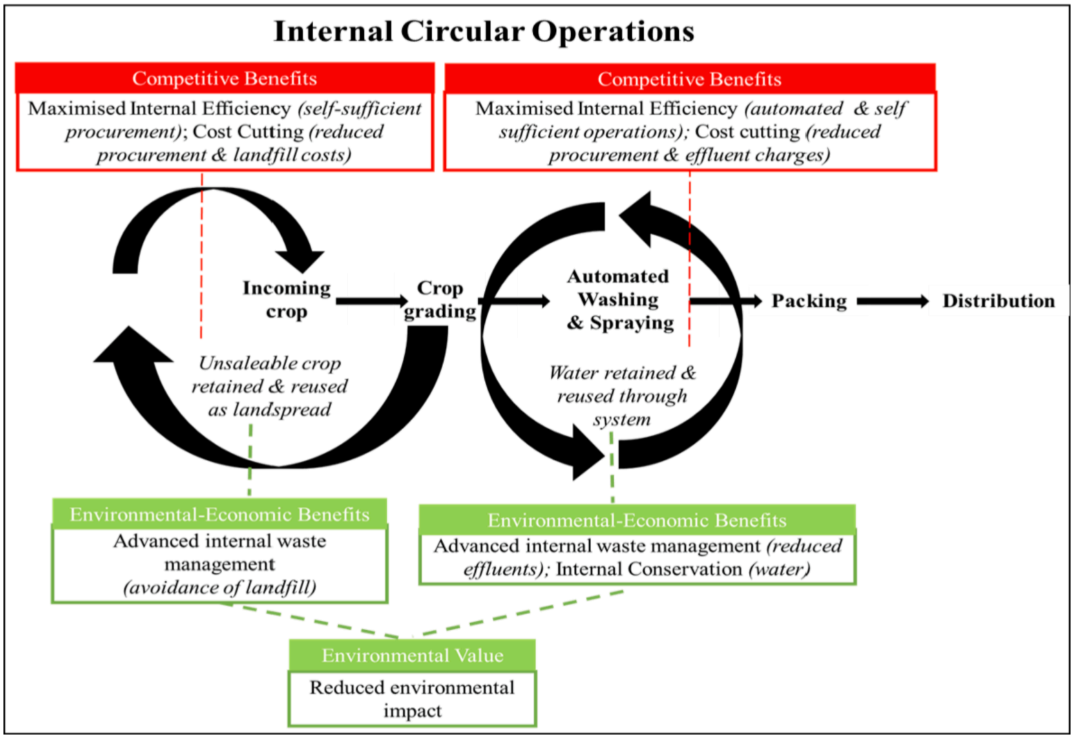

Fig. 1. Capturing Benefits in Internal Circular Operations.

