

# How to innovate business models for a circular bio-economy?

Mechthild Donner, Hugo de Vries

▶ **To cite this version:**

Mechthild Donner, Hugo de Vries. How to innovate business models for a circular bio-economy?. Business Strategy and the Environment, 2021, 30 (4), pp.1932-1947. 10.1002/bse.2725 . hal-03111854

**HAL Id: hal-03111854**
**https://hal.inrae.fr/hal-03111854**

Submitted on 15 Jan 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution - NonCommercial - NoDerivatives 4.0 International License

Received: 31 July 2020 | Revised: 10 December 2020 | Accepted: 25 December 2020

DOI: 10.1002/bse.2725

Check for updates

RESEARCH ARTICLE

Business Strategy and the Environment

WILEY

# How to innovate business models for a circular bio-economy?

Mechthild Donner[1] | Hugo de Vries[2]

[1]INRAE – French National Research Institute for Agriculture, Food and Environment, UMR MOISA (University Montpellier, CIRAD, CIHEAM-IAMM, INRAE, Institut Agro), Montpellier, France

[2]INRAE – French National Research Institute for Agriculture, Food and Environment, UMR IATE (INRAE, Institut Agro, University Montpellier), Montpellier, France

**Correspondence**
Mechthild Donner, INRAE, Joint Research Centre MOISA, 2 Place Pierre Viala, 34060 Montpellier Cedex 1, France.
Email: mechthild.donner@inrae.fr

**Funding information**
European Union's Horizon 2020 research and innovation programme, Grant/Award Number: 688338

## Abstract

Shifting from a linear to a circular bio-economy requires new business models. The objective was getting insights into the uncharted research field of business model innovation for a circular and sustainable bio-economy within the agrifood sector. Eight European cases valorising agricultural waste and by-products by closing loops or cascading were studied regarding their innovation drivers and elements, via interviews, on-site visits and secondary data. In this domain, the findings highlight that business model innovations are depending on the (i) macro-environmental institutional-legal conditions and market trends, (ii) driven by internal economic, environmental and/or social objectives, but especially strongly linked to (iii) other actors often from different sectors seeking synergies and (iv) value co-creation via combined organisational and technological innovations. Business models for a circular bio-economy thus depend on various action levels and need radical combined organisational and technological innovations for a most efficient usage of agricultural waste and by-products. This also means new business configurations instead of linear innovation strategies currently still being dominant due to economic viability.

**KEYWORDS**
agricultural waste and by-products, bio-economy, business models, circular economy, co-creation, innovation, sustainability

## 1 | INTRODUCTION

In a context of limited natural resources, climate change and growing population, circular economy has become a popular concept for sustainable development and of increasing interest for policy makers, companies and the civil society. It aims to shift from the current linear 'take-make-dispose' model to closing loops by recycling and reusing products, components and materials, and by reducing waste to a minimum (Ellen MacArthur Foundation [EMF], 2013; Murray, Skene, & Haynes, 2017). It is thus considered as a new and alternative way to reconcile economic growth with the use of natural resources and to develop sustainable economic systems, but with a narrower focus on economic and environmental dimensions (Geissdoerfer, Savaget, Bocken, & Hultink, 2017). The implementation of circular economy is still in an early stage but driven worldwide by diverse policies, concerning macro, meso and micro action levels (Ghisellini, Cialani, & Ulgiati, 2016). As an emerging concept (Velenturf et al., 2019), there is not yet a common definition of circular economy (Kirchherr, Reike, & Hekkert, 2017; Korhonen, Honkasalo, & Seppälä, 2018), it is rather used as an 'umbrella term' (Homrich, Galvao, Abadia, & Carvalho, 2018). The Ellen MacArthur Foundation conceptualises and defines circular economy as 'an industrial system that is restorative or regenerative by intention and design' (EMF, 2015).

In the past years, the importance of circular economy for the agrifood sector has been highlighted (Barros, Salvador, de Francisco, & Piekarski, 2020; EMF, 2015; Esposito, Sessa, Sica, &

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.
© 2021 The Authors. Business Strategy and The Environment published by ERP Environment and John Wiley & Sons Ltd..

