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Sustainability-oriented innovation in the agri-food system: Current issues and the road ahead

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Abstract: The agri-food system features prominently in discussions about sustainable development because of its broad economic, social, and environmental impacts. To examine how the agri-food system is responding – and can respond – to the grand challenges of sustainability, we position this Special Issue (SI) within the stream of sustainability-oriented innovation (SOI) literature, and in relation to the much-cited framework provided by Adams et al. (2016). This introductory article contains an overview of the selected papers, described by using the above-mentioned framework and by highlighting the contributions that these articles bring to fill current knowledge gaps in the field. Such knowledge gaps have been identified by investigating SOI links to sustainability and circular economy concepts and by studying how SOI relates to development in the agri-food system. The contributions to this SI explore different facets of the research agenda we have laid out and covers the range of SOI proposed by Adams et al. To help the field move forward, we finally identify a few areas as the most relevant for future research.

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Introduction

Meeting our needs in the present without compromising the ability of future generations to meet their needs is arguably the most urgent challenge facing humanity (World Commission on Environment and Development, 1987). Overcoming this challenge will entail transitioning to a sustainable food system, which is why the agri-food system now features so prominently in discussions about sustainable development. Achieving this necessary transition is a highly complex matter, however, since the ways in which we produce and consume food are deeply embedded in the cultural fabric of society and have significant and wide-ranging socio-economic and environmental impacts. International consensus on the urgency and importance of ensuring food security, nutrition, and sustainable agriculture is reflected in the UN's Sustainable Development Goals (SDGs), as is evident in the following rationale of SDGs pertaining to food:

> As the world population continues to grow, much more effort and innovation will be urgently needed in order to sustainably increase agricultural production, improve the global supply chain, decrease food losses and waste, and ensure that all who are suffering from hunger and malnutrition have access to nutritious food. Many in the international community believe that it is possible to eradicate hunger within the next generation, and are working together to achieve this goal … Agriculture systems worldwide must become more productive and less wasteful. Sustainable agricultural practices and food systems, including both production and consumption, must be pursued from a holistic and integrated perspective[1].

Lying "at the centre of a global nexus of social, environmental, and economic problems" (El Bilali, 2019, p. 354), the agri-food system is saddled with enormous responsibilities to overcome sustainability challenges, with agri-food businesses now needing to navigate a complex and dynamic landscape of changing public demands and expectations, conflicting goals, and wicked problems involving difficult dilemmas and trade-offs.

This special issue examines how the agri-food system is currently responding to the grand challenges of sustainability and reviews the literature related to sustainability-oriented innovation to identify ways in which this system could better respond to this challenge in the future. More specifically, the aim of this issue is to showcase some of the ways in which

[1] Food security and nutrition and sustainable agriculture | Department of Economic and Social Affairs (un.org)

companies within the agri-food system can experiment with and apply sustainability-oriented innovation to minimize or ideally negate the adverse environmental and social impacts of the food sector.

Sustainability-oriented innovation (SOI) is understood here according to the definition given by Adams et al. (2016, p. 181) as consisting of "intentional changes to an organization's philosophy and values, as well as to its products, processes or practices, to serve the specific purpose of creating and realizing social and environmental value in addition to economic returns." The management of SOI ideally extends beyond the phases of production and use to encompass the entire life cycle of products, moreover, SOI clearly has close affinities with notions of circularity and circular business models (Fehrer & Wieland, 2021; Hansen & Groβe-Dunker, 2013). With this special issue we identify and address some of the current gaps in our knowledge about managing SOI in the agri-food system, including a review of some of the most promising approaches to analysing and overcoming the sustainability challenges facing the food system.

The environmental impacts of the unsustainable agri-food system that currently prevails are wide-ranging and multifaceted, including several severe negative externalities. Amongst the most pressing of these detrimental impacts are significant greenhouse gas (GHG) emissions, large-scale loss of biodiversity, water scarcity, and major depletion of water and soil quality due to unsustainable land use, even to the point of desertification. In addition, the environmental impacts of the rapidly expanding use of genetically modified organisms and biofuels are also the subject of significant controversy (Notarnicola et al., 2012; Notarnicola, Sala et al., 2017; Notarnicola, Tassielli et al., 2017).