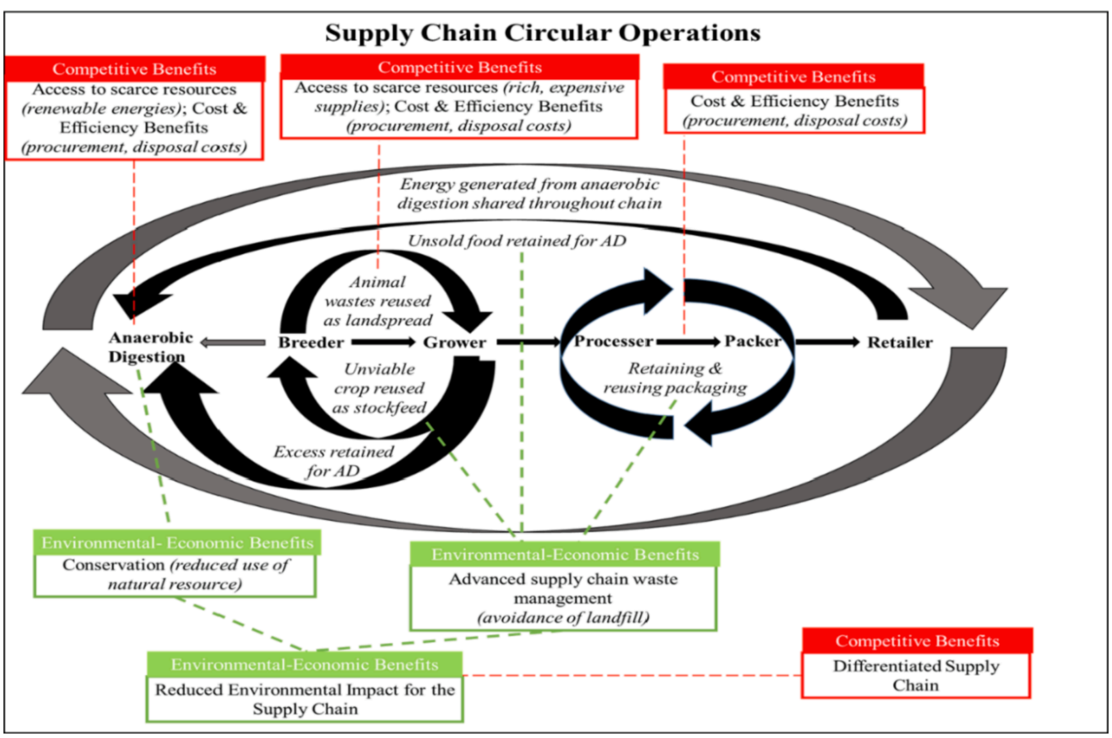

Fig. 2. Capturing Benefits in Supply Chain Circular Operations.

specifically built for environment and the top end of efficiency" (FC1).

Whilst this implicates environmental-economic incentivisation of circular operations, competitive benefits play a more prominent role in driving circular operations. Competitive cost-cutting emerged as the main reason for implementation: *"once you've worked out where your opportunity is* [for circular operations] *you quickly see costs go right down and that is how you get people on board, you invest because there is money to be made and then some"* (FC7). There is an important distinction between acknowledging that circular operations may save money (embedded economic benefits/ triple-bottom line perspective) and the deliberate exploitation of circular operations for financial gain (competitive benefits/NRBV perspective). Interviewees demonstrated the latter: *"although I am improving the environment and I am improving efficiency I am doing it because that saves money, absolutely"* (FC1). This demonstrates