Malandrino, 2020; FoodDrinkEurope, 2020; Jurgilevich et al., 2016). In Europe alone, around 90 million tonnes of food and 700 million tonnes of crops are wasted each year (http://agrimax-project.eu/), and the worldwide food production and supply chains consume about 30% of the global energy production (Food and Agricultural Organisation of the United Nations, 2015). Agricultural waste and by-products are usually defined as plant or animal residues that are produced during various agricultural operations and that are not or not further processed into food or feed (Organisation for Economic Co-operation and Development, 1997). Waste streams are produced in all parts of the agrifood system or chains, mainly due to over-dimensioned, spatially or temporarily in-adapted processes and handling schemes. However, agricultural waste and by-products can be converted into valuable resources, resulting in new value-added bio-based products such as bio-energy, bio-fertilisers, bio-materials or bio-molecules (Venkata Mohan et al., 2016). Creating value from or valorising agricultural waste and by-products is challenging due to the heterogeneity and perishability of agri-resources, and the seasonal and territorial fluctuations in volumes and quality (Donner, Gohier, & De Vries, 2020); this even more holds for urban food waste. Moreover, different valorisation opportunities exist in alternative sectors, with differences in value, as shown in the value pyramid for biomass valorisation (Rood, Muilwijk, & Westhoek, 2017). Cascading approaches, that is, a multiple and diversified use of waste streams through consecutive production processes (Ghisellini et al., 2016) via, for example, biorefineries require then careful consideration (Donner et al., 2020). Research on circular bio-economy approaches for valorising agricultural waste for new products is relevant but still presenting important gaps, including new circular business models, as highlighted in the recent literature review by Barros et al. (2020).

A shift from a linear to a circular and sustainable bio-economy requires a radical change at a system level (Science Advice for Policy by European Academies, 2020). Circular economy is thus strongly linked to innovation, as important policy measures and socio-economic changes, including new technologies and products, are needed for a transition. On the other hand, circular economy can also be a driver for eco-, responsible or sustainable innovation in production and consumption (Boons & McMeekin, 2019). Companies need to rethink and redefine how they understand and do business and how they generate and offer value to customers (Centobelli, Cerchione, Chiaroni, Del Vecchio, & Urbinati, 2020; Pieroni, McAloone, & Pigosso, 2019). Hence, business model innovations are needed that offer new products or services and/or new market opportunities (EMF, 2013); especially between businesses, new interactions emerge (Stewart & Niero, 2018). Therefore, business managers and researchers increasingly explore how new, sustainable and circular business models can create economic growth while reducing negative effects on the natural environment and society (e.g. Bocken, Strupeit, Whalen, & Nußholz, 2019; Boons & Lüdeke-Freund, 2013; De Giacomo & Bleischwitz, 2020; Schaltegger, Hansen, & Lüdeke-Freund, 2016; Stubbs & Cocklin, 2008).

Our research objective is to get insights into the drivers and elements of business model innovation within the agrifood sector and contributing to the circular bio-economy transition via agricultural waste and by-product valorisation. Eight European circular business cases are studied that convert agricultural waste and by-products into value-added products, with particular attention to their business model and technological innovations. The underlying questions are: (i) What types of circular business model innovations exist in the agricultural sector? (ii) Is agribusiness model innovation for a circular bio-economy different from the linear economy? And (iii) What would be needed for more radical innovations in the agrifood domain leading to more circularity? With our study, we contribute to the recent discussion on business models for a circular bio-economy and fill the specific gap in the agricultural sector. We also propose a new conceptual framework for circular business model innovation connected to bio-technological innovations in the agrifood sector, which shows the complexity and interactions at different action levels.

## 2 | LITERATURE REVIEW AND THEORETICAL FRAMEWORK

### 2.1 | The business model concept

Despite an increasing research interest in business models and business model innovations, a sound theoretical foundation is still missing (Pucihar, Lenart, Kljajić Borštnar, Vidmar, & Marolt, 2019). In general, a business model describes how a firm does business, that is, the activities of a firm, the way it operates and how it creates value for its stakeholders (Casadesus-Masanell & Ricart, 2010; Magretta, 2002; Teece, 2010). The notion of value is central to a business model and has been broadened from economic value to environmental and social value within the emerging literature on new and sustainable business models (e.g. Birkin, Polesie, & Lewis, 2009; Schaltegger, Lüdeke-Freund, & Hansen, 2012), hence including the three pillars of sustainability (people, plant and profit; Elkington, 1998). The concept of circular business models is more recent and builds on management literature and on circular strategies from the resource efficiency field (Nußholz, 2017). It thus integrates principles and practices from the circular economy with the goal to achieve a more resource effective and efficient economic system (EMF, 2015). Accordingly, Mentink (2014, p. 35) defines a circular business model as 'the rationale of how an organization creates, delivers and captures value with and within closed material loops'. Linder and Williander (2017, p. 2) define it as 'a business model in which the conceptual logic for value creation is based on utilizing the economic value retained in products after use in the production of new offerings', thus highlighting the return flow from the user to the producer. Sustainable and circular business models are closely related and can be considered as a sub-category of business models (Antikainen & Valkokari, 2016). However, circular business models offer new perspectives by developing strategies to close, slow, intensify, de-materialise or narrow resource loops (Bocken, De Pauw, Bakker, & Van Der Grinten, 2016; Ünal, Urbinati, Chiaroni, & Manzini, 2019).