The agri-food system is thus faced with major sustainability challenges, as is evident in the stark statistic that agri-food now accounts for approximately 26% of global GHG emissions (Notarnicola, Tassielli et al., 2017). These high GHG emissions are especially problematic because few technical solutions for decarbonization in the agri-food have been developed compared to other sectors (Poore & Nemecek, 2018). The numerous social issues surrounding and arising from the agri-food system are also highly relevant, including stark social inequalities related to hunger and malnutrition, inadequate diets, food insecurity, food scarcity, and food waste (El Bilali et al., 2019). Labour conditions must also be considered in any approach to SOI in the agri-food system, including the precarious economic conditions faced by many small farmers and the need to create a "fair" market in "base of the pyramid" contexts.

Actors within the agri-food system can pursue a range of different possible responses and strategies to meet these sustainability challenges. Sustainability-oriented innovation is by no means limited to merely incremental improvements in traditional products and processes aimed at operational optimization but rather encompasses technological and organizational as well as wide-ranging institutional and social changes. As such, SOI can also lead to more profound organizational transformation and radical systemic change (Adams et al., 2016). Achieving such large-scale change requires dynamic capacities and the adoption of systemic approaches to ecosystems, all the while entailing openness, stakeholder inclusion and dialogue, responsiveness to regulatory and technological changes, and the development of mutually trusting relationships (Inigo & Albareda, 2019).

Despite the emergence of numerous SOI-related initiatives aimed at making a positive difference to sustainability in agri-food systems (see, e.g., Cagliano et al., 2016), the overall picture remains bleak. Indeed, there are many worrying indications that the agri-food system is moving in the wrong direction, with continuous increases in the production and consumption of meat and dairy products and processed foods (Notarnicola, Tassielli et al., 2017).

Achieving positive change and aligning initiatives for sustainability in the agri-food system is a complex endeavour, therefore, not least due to the numerous actors and interests involved. This sustainability challenge is further exacerbated by the geographic dispersion of this industry and its extensive value chains, consisting of large and small actors equipped with different resources and capabilities and driven by different motivations (see, e.g., Depken & Zeman, 2018). The aim of this special issue is to explore how SOI can support sustainable development in such a complex system. The articles selected for this issue cover key insights from current research on consumer-side demand, supply-side mechanisms for improving sustainability, and governance issues related to sustainable value chains in the agri-food system.

In the following sections we first provide the background and positioning of our approach to SOI, including the links between SOI and concepts related to the circular economy. We then elaborate in more depth on how trends in scholarship and approaches to SOI reflect developments in the agri-food system and the growing need for system-wide approaches. After highlighting the key contributions to our understanding of SOI of seven articles in this special issue, we reflect on three potential avenues for future research.

Sustainability-oriented innovation in context

The field and scope of research on sustainability transitions in agri-food systems remains ill-defined (see El Bilali et al., 2019), and there is a need for greater elucidation of how SOI can make a difference in this system. In this section, we first relate SOI to the broader field of sustainability and research on the circular economy (CE). This reference to CE is not merely a matter of identifying parallels and overlaps between different sustainability-related research streams, but also to inform and enrich our understanding of SOI as a *social* process. In sum, a key aim here is to identify important takeaways for SOI from developments in scholarship on sustainability and CE.

We proceed from the premise that SOI has a vital role to play in transitioning toward a greener and more circular economy, even though extant research has so far paid relatively little attention to SOI (Doherty et al., 2014). The extant scholarship on SOI itself suffers from certain deficiencies that are arguably symptomatic of the wider field of sustainability research (Adams et al., 2016). In addition to ubiquitous concerns regarding the lack of any single agreed-upon definition of sustainability, for example, previous research has tended "to treat sustainability dichotomously (sustainable/not sustainable) rather than embedding SOI as a dynamic, unfolding process that is achieved over time" (Adams et al., 2016, p. 181). This limitation also pertains to scholarly treatments of the CE, which often exclude considerations of long-term viability and thus overlook key aspects of time and process (Geissdoerfer et al., 2017). Short-term approaches to CE and a tendency to oversimplify its objectives have prevailed (Inigo & Blok, 2019), resulting in a dichotomous view of idealized circularity versus linear models of production and consumption, including correspondingly over-optimistic expectations of CE. However, more recent definitions of CE are increasingly beginning to reflect considerations of time and process, including considering the intermediary steps and stages involved along the way to desired end-states. The important takeaway from this for scholars of SOI, as Adams et al. (2016) have likewise concluded, is that we need to work towards a clearer articulation of the time and process aspects and the intermediary steps involved in developing SOI.