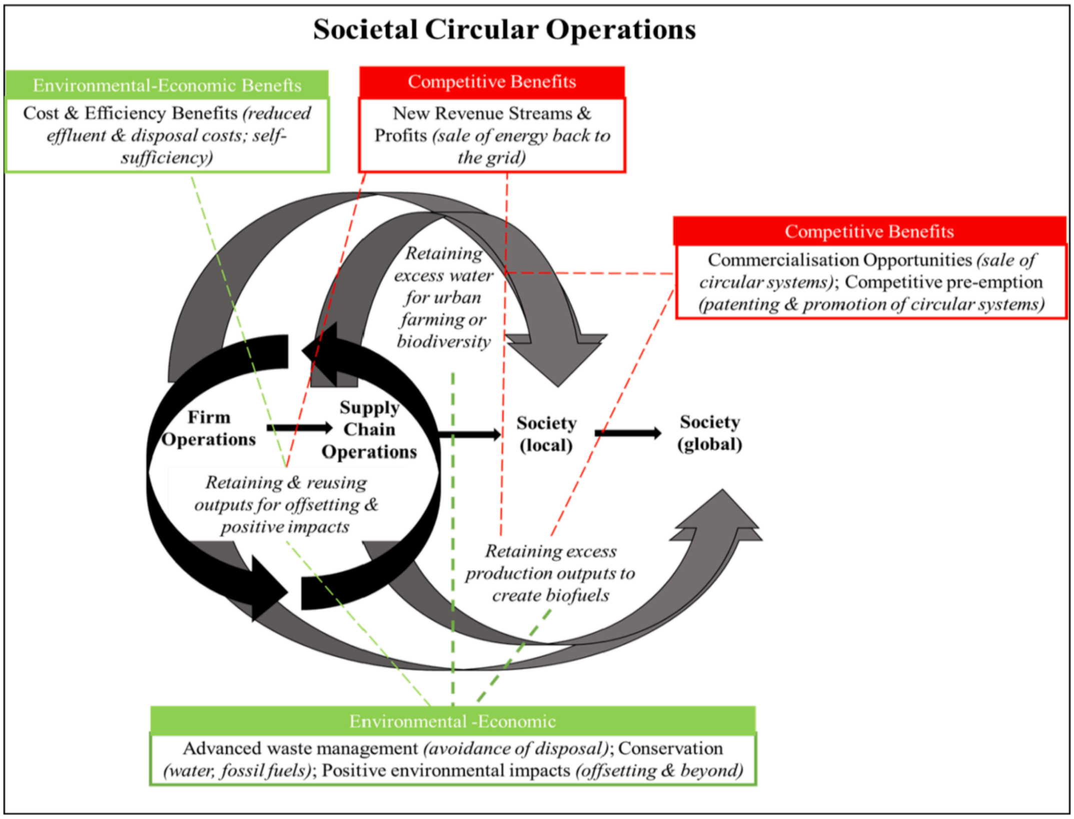

Fig. 3. Capturing Benefits in the Societal Circular Operations.

a change in mind-set, from internal circular operations as an environmental solution towards internal circular operations for financial gain for the firm. The deliberate exploitation of these financial gains corresponds with resource-based theory's exploitation of internal activities and resources for competitiveness (Powell, 1992) and pollution prevention's competitive cost-cutting (Hart, 1995). This adds some support to Schmidt et al (2021) who find strategic, cultural shifts in the firm drive a NRBV perspective of internal circular operations. Competitive exploitation of internal circular operations is particularly appealing for SMEs who may struggle with complexity of circular operations against limited financial resources (Dey et al, 2020). Retaining and reusing waste is done because *"it's amazing the amount of money you can find lying on the factory floor"* (FC8), creating *"real financial benefits, real money to be made from waste and pollution"* (FC2). The complexity of embedding such internal circular operations supports rarity and non-substitutability: *"that's why I was brought in, to look at the floor and put in place systems to save money - not just me, we have a whole team - but you get it right and you're basically a wizard"* (FC2).

5.2. *Supply chain circular operations*

Circular operations at supply chain level are widely recognised in agri-food, surrounding the redistribution and reuse of by-products to supply chain partners. As with the internal level, this involves different types of waste and can manifest differently throughout the chain *(see Fig. 2 for example)*. Food waste is prevalent, with crops graded according to saleability, reusability or recyclability throughout the agri-food chain. This facilitates the creation of rich stockfeed and landspreads or supports anaerobic digestion, shared throughout the chain. Packaging from inter-firm distribution also provides a considerable waste source, encouraging all supply chain actors to *"look at resale and packaging and the best ways to segregate and decide what to do with it"* (FC13). As with the internal level, this demonstrates capacities of retain, reuse and recycle that characterise circular operations (Kalaitzi et al, 2019). However, at the supply chain level this is a larger, collaborative effort *"circularity is also important for us all, particularly in food waste; so, this idea that everything can be reused or reincorporated* [in the chain]*, like anaerobic digestion and feed stock"* (FC10). This requires dynamic recovery of supply chain wastes (Govindan et al, 2015) and inspection and disposition for reuse (Jensen et al, 2013). This means that environmentalism is embedded throughout the supply chain as circular operations support *"more sustainable practices in every corner of our supply chain"* (FC10). Environmental benefits are shared throughout the supply chain: creating *"dramatically less waste for everyone involved"* (FC1); and *"actually a nice deal that benefits the whole supply chain in terms of environmental impacts"* (FC10). This again delivers shared economic benefits relating to efficiency and costs (Mishra et al, 2021): *"we get all stockfeed from the farm down the road, and we don't pay for that because we give them our manures* [...] *and so both sides are being efficient saving money in terms of both buying resources and disposal charges, which are big, big costs"* (FC10). Therefore, supply chain circular operations promote effective resource use for resource-constrained SMEs and promote conservation and advanced waste management in the agri-food chain.