## 2.2 | Business model innovation

In contrast to business models, the concept of business model innovation (BMI) is less well understood, perhaps because its literature is more recent (Foss & Saebi, 2017). There is general agreement that business model innovation (BMI) is continuously needed due to market liberalisation, increased competition and changing socio-economic conditions. Nowadays, products can easily be copied and local markets overtaken by international competitors (Taran, Boer, & Lindgren, 2015). BMI can thus increase the resilience of firms to changes in its environment and become a source of a firms' competitive advantage (Mitchell & Coles, 2003). Some authors go even further by considering that BMI can reshape industries, contribute to more sustainability (Geissdoerfer, Vladimirova, & Evans, 2018) and possibly even 'change the world' (Massa & Tucci, 2013, p. 438). However, BMIs are risky, as they are time-consuming and require investments, for example, in R&D, resources or equipment. Therefore, a systemic and holistic thinking to innovation is recommended, instead of an individual and isolated approach (Amit & Zott, 2012). BMI consists of changing a business model by creating, diversifying, acquiring or transforming it (Pieroni et al., 2019). Massa and Tucci (2013) distinguish between two types of BMI. The first refers to the design of novel business models for newly created organisations (*business model design*), the second to the reconfiguration of an existing business model (*business model reconfiguration*), in which managers acquire new or reconfigure existing resources to change their business model. Regarding the degree of innovation, one can distinguish between *radical* and *incremental*. While radical innovation describes a high degree of novelty or a breakthrough, that is, an innovation which breaks with previous structures, procedures, activities or products in a firm, an incremental innovation has a low degree of novelty, is less risky, and does not break with previous products, processes or organisation methods but significantly improves them (Souto, 2015). Moreover, Bocken, Short, Rana and Evans (2014) describe eight archetypes of sustainable business models, classified in higher order groupings that show three main types of innovation: *technological*, *social or organisational*. They suppose that firms can use one or several archetypes as references for shaping their own transformation.

## 2.3 | Drivers of business model innovation

There are few studies on BMI drivers, which may be 'many, different in nature, placed at different levels, and be external or internal to a firm' (Foss & Saebi, 2017, p. 217). Hence, BMI can be triggered either by *internal* (technology-push or inside-out) or *external* (market-pull or outside-in) opportunities or threats (Bucherer, Eisert, & Gassmann, 2012). Innovations due to changes in the external environment have been described in earlier studies, such as changing demands of stakeholders (e.g. Ferreira, Proença, Spencer, & Cova, 2013), changes in the competitive environment (e.g., De Reuver, Bouwman, & MacInnes, 2009), opportunities brought about by new, for example, information and communication technologies (e.g. Pateli & Giaglis, 2005), or other general trends such as consumer awareness, circular economy or CSR (corporate social responsibility) (Todeschini, Cortimiglia, Callegaro-de-Menezes, & Ghezzi 2017). The ability to innovate a business model in response to major external environment changes has been characterised as 'dynamic capability' (Teece, 2018; Zott, Amit, & Massa, 2011). Bocken and Geradts (2020) have identified internal drivers for sustainable BMI within large multinational corporations at three levels: institutional (e.g. norms and believes that affect organisational behaviour), strategic (e.g. collaborative innovation) and operational (e.g. people capability development). Finally, Schaltegger et al. (2012) highlight the link between a firms' overall strategy and its BMI for sustainability: (a) *defensive strategies* with slight degrees of business model adjustment or adoption might be motivated only by a need to comply with legislation and protect the current business model, (b) *accommodative strategies* go along with a change and improvement of the business model by addressing environmental and/or social objectives; (c) *proactive strategies* lead to business model redesign and fully integrate sustainability issues in their products and processes.

## 2.4 | Circular business model innovation

Circular business models are in general driven by the objective to reconcile commercial value creation with resource efficiency strategies (Nußholz, 2017). However, circular business model (innovation) is a recent field of research (Bocken et al., 2019; Ferasso, Beliaeva, Kraus, Clauss, & Ribeiro-Soriano, 2020; Lopez, Bastein, & Tukker, 2019; Lüdeke-Freund, Gold, & Bocken, 2019; Pieroni et al., 2019) and especially in the context of agriculture, still reveals a gap in literature (Barros et al., 2020). Circular BMI depends on the larger business ecosystem and a broad range of actors and stakeholders (Antikainen & Valkokari, 2016; Brown & Bajada, 2018; Evans et al., 2017; Lüdeke-Freund, 2020): 'Circular business model innovations are by nature networked: they require collaboration, communication, and coordination within complex networks of interdependent but independent actors/stakeholders'. (Antikainen & Valkokari, 2016, p. 7). Therefore, an analysis of circular BMI should be linked to an innovation system perspective. Boons and Lüdeke-Freund (2013), by reviewing literature on sustainable innovation, have identified three levels of analysis at the system boundaries: (i) an *organisational*, focused on individual firms and their own value adding activities; (ii) an *inter-organisational*, concerning the interrelationship with other actors that co-create and share values; and (iii) a *societal*, considering the wider landscape for transition and interrelationship with other organisations to produce a shared societal value. However, research on circular economy has mostly been limited to one action level (Barreiro-Gen & Lozano, 2020). Furthermore, Antikainen and Valkokari (2016) have offered a framework for sustainable circular business model innovation. In this framework, they integrate—apart from the business level, which consists of the nine business model canvas building blocks proposed by Osterwalder and Pigneur (2010)—the 'business ecosystem level' (referring to trends and drivers and to a stakeholder