Extant SOI research suffers from a further and related deficiency insofar as it tends to overlook the social dimension of sustainability and innovation processes (Adams et al., 2016; Schiederig et al., 2012). Again, this is a problem that also pertains more broadly to the fields of sustainability and CE. Already in 2012, for example, Hoffman (2012) described the sustainability literature as being "dominated by the physical sciences in defining the problem and by economics in defining the solutions" (p. 13), resulting in an over-emphasis on rational and quantitative treatments at the cost of behavioral and cultural aspects. Likewise for Inigo

and Blok (2019), the major shortcoming of CE scholarship is that it overlooks and/or simplifies the sustainability implications of "the social", in part due to its origins in industrial ecology and its propensity to draw on analogies with "natural" systems. By contrast, we argue that any discussion of sustainability, CE and SOI must address at least the following three key social issues: (i) the behavioral aspects of public and consumer involvement in the design of socially acceptable and desirable circular solutions (Murray, Skene & Haynes, 2017; Sauvé, Bernard & Sloan, 2016); (ii) stakeholder engagement as a prerequisite for ensuring the successful implementation and positive outcomes of CE and SOI (Winans et al., 2017); and (iii) consideration of governance and regulation that can lead to fragmentation instead of effective systemic solutions (Korhonen et al., 2018).

As an additional gap in the CE literature, business models and roles of consumers are only scarcely discussed in this scholarship, although such discussion could help clarify matters of ownership and value capture (Inigo & Blok, 2019; Kirchherr et al., 2017; Linder & Williander, 2017). To this list of deficiencies in current research we can also add a lack of attention to issues regarding collaboration and partnerships for sustainable development. For scholars of SOI in general, the important takeaway from all this is that we need to attain a holistic and cross-disciplinary understanding of SOI that reflects the social embeddedness of such innovation and that this encompasses not only the technical and economic aspects of transitioning to sustainable food systems but also the significant social and behavioral enablers and constraints related to SOI.

Philosophically speaking, CE most often refers to processes of *becoming* rather than states of being. Advocates of CE promote *a future* in which current linear "take-make-use-dispose" solutions are replaced or supplemented by more circular models (Völker et al., 2020). In relation to EU policy "in-the-making", for example, Völker et al. (2020) consider CE as a *sociotechnical imaginary* that enables us to explore "how ideas about attainable futures are combined with particular goals, priorities, benefits and risks as well as with discourses of innovation, sustainability and growth" (p. 106). Similarly, Bauwens, Hekkert and Kirchherr (2020) have emphasized that CE is to a large extent an emerging phenomenon that is by no means fully realized but rather refers to desirable (circular) futures and possible means of achieving these futures. Here, the important takeaway for SOI is the need to recognize that SOI is imbued with a strong sense of emergence and becoming, often referring to processes-in-the-making and aspirational goals, together with an understanding that there is a performative dimension to such orientation towards the future (Christensen, Morsing & Thyssen, 2013,

2020). This performative dimension in turn implies that it *matters* how our talk and actions in support of SOI "make use of the future" to engage, inspire and motivate action.

Bearing in mind these important insights, we found Adams et al. (2016)'s categorization of the following three types of SOI useful for organizing the contributions to this special issue: *operational optimization*; *organizational transformation*; and *systems building.*

Operational optimization as a form of SOI can be characterized as an approach aimed at "doing the same things but better". This approach focuses on innovations at internal organizational level through small and incremental steps that are usually technical in nature, stand-alone and insular. Innovations undertaken as part of an operational optimization approach tend to be reactive and driven by a "compliance mindset", though such reactive responses may also be supplemented by more proactive efforts to pursue efficiency gains.

The second type of SOI approach identified by Adams et al. (2016) is that of *organizational transformation*, which can be described as "doing good by doing new things". This approach constitutes an important first step towards making sustainability more people-oriented, less insular, and more integrated within organizations. The focus of an organizational transformation approach is on redefining and reconceptualizing both internal and external organizational relationships in terms of their environmental and social impacts. Although this approach to SOI is primarily oriented to internal organizational aspects, it also extends to immediate stakeholders.