Whilst environmental-economic benefits are prominent in literature, other benefits are under-acknowledged. Sharing of wastes creates *"rich landspreads which without the by-product of our supply chain partners we would never have"* (FC7). Attaining such resources is an increasing challenge in manufacturing sectors (Lieder & Rashid, 2016), particularly for SMEs (Dey et al, 2019). However, whilst this implicates product stewardship's access to scarce resources (Hart, 1995), this was not a prominent incentive. Rather, competitive cost-cutting again emerged as the leading incentive for supply chain circular operations. Circular operations are purposefully exploited for financial benefits for all supply chain actors: *"it's about making it work for everyone from a financial perspective, that's what makes it work"* (FC8). As well as further demonstrating resource-based theory's competitive exploitation, this is particularly significant for SMEs who are critical in driving implementation of supply chain circular operations (Katz-Gerro, & López Sintas, 2019). Supply chain collaboration is essential for circular operations but can paradoxically serves as a barrier to implementation (Mishra et al, 2021). As FC10 explains, *"convincing* [partners] *can be an uphill battle with the big guys, it has to be worth it"*. Competitive incentivisation helps with this: *"we can't do this without the whole supply chain on board and getting them on board is showing them how much money they can save"*. This is further indicative of a changed mind-set, from supplier engagement as an environmental responsibility towards supplier engagement as a competitive opportunity – or rather from environmental obligation to competitive exploitation (Schmidt et al, 2021).

Alongside, competitive cost-cutting, product stewardship's differentiation (McDougall et al, 2019) emerges as a competitive benefit that incentivises uptake. According to FC10, implementation of supply chain circular operations was *"important for us all as a group",* making them *"known in the industry"*. This derives from the increasing complexity of circular supply chain operations: *"I don't know anyone else in the industry with a food chain as tight and strong as ours; it's actually really unique on a global scale"* (FC8). This corresponds with Agyabeng-Mensah et al (2021) who found that inter-organisational circularity establishes unique organisational identity and favourable reputation. Associated social complexity implicates inimitability and immobility which competitive resources rely on (Lockett et al, 2009).

5.3. Societal circular operations

At a societal level, agri-food circular operations expand beyond firm and supply chain operations to realise positive impacts in local and global societies *(see* Fig. 3 *for example).* In agri-food this often involves the creation of renewable energy and promotion of biodiversity. For example, circular operations' collection and reuse of manufacturing oils not only delivers carbon offsetting but facilitates additional biofuel creation for positive rather than negative CO_2 emissions. *"Better ways of generating energy"* (FC14) also arise in the reuse of slurry for hydrogen power or straw as bioethanol. Alongside energy, water is again prevalent in societal circular operations. Whilst this is driven by pollution and conservation at an internal level, the societal level seeks to support biodiversity and urban farming. More specifically, as circular operations expand, it *"generates all this water that we can use to do something good"* (FC1). Once reused several times, excess water is used to support purpose-built biodiversity ponds and sites. Alternatively, circular water systems such as hydroponics and aquaculture allow firms to *"farm fish in water without soil"*, creating a *"closed-loop system that allows us to bring healthy, clean food to urban areas where it is needed"* (FC8). These examples demonstrate retain, reuse and recycle, but in greater scope than internal or societal levels.