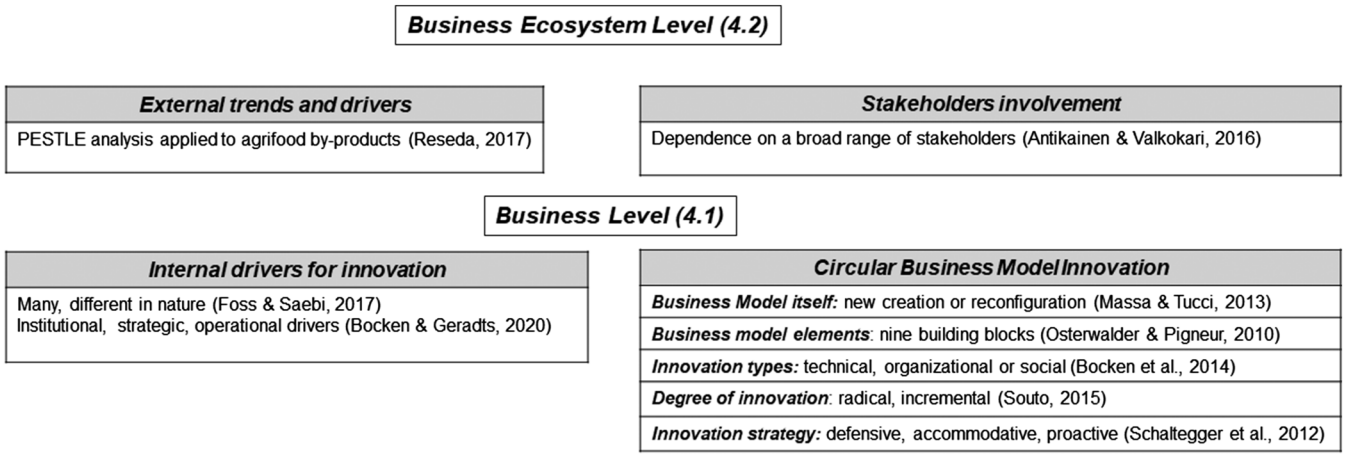



**FIGURE 1** Theoretical framework

involvement having a direct impact on the business model) and the 'sustainability impact' (environmental, social and business requirements and benefits). The idea is to come to a continuous sustainability and circularity evaluation of the business model innovation, in order to optimise the processes.

## 2.5 | Towards a theoretical framework

The considerations above about business models and their innovations are summarised in a theoretical framework (Figure 1) that is used as basis for analysing and discussing our results. It consists of two levels, the business level itself and the wider context, that is, the business eco-system level. At the business level, one recognises the internal drivers for innovation (Bocken & Geradts, 2020; Foss & Saebi, 2017) and the main features of the circular business model innovation. The latter refer to the (i) *business model itself* (Massa & Tucci, 2013), (ii) *business model or canvas model elements* (Osterwalder & Pigneur, 2010), (iii) *innovation types* (Bocken et al., 2014), (iv) *degree of innovation* (Souto, 2015) and (v) *innovation strategy* (Schaltegger et al., 2012). At the business eco-system level, the external drivers are to be considered; if adapted to the specific bio-economy context, the Reseda (2017) methodology for analysing by-product valorisation pathways is most relevant. Also, the stakeholder involvement is crucial as revealed in the sustainable circular BMI framework by Antikainen and Valkokari (2016).

# 3 | METHODOLOGY

Our study was realised within the European H2020 project NoAW (No Agricultural Waste), driven by a 'near zero-waste' society requirement and aiming to develop innovative approaches for the conversion of increasing volumes of agricultural waste and by-products into eco-efficient bio-based products. In particular, co-products from wine, cereals and manure were addressed. Although the focus of the project was on technological development aspects, one working package was dedicated to the challenge of how to design new business and marketing strategies for a cross-sectoral valorisation of agricultural waste and by-products.

For this socio-economic working package, a qualitative research approach was defined, which is the dominant methodology for analysing business models so far, to explore them as current phenomena in their given contexts, as well as the antecedents and consequences of their configurations (Ehret, Kashyap, & Wirtz, 2013). The case study method was chosen, as 'an empirical enquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident' (Yin, 2009, p. 18). This method is particularly appropriate for developing a new theory and answering questions of why, what and how, and it allows better understanding of the nature and complexity of a phenomenon (Voss, Tsikriktsis, & Frohlich, 2010). It is also suited to generate relevant knowledge for managers (De Massis & Kotlar, 2014). In business model research, a scarcity of case studies has been stated, making it 'challenging for firms to understand how to innovate their business models, identify and design alternatives, then assess and select the most adequate one' (Evans et al., 2017, p. 598).