The third category of SOI by which we organize the contributions to this special issue is that of *systems building*, which can be characterized as an approach centred on "doing good by doing new things with others". This approach is based on the systemic assumption or premise that sustainability cannot ultimately be considered an attribute of any single firm but rather needs to be conceptualized at the level of ecosystems. In this approach to SOI the focus shifts from a preoccupation with single firms and individual value creation to networks and collaborative value creation. Achieving sustainable transformation in this view thus becomes a matter of raising the bar for an entire industry or sector, or even the economy as a whole, to shift the whole ecosystem onto a more sustainable path (Draper, 2013). This approach thus recognizes that such transformation is beyond the capacity of any individual firm or organization to accomplish and must be driven instead by several actors or "system builders", which could include private businesses and/or governments and/or civil society actors. The task of such actors in this approach is thus not only to initiate, mobilize, inspire, and lead

transformational change but also to empower other participants to contribute (Adams et al., 2016).

Sustainability-oriented innovation in agri-food systems

To review the evolution of concepts related to SOI in the agri-food context in the literature, we first conducted a search on the Scopus database[2] to visualize recent developments in the scholarship on SOI and agri-food systems. Based on this review, we identified and extracted 99 relevant articles published in the period 2007–2021. Employing visual coding through VosViewer, we focused our analysis on the evolution of this research field from 2016 to 2021, identifying the dominant keywords[3] and concepts associated with the agri-food system and SOI and observing how the frequency of these terms have evolved and new concepts have emerged over time (See Figure 1).

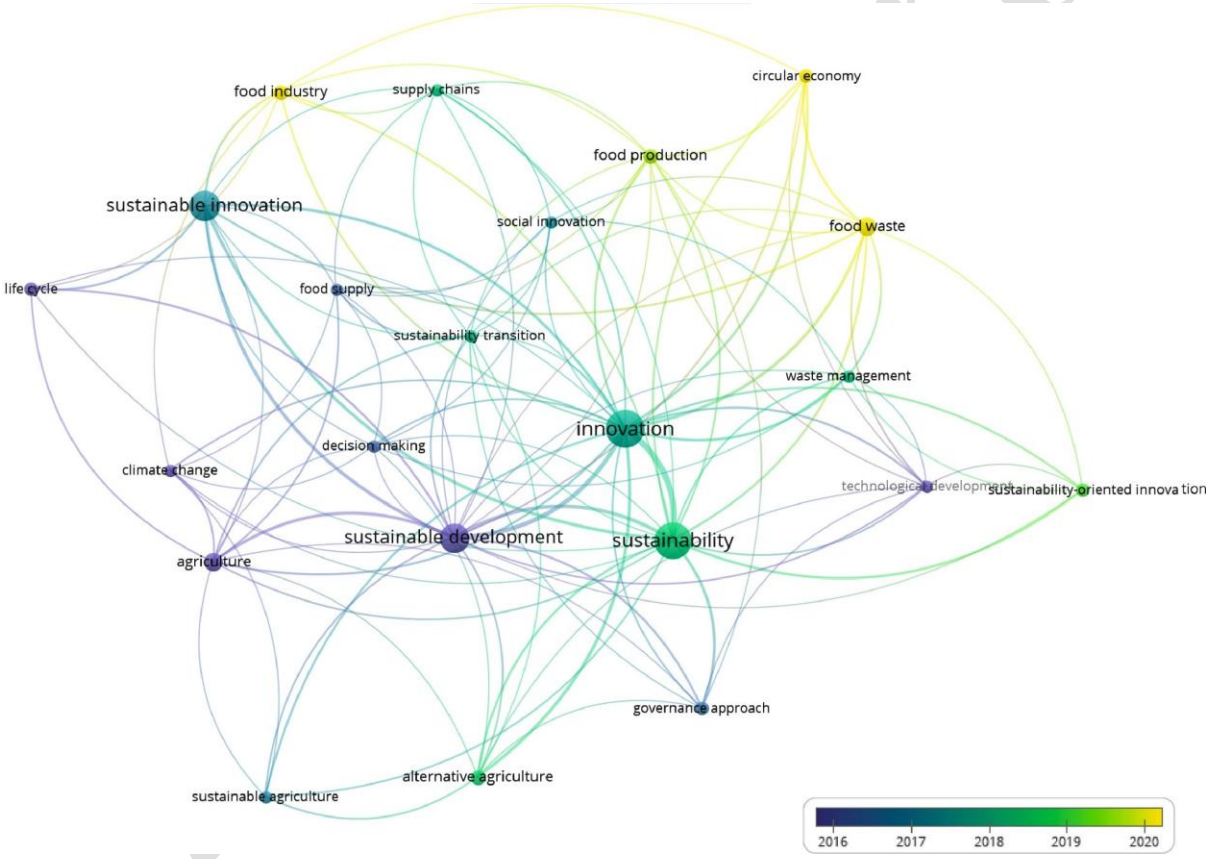

Figure 1 – Temporal analysis of the occurrence and co-occurrence of keywords on Scopus search

[2] Search string: (TITLE-ABS-KEY ("sustainability oriented innovation") OR TITLE-ABS-KEY ("sustainable innovation")) AND (TITLE-ABS-KEY (food) OR TITLE-ABS-KEY (agri*)) within the domains of business, accounting and management, economics, decision behavior and social sciences.