Environmental-economic benefits are inseparable and embedded in circular operations, but on a wider, societal scale. The retaining and reusing of resources deliver societal level environmental benefits of positive CO_2 emissions and biodiversity: *it isn't just about reducing what we use, but actually creating and giving green energy* [...] *environmental offsetting and then some, with our solar and planting trees and in everything we do there is a premise of giving back"* (FC18). From an economic perspective the societal circular economy is *"self-financing and self-sufficient"* (FC18), whilst further socio-economic benefits are delivered by access to healthy and sustainable food in urban areas. This demonstrates the intended positive impacts of circular operations (Morana & Seuring, 2011; Rizos et al, 2018) and the NRBV's clean technologies (Hart, 1997).

Nonetheless, whilst circular operations do seek to mitigate ecological degradation (Korhonen et al, 2017; Merli et al, 2018), this is not considered the responsibility of the firm or supply chain. Mitigation is an ethical obligation embedded in global operations: *"as a population we've made a real mess, and we need to work together to clean it all up"* (FC16). Environmentalism as obligation is a limited incentive for circular operations (Schmidt et al, 2021) and is intimidating for SMEs that have limited resources to engage with issues of such magnitude. Rather, the findings suggest agri-food SMEs implement societal level circular operation to exploit firm level competitive benefits. Such benefits – namely new revenue streams, commercialisation and competitive pre-emption - directly correspond with the NRBV's clean technologies (McDougall et al, 2019).

New revenue streams are exploited via sale of outputs as the scale of societal circular systems often results in excess resources for reuse. For example, FC18 generates *"more power than we know what to do with, so we can sell back to the grid* [….] *so now we're in the energy sector, going from solar to wind, it's opened the whole thing up"*. Whilst this aligns with existing implications for revenue creation in circular operations (Korhonen et al, 2017), this goes beyond profits from end-of-life recovery (Govindan et al, 2015). Rather, there is clear exploitation of societal circular operations as new revenue streams. The capacity for exploitation incentivises implementation of circular systems and technologies for agri-food SMEs. For example, the decision to capture one resource over another is driven by the value of sale: FC1 implemented ground source heat pumps *"because tariffs are going up, so you are getting paid more for producing that compared to solar"*. In a water context, FC1 moved beyond recapture for reuse towards the treatment and sale of excess water as topsoil. The focus here in no longer on environmental benefits, but rather the greatest capacity for new revenue streams.

Commercialisation was less prominent, but still emerged as a competitive benefit to incentivise societal circular operations. Having recognised the commercial appeal of circular systems and technologies, FC2 discussed development of circular water systems which can be sold in the global market. This demonstrates circular operations' development of new technologies and systems (Jensen et al, 2013) and complete redesign of operations and industries (Murray et al, 2015). However, rather than development and redesign being necessitated to meet environmental-economic goals, the development and redesign itself is exploited for competitive gain and recognised as a commercial opportunity. This further demonstrates a shift away from environmental obligations (triple-bottom-line perspective) towards competitive opportunities (NRBV perspective) (Schmidt et al, 2021). This aligns with the NRBV's clean technologies' new lower impact operations (Hart, 1997) and transition away from traditional routines (Hart & Milstein, 1999). Considering resource-based theory underpinnings, exploiting new technologies and systems creates value and promotes rarity for competitive resources.

Early adoption is important here to stimulate demand and permitting patenting and commercialisation. *"We fought tooth and nail to overcome the barriers required to set* [circular system] *up to enter the renewable division because it opened up an entirely new revenue stream and it reinforced that we want to be seen as the leaders in green innovation* [….] *and now that is a big part of who we are, leaders in innovation"* (FC18). FC10 reinforces this, explaining of their circular system *"it's really, really fast moving and competitive out there, we wanted to be ahead of everyone else, we had to do what we had to do and quick"*. This presents circular operations as powerful innovations (Szekely & Strebel, 2013; Kalmykova et al, 2018). Moreover, from a resource-based theory perspective competitive pre-emption ensuring circular operations are *"presently scarce, difficult to imitate, nonsubstitutable and not readily available"* (Powell, 1992, p552), thus advancing competitiveness. This supports Schmidt et al (2021) and Lichtenthaler (2021) who suggest increasing implementation of environmental operations calls for quicker uptake to protect competitiveness. Accordingly, competitive pre-emption incentivises early implementation.