Eight cases were studied in 2016–2019, four from France, two from Germany, one from Italy and one from the Netherlands. Multiple case study augments the external validity (Voss et al., 2010). The cases were selected for the following reasons. First, because they offered sufficient elements for an analysis of their innovation. The selected cases were also representative as they consisted of different types of business models (Donner et al., 2020), were centred on the three different focal product chains of the research project (wine, cereals and manure), and their agricultural waste and by-product valorisation relied on different technologies with different product outputs: either via a simple closing loop (e.g. bioenergy production[1])

[1]Mostly via anaerobic digestion, that is, processes by which microorganisms break down biodegradable material in the absence of oxygen, used to produce bioenergy.

or a cascading (diversified used of waste streams) approach implying many actors. Another reason to investigate these business cases was the relative availability and openness of the managers to share more detailed information and organise site visits. As the cases were from project-partner countries, partners could provide additional information for the cases and their contexts. Nonetheless, we had to limit the number of interviewees and interviews considering the realities of (especially small and medium-sized) enterprises, characterised by limited time and resources that can be allocated for external activities (Ünal et al., 2019).

The data collection was done through field and desk research. The field research involved an on-site visit for each case and at least one semi-structured interview with one or several members of the company, with different positions, for example, CEO, R&D or marketing managers (Table 1). The interviews had an approximate duration of 2 h. Key informants were also regularly contacted by e-mail for further clarifications. The interview guide included questions about the macro-environmental political-legal (policies, laws and regulations), economic (markets and subsidies), social, technological and environmental conditions, as well as micro-level business aspects such as historical (origin, triggers and development of the initiative), organisational (governance, partnerships and logistics), technological (type and maturity of technologies used, examples of by-product valorisation and outputs), marketing and financial (investments and cost–benefit structure) elements. The site visits focused on the presentation and explanations of the technologies, the observations of the different agricultural waste and by-products used for valorisation (from animals or crops) and the logistics (transport, storage and weight). These visits had durations between 1 and 4 h and were mainly guided by the interviewed persons, sometimes with support of technical experts. The data from these field visits, mostly in form of photos or notes, were discussed after the visits by the authors and provided additional insights especially regarding the amounts of waste valorised, the innovativeness and technology-readiness-levels (from pilot-scale to full implementation). The primary data were triangulated with secondary data from desk research, that is, academic articles if available, online articles, videos and internet sites of the companies, and internal documents such as reports or presentations directly received from the companies.

Interview and secondary data were transcribed and analysed according to the content method, which relies on an analytical interpretation of data and is used to make 'replicable and valid inferences from texts' (Krippendorff, 2004, p. 18; Berg, 2009). A hand-coding was done for each case (within-case analysis). This was done by the leading author and then verified and discussed with the other author. In a first step, general features assigned to the businesses were studied. This was done to provide first insights and illustrate major issues for each case regarding its main actor(s), resources and transformation

**TABLE 1** Research methodology characteristics

| Case | Country | Type of business model | Data collection |
|---|---|---|---|
| 1 | Germany | Small biogas plant | The biogas plant owner is a customer of a project partner, who is consultant within the biogas domain. Regular exchanges, one group face-to-face interview with the plant owner and one joint field visit with the project partner. |
| 2 | Italy | Small upcycling entrepreneur | The firm is a project partner. Regular exchanges, one group interview and discussion with 3 persons, joint field visit. |
| 3 | France | Large environmental biorefinery | Preliminary face-to-face and e-mail exchanges, one telephone and two face-to-face interviews with the director of the open innovation platform and field visit. |
| 4 | France | Large agricultural cooperative | The firm is a project partner. Regular exchanges, four interviews, two with R&D and two with marketing manager, including field visit. |
| 5 | Netherlands | Large agripark | The lead firm of the park is a project partner. One group interview with CEO and operational manager, regular e-mail exchanges, field visit to get a general overview of the park. |
| 6 | Germany | Small agripark | Two interviews (1 telephone and 1 face-to-face), one field visit. |
| 7 | France | Small support structure | First exchange about their main activities followed by in-depth interview, a field visit and several e-mail exchanges. |
| 8 | France | Medium-sized support structure | One group interview with four persons (director of the association, of the cluster of enterprises, of a waste treatment firm, of an international firm) and joint discussion, field visit. |