[3] Authors and indexed keywords were both included, with the threshold fixed on keywords occurring at least four times.

As shown in Figure 1, this temporal analysis yielded some interesting insights into consolidated and emerging trends regarding sustainability innovation in the agri-food industry. Up to 2016, for example, "sustainable development" was among the most cited keywords and concepts by which to identify contributions in the area of sustainability, with this broader focus dating back to a definition first provided in the Brundtland Report in 1987.

In the years leading up to 2016, the prevailing approach to innovation for sustainability in the agri-food system focused on technological innovations in the upstream stages of the agri-food supply chain aimed at reducing the environmental impacts of GHG emissions and climate change (e.g., Long et al., 2017). Research into such innovations was accordingly focused primarily on improving planning and decision-making in agricultural activities (e.g., de Luca et al., 2018).

This earlier focus on innovations in the upstream stages of the agri-food supply chain is evident in the widespread adoption in the literature in this period of concepts like "food supply" as a keyword to define the scope of analysis. This usage contrasts with later prevailing terms such as "food production" and the broader concept of the "food industry" and industry-wide alliances (Jeong and Shin, 2020) or SOIs that relate to a specific sector of the food industry. (e.g., Cannas et al., 2020). From Figure 1 we can further see how new trends and new terms have emerged since 2018, including the increasing use of "supply chain". This term together with an extended focus on food industry, reflects the transformations of an industry that appear to have progressively called for new and more systemic modes of innovation (El Bilali, 2018). More specifically, they reflect a growing recognition of the need for a set of coordinated actions to be undertaken not only by a single company or even its immediate stakeholders but by a much larger "system" of actors (e.g., Pancino et al., 2019).

This emergent perspective of SOI with a broader focus extends to and expands the range and nature of innovations that fall within the scope of our research and consideration. Such an expansion in scope is necessary because SOI in agri-food, as we have seen, clearly comprises far more than merely technical innovations aimed at reducing the environmental impacts of agriculture, not least in encompassing multifarious social innovations. The crucial role of social innovation in food systems is evident, for example, in the redistribution of surplus but edible food to people in need. Such redistribution has a social purpose (Garrone et al., 2016) as well as being a possible strategy of "closing the loop" in the agri-food supply chain by avoiding the waste of edible food through social value creation (Kölmel et al., 2019).

Our survey of the literature also shows that social innovation has been associated with value creation models based on the provision of healthy food and commitment to social responsibility (e.g., Nazzaro et al., 2020). Here, "social" refers not only to the subject of an innovation but also to a set of key societal objectives. The importance of social innovation to sustainability efforts is also reflected in the incorporation of social performance indicators in life cycle assessments of sustainable innovations, i.e., in Social Life Cycle Assessment (Falcone et al., 2019).

Finally, the last couple of years have seen an increasing focus in research on matters regarding the circular economy, food waste, and waste management, reflecting one of the focus areas of the EU's Horizon 2020 programme. Although technological adaptation continues to play a key role in achieving these aims, as exemplified by developments aimed at reducing and managing food waste through innovations in packing and tracking technologies and the use of emerging digital technologies, including the internet of things and big data analytics (Keränen et al., 2021; Lee & Jung, 2018), the focus on circularity in agri-food systems is more than a matter of technological solutions to prevent and manage food waste (e.g., Stenton et al., 2021). For example, such circularity is also linked with the development of a new and well-organized value network for recovering food waste and the diffusion of the related sustainable innovations (e.g., Keränen et al., 2021) as well as with a change in food purchasing habits to embrace food sharing (Kölmel et al., 2020).

Articles in this Special Issue

Of more than thirty initial articles submitted for this special issue, seven papers were finally accepted in accordance with our selection criteria, including the need for contributions to be original and relevant to the theme of the issue and the need for a balanced mix of disciplinary and methodological backgrounds. The seven selected articles explore different facets of the research agenda that we have outlined above, together covering the three main types of SOI proposed by Adams et al. (2016), with a particular emphasis on consumers and behavioral issues.