5.4. An interconnected multi-level approach

The findings describe agri-food circular operations at internal, supply chain and societal levels. Reflection on the findings also offers some interesting insights relating to interconnectivity between levels of implementation. Specifically, implementation at one level supports implementation at another level due to resource and capacity building. For example, excess waste retained from circular operations can be transferred for reuse throughout the supply chain, supporting supply chain circular operations. This is more complex than extension of internal environmental practices to external supply chain practices. Supply chain circular operations require complex interactions and engagement from all actors (Merli et al, 2018). Here the capacity for incentivisation is once again highlighted, as the agri-food SME must initiate willingness from supply chain partners to receive, treat or use the waste. This may involve joint investment in systems or technologies, such as anaerobic digestion, rendering implications for co-creation. Vertical integration can be advantageous, allowing easy and quick transitions between internal and external operations and facilitating wider reuse of waste. Interconnectivity also expands to the societal level as water retained in internal circular operations can be transferred to support biodiversity at the societal level. Similarly, biofuel production in supply chain circular operations can expand beyond the needs of the lifecycle, allowing reproduction and sale at the societal level. This can occur opportunistically, as supply chain circular operations generate more resource than can be reused in supply chain operations. The agri-food SME evolves from creating scarce resources for supply chain circular operations to facilitating new revenue streams for societal circular economies. This is indicative of resource-based theory's exploitation of resources and activities (Penrose, 1959).

Importantly, as agri-food companies are often active in more than one sub-sector or stage in the food chain, the close integration of operations may support implementation of circular operations at different levels. Nonetheless, implications for interconnectivity can be noted in existing literature. Morana & Seuring (2011, p688) welcome distinction between levels of implementation but suggest *"levels interact and interrelate"*. Implementation of circularity at one level may stimulate path-dependent evolution to support wider adoption of circular operations (Katz-Gerro, & López Sintas, 2019). Agyabeng-Mensah et al (2021) offer some evidence of this, finding that intra-firm circular capacities underpin inter-firm learning towards circularity on a supply chain level. From a resource-based theory perspective, NRBV resources are also interconnected (Hart, 1995) and the implications of this are considered in existing NRBV-circular operations studies: Miemczyk et al (2016) identify dependencies on internal pollution prevention capacities in their study of product stewardship closed-loop operations; and Schmidt et al (2021) suggest internal circular capacities are a 'necessary precondition' for product stewardship-based circular operations.

It is also notable that benefits expand alongside levels of implementation. Environmental capacities relating to waste are shared and embedded across all three levels. However, the scope of this expands, with internal circular operations minimising waste for the firm, supply chain circular operations minimising waste for the supply chain and societal circular operations tackling waste as a societal issue. Conservation expands from firm-led to supply chain-led efforts before taking a global perspective of conservation of natural resources for global ecologies. Considering competitive benefits, cost-cutting is shared across all three levels but additional benefits expand from level to level. Alongside cost, supply chain circular operations offer access to scarce resources and differentiation, whilst the societal level offers the greatest scope for competitive via new revenue streams & profits, commercialisation opportunities and competitive pre-emption. Resource-based underpinning offer some explanation of this, as possession of more than one resource creates combinative resources bundles that advance competitiveness (Teece et al, 1997).