processes, value proposition, key partners, customers and strategic approach (Table 2). Next, data were analysed regarding the more specific innovation elements as main focus of this work. For processing this coding, the theoretical framework (Figure 1) was used as basis. Here, we first identified the main trends and drivers at a macro-level and stakeholders involved. Second, the contents regarding the origin, evolution and key milestones of the businesses over time, and in particular their main internal drivers to start or further develop their business, were identified. Third, the innovation of the business model itself and its nine buildings blocks (Osterwalder & Pigneur, 2010), the innovation types (technical, organisational and social; Bocken et al., 2014), degree of innovation (radical and incremental; Souto, 2015) and innovation strategies (defensive, accommodative and proactive; Schaltegger et al., 2012) were analysed. The main outcomes were then summarised in Table 3. The overall objective of the data analysis was to get insights into the external and internal drivers for innovation, stakeholders involvement as well as specific elements of circular business model innovation per case. On the other hand, it served to summarise generic outcomes within a single scheme (Figure 2). Finally, it allowed to develop a new conceptual framework for circular business model and technological innovations (Figure 4).

## 4 | RESULTS

This section starts with a more general presentation of the characteristics of the eight cases studied, as described in the methodology, including their main actor(s), resources and transformation processes, value proposition, key partners, customers and strategic approach (Table 2). This provides a first introduction to each case. Next, following the theoretical framework, in section 4.1, results about the internal drivers for innovation and innovations at the business model level are given (Table 3). In section 4.2, insights from the business ecosystem level including stakeholders involved and external trends and drivers are shown.

### 4.1 | Internal drivers and innovations at the business model level for the eight cases

In Table 3, the internal drivers and elements of innovations at the business model level are presented for each case. A difference is made between innovation of the business model itself, either as a new creation or reconfiguration of an existing model, and of innovative business model elements, for example, novel products, technologies or forms of organisation. Each case is then classified according to its main innovation type(s), degree and innovation strategy.

Case 1, initially a farmer, was driven by the question of how to create economic value out of agricultural waste, in the early 2000s when the biogas boom started in Germany. In 2004, when the biogas plant was already in operation for years and enlarged, he noticed that the area to spread digestate[2] and nutrients would become a limiting factor. Therefore, he decided to dry digestate in a new special large-scale production facility and to produce and market a pellet fertiliser himself. This allowed him to divert nutrients from agriculture into other sectors like viti- or horticulture and to expand his business; this required new scale-adapted supplies, distribution and market outlets with stakeholders. Apart from this, he delivers the (often lost) heat from his biogas plant to the nearby (eco-)village via appropriate, new infrastructure, thanks to a joint initiative with the local community. Also, he is building a new partnership with a local e-car sharing company for utilising locally produced electricity.

Case 2 was created in 2013 as a university spin-off in order to enable and facilitate a market uptake of new technologies for agricultural by-product valorisation. It is actually fully operational after the creation of a first spin-off that had to stop after one year, mainly for financial reasons. The spin-off is well embedded in a large cooperative providing resources, housing and local assistance, while receiving advice on biogas production and potential new biotechnological ways to valorise their co-products; this allows mutually benefiting from know-how and new opportunities. The university is now intended to fully spin-out the company. The company attracts new employees and continues to operate within the cooperative however also as an international consultancy firm in the agricultural sector. The key technological innovation is the combined biogas and PHA production—a biodegradable polyester which potentially may, for example, replace fossil-based plastics—via a new biotechnological concept exploited at pilot-scale.

Case 3 was based on the willingness of local cooperatives to diversify their activities in a synergistic way and to define a joint local sustainable bio-economy development strategy. The aim of this process of clustering was to create synergies by common technological investments, to enter new markets via cereal and sugar cane by-product valorisation activities, to close energy and material cycles and increase farmers' revenues. The biorefinery can be characterised by its high technological and organisational innovation capability. Its concept is adopted by the regional government as a unique and attractive example internationally, and fuels teaching and research activities, even leading to the creation of an industrial chair on bio-economy, hence providing scientific feedback to the case.

Case 4 was created in 1969 in order to ensure the existence of the wine cooperatives in the region. In 1970, a new law obliged the winemakers to deliver their waste from the production for distillation. The valorisation of grape marc for distillation in one larger unit was thus a collective response to this legal obligation. Since 1994, the business started a diversification of new products and ingredients towards new markets, the food and petfood industry and nutraceutical companies, hence evolving into a small 'biorefinery' with the inclusion of novel bio- and extraction technologies. In 2007, a geographical expansion was decided upon in order to reach critical mass of waste,

[2]Digestate is the remaining part of organic matter treated by anaerobic digestion, rich in nutrients and nitrogen, and therefore an excellent organic fertiliser. But the management of quantities is regulated because a surplus of nitrogen and phosphate damage the environment.