The article by Bauer, Aarestrup, Hansen and Reisch (this issue) presents a consumer-focused study aimed at identifying ways in which supermarkets can employ behavioral interventions to increase the uptake of healthier and more climate-friendly foods while still meeting their economic bottom line. A subsequent field experiment supports the notion that supermarkets have significant agency and ability to nudge consumers towards more sustainable

diets, and the authors of this article explore how these findings provide guidance as to how such practices could be scaled up to drive significant changes in consumption. While these findings also reveal limitations to the effects of nudges in shifting consumer behavior, the overall evidence clearly indicates that at least some consumer preferences and choices are shaped by the retailing contexts they inhabit. From this it can be concluded that organizational changes can lead to significant improvements in the eco-efficiency of supermarkets and facilitate the needed changes in consumption patterns. Their paper thus provides novel insights into how supermarkets can – by "doing the same things but better" – employ their built environment to promote climate-friendly foods.

The article by Troise, Tani, Dinsmore and Schiuma (this issue) is part of the recent literature that recognizes the role of crowdfunding in moving towards a sustainable society (Testa et al, 2019). It focuses on a new potential role that consumers could play in supporting SOI by acting as investors backing open innovation through crowdfunding platforms. The authors emphasize that crowdfunding as a social and relational practice can be a source not only of funding but also of knowledge to inform and support the SOI efforts of agri-food companies. This article thus makes an important and original contribution to the field of SOI by showing how crowdfunding provides SOI-oriented actors with a source of revenue as well as significant input from a wide diversity of actors. The authors conclude that emerging and incumbent actors could employ crowdfunding to finance operational improvements and even bring about organizational transformation towards greater sustainability in the agri-food system. Crowdfunding thus provides organizations the opportunity to "do good by doing new things" via collaboration with consumers.

The article by Aschemann-Witzel and Do Carmo Stangherlin (this issue) relates consumer perceptions to circular solutions by presenting a study of the key factors affecting consumer acceptance of waste-to-value food products. Through a systematic review of empirical consumer research on waste-to-value practices in the food and drink industry, the authors show that the acceptance of waste-to-value food products among consumers is determined by individual, context- and product-related factors. The article confirms the findings of recent literature (e.g., Riccaboni et al., 2021) that it is not only technological constraints that limit the diffusion of such practices, underlining the importance of taking into account the demands, needs and behaviors of consumers in driving change in the food value chain. This finding has three key implications for agri-food businesses pursuing SOI in the form of "doing good by doing new things". The first of these implications is that such

businesses must take account of consumer attitudes, intention to use, and the processes involved in adopting foods using waste-to-value ingredients. Second, businesses should identify those segments of consumers who are open to accepting SOIs, including targeting consumers who are concerned about the environment. Third, businesses adopting SOIs need to develop more effective and appropriate communication strategies consistent with the important aim of making sustainability more people-oriented (Adams et al., 2016). This article thus reflects on the sociocultural aspects that need to be addressed to pursue CE-driven systemic transition through SOI, thereby transcending the limits of most extant studies on CE and sustainability in which circularity is confined to a narrow and primarily economic vision of CE (Zwiers et al., 2020), As such, the article makes an important contribution to our understanding of the emerging waste-to-value food market. This emerging market is opening a wide range of new opportunities that could even signal a shift in the overall food system by reorienting our understanding of what constitutes and qualifies as waste.

By examining how firms collaborate with various other organizations to address social and environmental issues, the article by Riandita (this issue) focuses on the most advanced form of SOI in the typology offered by Adams et al. (2016), i.e., of "doing good by doing new things with others". While numerous previous studies have discussed the success factors in such partnerships and the opportunities they present, few studies have yet provided an overview of the role of partnerships in the context of firms' sustainability initiatives. The author addresses this gap here through an investigation of sustainability partnerships that uses content analysis methods to focus on partnership mechanisms and choices of partners over time, drawing on data collected from 12 European retailers in the agri-food sector from 2014 to 2018. This analysis shows that although the frequency of partnerships formed to support philanthropic endeavours declined during this period, with a corresponding reduction in the number of retailers partnering with nongovernmental organizations (NGOs), the same period also saw an increase in retailers' engagements in partnerships with sustainability ventures for SOI. The authors interpret these trends and changes in mechanisms and choices of partner for SOI as reflective of a shift in retailers' objectives, i.e., from having mainly engaged with legitimacy-oriented partnerships to exploring greater participation in competence-oriented partnerships. The article thus succeeds in addressing an important gap in the literature regarding the issue of collaboration and partnerships for sustainable development.