Based on the findings, Fig. 4 depicts the manifestation of circular operations across three levels (internal, supply chain, societal) in agri-food. The levels are distinct, but capacities developed at one level may support implementation at another. Environmental-economic benefits of advanced waste management, conservation and efficiency are embedded across all three levels. This expands from level to level, moving from reduced impact operations to zero impact operations and eventually to positive impact operations. Exploitation of circular operations at each level delivers competitive benefits that can be prioritised to incentive uptake. This too expands from level to level, with cost assuming prevalence. At an internal level, competitive cost-cutting drives uptake. At a supply chain level, the focal firm encourages uptake via promotion of cost benefits and pursuit of competitive differentiation. Access to scarce resources also emerges as a benefit at this level but plays a lesser role in incentivisation. Costs are cut at the societal level due to advanced operations, but financial benefits arise more prominently via new revenue streams, profits and commercialisation opportunities. Along with competitive pre-emption, such benefits incentivise uptake of societal circular operations. Taking all this into consideration, an interconnected three-level approach for circular operations for competitive benefits is proposed. This is depicted in Fig. 4, below.

6. Conclusions

The findings offer important theoretical implications for circular operations research. Most prominently, this relates to explanation of competitive benefits and incentivisation of circular operations across three levels of implementation. Explicit application of NRBV resources to circular operations expands on existing literature to allow, for the first time, empirical definition of competitive benefits for internal, supply chain and societal circular operations. In bringing competitive benefits to the fore, this paper supports a transition from a triple-bottom-line perspective to a NRBV perspective (Lichtenthaler, 2021; Schmidt et al, 2021). Accordingly, circular operations are presented as an opportunity for firm or supply chain competitive benefits, as opposed to an environmental obligation. This challenges the long-standing dominance of environmental-economic benefits (Oh and Jeong, 2014; Geissedoerfer et al, 2017) to define and explain the increasing role of competitive

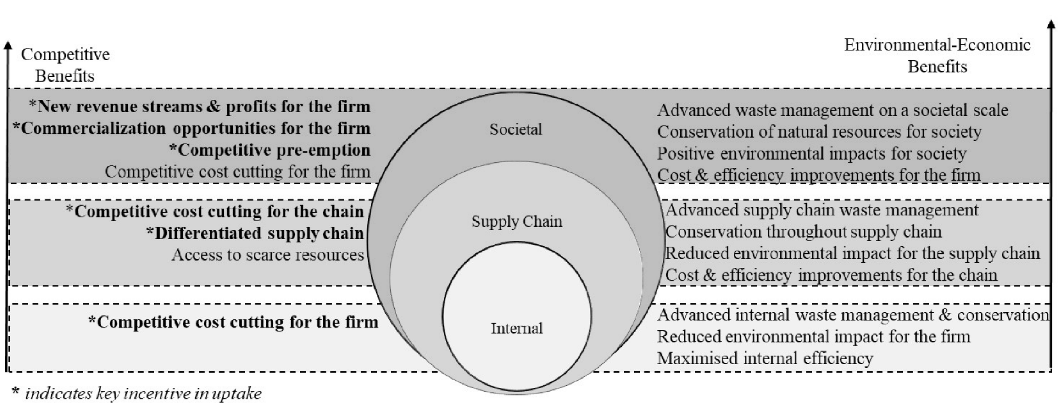

Fig. 4. Competitive & Environmental Benefits across the Three Levels.

exploitation.

Theoretical implications also derive from the three-level approach. Again, this study expands on existing research (e.g., Morana & Seuring, 2011; Merli et al, 2018) to offer empirical insights of circular operations at internal, supply chain and societal levels. Clear explanation of agri-food circular operations at each level is offered and implications for interconnectivity presented. Prior to this study, understanding of circular operations across different levels was overly reliant on conceptualisation (Merli et al, 2018). This study addresses this gap, using rich qualitative tools to deliver valuable, tangible insights of circular operations across three levels.

Such explanation also offers practical contributions, as a prior lack of understanding prevented realisation of circular operations as a complex, multi-level concept (Murray et al, 2015). Detailed empirical examples of circular operations across three levels adds approachability to complex circular operations, particularly for agri-food SMEs. As circular operations require complete redevelopment of operations (Murray et al, 2015; Lahane et al, 2020) and system-wide innovation (Farooque et al, 2019) this is important. Moreover, this addresses the lack of guidance for SMEs in circular operations research (Dey et al, 2020).