**TABLE 2** Presentation of the characteristics of 8 business cases valorising agricultural waste and by-products

| | Case 1 Biogas plant | Case 2 Upcycling entrepreneur | Case 3 Environmental biorefinery | Case 4 Agricultural cooperative | Case 5 Agripark | Case 6 Agripark | Case 7 Support structure | Case 8 Support structure |
|---|---|---|---|---|---|---|---|---|
| Main actor(s) | Farmer with a biogas plant | University spin-off | Eco-industrial cluster with various firms | Union of wine cooperatives | Agribusiness park manager | Consulting and service company | Association | Local cluster of different stakeholders |
| **Resources and transformation process** | Pig manure & vegetables; anaerobic digestion, new drying system | Cow manure & wine; anaerobic digestion, new extraction methods | Focus on cereals and sugar cane by-products; full range of agricultural, forestry and marine residues; different bio-refinery processes | Waste and by-products from wine; extraction and distillery processes | Combined heat electricity and water recirculation systems | Manure, energy crops; anaerobic digestion, drying | Cereal husks; new separation (de-hulling),quality schemes and treatment procedures | Organic urban food and agricultural waste handling processes, anaerobic digestion |
| **Value proposition** | Biogas, electricity, bio-fertiliser, heat | Electricity, fertilisers, PHA for bio-materials, pilot-scale equipment, consultancy | Diverse plant by-products, applications in the domain of agriculture, food, bio-materials, chemical industry, energy | Compost, ingredients for food, pharma & pet food industries | Heat, electricity, logistics | Consulting for waste collection & valorisation, fertiliser, humus, electricity & heat | Cross-sector cooperation between farmers and eco-constructors | Biogas, network |
| **Key partners** | Local farmers & community, technology supplier, e-car company | Cooperative, two other universities, research centres in EU | Agrifood enterprises, research | Cooperatives and research | Vegetable producers (greenhouses) and traders; private partners in water and energy recycling | Public partner (county), several companies and research partners | Farmers, research institutes, other associations | Local authorities, enterprises and research |
| **Customers** | Public suppliers, private households (electricity), wholesaler (fertiliser) | Electricity corporations, operators of biogas plants | A large variety of enterprises for different products | Enterprises in different sectors, consumers | Data-centres using electricity and producing heat for greenhouses | Grid operator, famers, private customers and consumers | Architects, house constructors | Local enterprises |
| **Strategic approach** | Enlarge product portfolio for mixed market sectors | Innovation, upscaling, pilot-scale demonstration, consultancy | New markets for large volumes of by-products | Innovation, mixed market sectors | Networking, economies of scale | Technology development hub, networking | Networking | Support for networking, niche strategy (organic) |

**TABLE 3** Internal drivers and elements of circular business model innovation

| | Case 1 | Case 2 | Case 3 | Case 4 | Case 5 | Case 6 | Case 7 | Case 8 |
|---|---|---|---|---|---|---|---|---|
| **Internal driver(s)** | Create economic value out of agricultural waste | Enable and facilitate market uptake of new technologies for waste conversion | Diversify activities and define a common sustainable development strategy | Collective response to a legal obligation | Create multiple benefits by clustering actors locally; efficient usage of resources | Interest in jointly developing a value-adding circular economy approach | Enable cross-sector cooperation for by-product valorisation | Cluster public and private actors for rural sustainable development and circular economy |
| **Innovation of BM itself** | Stepwise reconfiguration of the BM from a farm to a modern biogas company, created as limited liability company | Newly created firm as university spin-off, currently considering to become a consultancy company | Originally sugar factory and distillery, stepwise reconfiguration to an agro-industrial and biorefinery park | Originally distillery cooperative, evolvement to a specialized enterprise for wine waste and by-product valorisation | Reconfiguration: from selling ground and logistics to an innovative eco –/agribusiness park | Development from a farm with biogas and herb drying company to an integrated food-energy park | Association founded to create cross-sector synergies among local actors for cereal by-product valorisation, role of intermediator, facilitator | Creation of a cooperative platform for local sustainable and agricultural development via a circular economy approach |
| **Innovative BM elements** | Product: dried bio-fertilizer via special production facility<br>Partners: e-car sharing company (electricity), technology supplier, local community for heat infrastructure<br>Customer: citizens in bio-village (heat) | Value proposition: combined biogas & PHA production with a new bio-technological concept, consultancy; shared infrastructure between farm and spin-off | Technological innovation platform<br>Partners: ongoing governance formalisation, integration of various members around different types of synergies (water, energy, products, R&D) | Value proposition: Product diversification to a large portfolio going from low to high added value via new technologies | Partners: Cross-sector cooperation for energy and water efficiency, interchange between Data-centres that use electricity from greenhouses and produce heat them<br>New channel: tourist excursions | Value proposition: technology development hub, creating 'modules' to be marketed (e.g. algae and humus projects)<br>Partners: public-private cooperation with partly shared infrastructure | Value proposition: Husks valorised for new value-added products: eco-insulation and decoration (former use: heating or animal litter)<br>Partners: cross-sector cooperation | Value proposition: thematic workshops and meetings on circular economy, eco-conception, waste prevention and valorisation, industrial ecology<br>Public-private partnership |
| **Main innovation type and degree** | Technological and organisational (incremental), social (radical) | Technological (radical but pilot scale), Organisational (incremental) | Technological (radical mixed industrial and laboratory scale), Organisational (radical) | Technological (incremental and radical but some at laboratory scale) | Organisational (radical) | Technological (radical but still pilot scale), organisational (radical) | Organisational (radical), technological (incremental) | Social (incremental), organisational (incremental) |
| **Main innovation strategy type** | Accommodative | Proactive | Accommodative, partly pro-active as 'cluster initiative' | Accommodative | Proactive | Accommodative, partly pro-active as 'cluster initiative' | Proactive | Accommodative |