The article by Miranda, Monteiro and Rodrigues (this issue) focuses on the governance dimension of sustainable agri-food value chains and the development of circular solutions in

the agri-food system. This contribution combines elements of organizational transformation and systems-building approaches to SOI, i.e., of both "doing good by doing new things" and of "doing good by doing new things with others". The authors argue that the promises of SOI and CE have been slow to materialize and that this lack of progress is partly due to a neglect of governance issues. The article provides a theoretical treatment of governance issues and governance costs based on Oliver E. Williamson's (1991) work on transaction cost economics. Defining "governance costs" as the costs of negotiating, supervising, and enforcing contractual relations, the authors argue that without taking account of the effects of governance costs on the design of agri-food systems it is not possible to explain why agri-food supply chains remain linear despite the existence of technical solutions and know-how supporting SOI and the circularization of food systems. The study presents a set of propositions regarding governance costs and their importance for the creation of circular agri-food systems, including factors such as interdependence among parties in the system, the existence of leading or bridging organizations, and technology. Overall, the authors provide a broad theoretical treatment of governance issues and governance mechanisms with a strong emphasis on the economizing forces at play. As such, this article makes a welcome contribution to the SOI scholarship by highlighting the need for research to transcend the technical, descriptive, and celebratory accounts of SOI and CE in the current literature and to consider the role of governance costs and the constraints these impose in the alignment of principles with practices and intentions with outcomes in this field. We therefore need to look not only into economic and market-oriented matters when studying SOI and CE, but also engage in reflections on the cultural, regulatory, and technical conditions and barriers to sustainable development (Kirchherr et al., 2018).

The focus of the article by Wang and Zhang (this issue) is on the prospects of achieving SOI through organizational transformation, i.e., of "doing good by doing new things". The authors apply life cycle assessment (LCA) methodology to compare the carbon emissions of online food recipe boxes with the emissions generated by the supermarket equivalents of these foods. The overall aim of the article is to provide data and analysis that could be helpful in reducing the negative environmental impacts of food systems all the way from production to consumption, with a particular emphasis on the potential benefits of adopting food provision systems such as online food recipe boxes as alternatives to the dominance of supermarket grocery retail. From their analysis of European data on five different types of meals (chicken, beef, fish, vegetarian, and vegan), the authors show how LCA can support SOI and

organizational transformation by providing a means of comparing the carbon footprints of different types of packaging and ways of bringing food to consumers. From their LCA analysis, the authors find that the carbon emissions of the five meals from online recipe boxes were 10.8% lower than those generated by their supermarket retail store equivalent. This is partly because recipe boxes produce less food waste due to the pre-portioning of ingredients for the meal. The LCA further shows that the reductions in emissions of online recipe boxes are greatest for chicken (19.4%), followed by beef (10.2%) and fish (19.5%), while less significant in the case of vegetarian meals (6.4%). For vegan meals, however, the recipe box was found to have a slightly larger carbon footprint (1.3%) than the supermarket equivalent. Based on these findings, the authors provide a set of recommendations to support the improvement of the environmental sustainability of food systems. These recommendations are centred on reducing waste in agriculture, and on reducing supply chain food losses, improving the circularity of packaging materials, and reducing emissions from food transportation. Overall, the findings suggest that online recipe boxes are significantly less harmful to the environment than the supermarket equivalent, particularly in the case of food products with the highest environmental impact. The article provides an excellent in-depth analysis of the extent to which this new form of incremental improvement in the business of putting dinner on the table, i.e., through online recipe boxes, translates into measurably improved environmental performance.

In the final article of this special issue, Friedman and Ormiston (this issue) explore developments in blockchain technology as a type of innovation that could prove highly effective as a means of supporting efforts to address sustainability challenges in global food supply chains. The authors point out that blockchain has the potential not only to address fraud and human rights violations in food supply chains by enabling greater traceability of food but also has further possible social and environmental implications for the agri-food system. These social implications include the possible creation of a more balanced distribution of income and wealth along the food supply chain by facilitating a more distributed and less centralized model that enables the establishment of direct connections between producers and farmers. In terms of the potential benefits of blockchain technology for SOI in the environmental sphere, the collection and storage of trustworthy data along the supply chain enables the environmental impacts of all actors in the chain to be accurately traced, thereby creating the basis for a more profound transformation of the food ecosystem. As such, while blockchain can be interpreted as a technical tool for attaining sustainability, its principles and implementation at scale can lead to SOI in the form of "doing good by doing new things" and can even become a driver for