Further practical contributions derive from incentivisation, as practitioners struggle to understand the competitive value of circular operations (Lieder & Rashid, 2016). Competitive benefits serve as a stronger incentive for implementation than environmental obligations (Schmidt et al, 2020). The prevalence of competitive cost benefits is particularly important, helping to mitigate concerns of cost and risk that deter implementation of circular operations (Souza, 2013; Coenen et al, 2018). This is particularly relevant for SMEs, who lack the resources of larger organisations and place greater emphasis on the tangible value of sustainable operations (Dey et al, 2020). Importantly, this is not limited to the focal firm, but can be used by that focal firm to stimulate engagement from supply chain partners at the supply chain level. Incentivisation is also significant at a policy level, as agri-food policy seeks to promote maximum value extraction to expand implementation of circular operations (DEFRA, 2020). Out-with agri-food, competitive appeal and approachability support existing industry and political efforts driving uptake of circular operations (Kalmykova et al, 2018).

6.1. Limitations & future research

Theoretical and practical limitations must be considered within the context of this study. Empirical findings are limited to the context of the UK agri-food SMEs. Circular operations relating to anaerobic digestions, biofuels, stockfeed and landspread are context specific and supported by high levels of food and organic waste in agri-food. Additionally, as agri-food companies are often active in more than one sub-sector or stage in the supply chain, opportunities for redistribution and reuse may be greater than in other sectors. Accordingly, manifestation of the circular economy at different levels of implementation may be entirely different in another sector. Moreover, the accessibility of such waste resources in agri-food may advance both environmental-economic and competitive benefits. Therefore, empirical investigation of internal, supply chain and societal circular operations for competitive benefits in other contexts is invited. This aligns with existing calls to explore country or sector characteristics in circular operations research (Wells & Seitz, 2005; Kalmykova et al, 2018). Further investigation of interconnectivity is also called for. Interconnectivity is an emergent finding in this study and as such more explicit conceptualisation and empirical definition of the relationship between different levels is required.

The exclusion of social benefits in this study can also be considered a limitation. Both circular operations (Rizos et al, 2015; Korhonen et al, 2017; Merli et al, 2018) and the NRBV (Hart & Dowell, 2010) comprise ecological and societal considerations. This study explores only competitive or environmental-economic benefits, thus overlooking social benefits. To date, social value is the least studied area in circular research (Kristensen & Mosgaard, 2020) and should be prioritised in future research.

Moreover, this study's focus on environmental-economic and competitive benefits presents limitations by only focusing the positive outcomes of circular operations. As discussed, uptake of circular operations is deterred by barriers of cost and risk (Coenen et al, 2018), which are exacerbated for SMEs (Dey et al, 2020). Alongside these barriers, financial tensions can arise in that waste required for reuse in the circular economy may have traditionally been sold on, risking profit loss. Environmental paradoxes also mean that circular operations may deliver positive environmental benefits in one context but negative environmental outcomes in another (Murray et al, 2015; Lichtenthaler, 2021). Notably, greater understanding of the negative outcomes further highlight the significance of competitive benefits and incentivisation offered in this study.

CRediT authorship contribution statement

Natalie McDougall: Conceptualization, Methodology, Data curation, Investigation, Writing – original draft, Writing – review & editing. **Beverly Wagner:** Conceptualization, Data curation, Writing – review & editing, Formal analysis, Methodology, Supervision. **Jill MacBryde:** Conceptualization, Data curation, Writing – review & editing, Supervision, Methodology, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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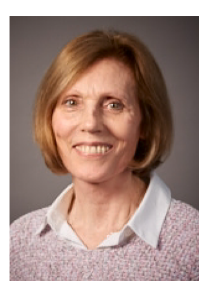

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