a system-building approach to SOI. Drawing on SOI- and innovation resistance theory, moreover, this article makes a further important contribution in its focus both on the potential opportunities of blockchain technology and on resistance to this new technology, including functional and psychological barriers to its adoption. We regard this focus on barriers to development to be a useful and important step forward in learning processes in the field of SOI and of sustainable development more broadly. This paper thus contributes to addressing a key knowledge gap related to social issues and social implications of SOIs. Blockchain is presented in the paper as a promising tool not only to counter social misconduct and fraud in global food supply chains but also as a potential tool for achieving a more equitable distribution of wealth and income among actors along the supply chain.

Where do we go from here?

Overall, the articles selected for this SI showcase the diversity of SOI research on the agri-food system with multiple actors and agendas. A further aim of this issue has been to highlight the need for socially embedded accounts of the organizational and individual factors that can make or break SOI initiatives. Based on our review of the rapidly growing literature on agri-food and SOI, we propose the following three topics as the most relevant foci for future research: the drivers of SOI; the influence of different actors on SOI along the agri-food supply chain; and the role of behavioral, cultural, and social factors in the adoption of SOIs.

Firstly, if we consider SOI as a *process* then there is an evident need to identify the internal and external tipping-points that enact change. For while it is evident that SOI is dependent on "the dynamic ability to adapt, integrate and reconfigure organizational skills, resources and functional competencies to respond to contemporary sustainability challenges" (Adams et al. 2016, p. 198), it remains unclear precisely which factors play the greatest role in driving organizations to focus on sustainability challenges in the first place. For example, some research has claimed to find evidence that such change can be driven by niche actors forcing a large number of incumbents to react (see Hockerts & Wüstenhagen 2010; Smith et al., 2010), with some studies highlighting the efforts of institutional entrepreneurs embedded within larger organizations to push for change (see Klein Woolthuis et al., 2013), while other scholars have stressed the importance of incumbents engaging with new forms of innovation processes as the main driver of adopting SOI (see Zimmerling et al., 2017). Future research should thus focus on identifying the specific internal and/or external factors that first lead firms to take on

sustainability challenges. An initial starting point for such research could be to draw on the extensive literature on sustainable entrepreneurship (see Belz & Binder, 2017).

Secondly, there is a need for more studies to focus on how sectoral differences and the respective locations of different actors along the supply chain influence SOI in the agri-food system. This focus is necessary both to identify areas of significant potential and to ascertain how these differences along the chain influence the form and output of SOI endeavours. From a sustainability perspective, this is especially pertinent to gain an understanding of how various parts of the agri-food system respond to sustainability challenges, what their potential might be for overcoming these challenges, and not least how these insights can be leveraged to bring about the necessary transition to a sustainable food system.

Thirdly, in line with the conclusion reached in a recent study by Nielsen et al. (2020, p.325) we find that "much of the literature on mitigation pathways addresses technological and economic aspects of feasibility, but overlooks the behavioral, cultural and social factors that affect theoretical and practical mitigation pathways". We thus encourage future researchers of SOI in the agri-food system not to confine their analyses to the technical potential and economic feasibility of a given solution but also to consider the feasibility of such initiatives being adopted in practice and the extent to which the targeted actors are likely to respond as envisaged by such solutions. For example, as further observed by Nielsen et al. (2020), shifts in meat consumption to a large extent "depend on public acceptance of initiatives to produce the change, on the efforts of other actors to block such initiatives (e.g., lobbying and advertising by meat producers), on the development of successful meat substitutes, and on cultural and social norms around meat consumption" (p. 327). In addition, users often do not act in the manner anticipated or desired by those driving and designing SOI initiatives. As Rohracher (2003) showed in their review of case studies of end-user participation in renewable energy technologies, many smart homes perform well below their potential in terms of how sustainable they are because the actions of the occupants undermine the original intentions of the designers and engineers.

Finally, the extent to which actors along the agri-food supply chain adopt and maintain certain behaviors is also subject to significant variation. Given this "behavioral plasticity", future research should include observational studies of actual behavior and conduct longitudinal studies to measure adoption rates and ascertain the factors that support the adoption of SOIs on a larger scale.

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