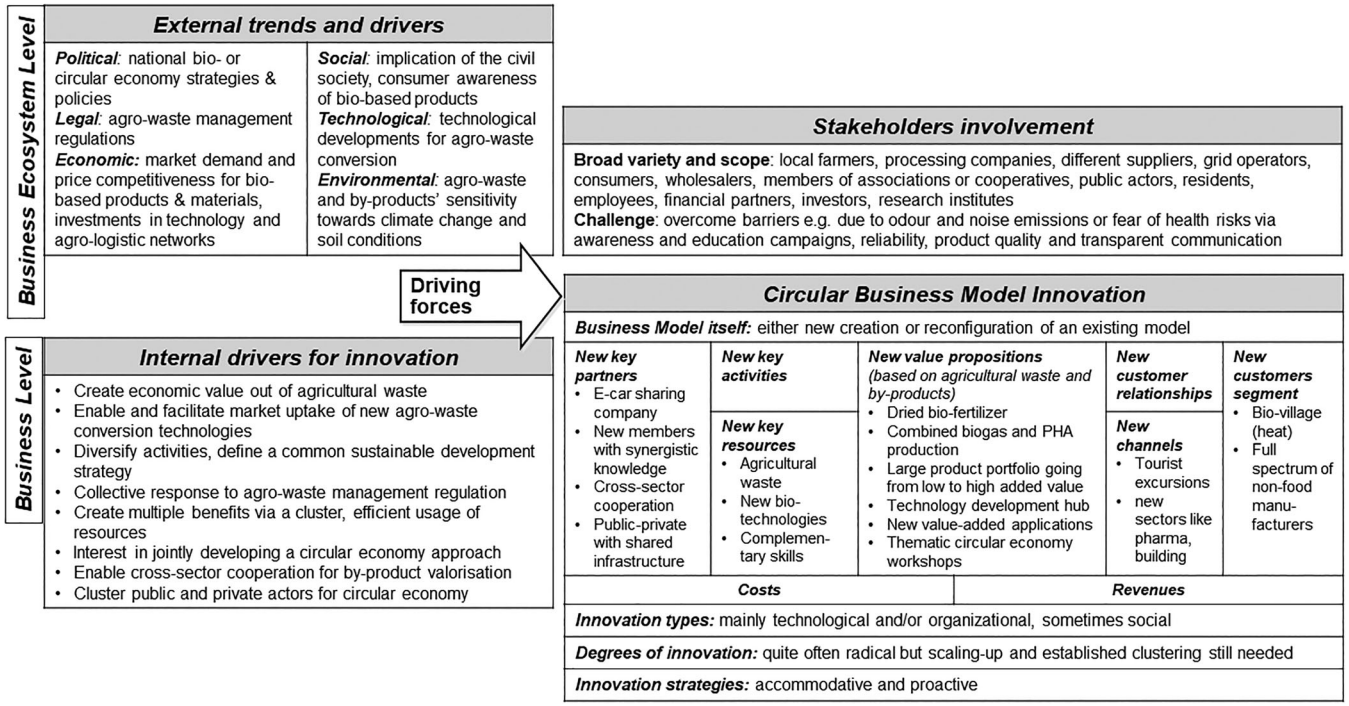



**FIGURE 2** Summary of the main findings

changing logistic supply and demand chains substantially. This case serves as example for national reports on valorising by-products from wineries, receives support from the region and provides input to various teaching courses, overall making it a private-public partnership focused case.

In Case 5, the key trigger in 2002 was to cluster local companies that could benefit from joint waste management, natural resources use and logistics. The objective was to create synergies between agrifood-related companies on a large-scale business park. At the beginning, the focus was on logistics. During the planning process, efficient usage of energy and water became more and more important. Today, cross-sector cooperation and interaction exists between big data-centres that use the electricity produced by greenhouses and deliver their heat for greenhouses. The park is even organising tourist excursion for promotional and educational reasons. The case has shown to transform barren land into a fully operational business park with only private means, hence serves internationally as an exemplary case within the presentations about agriparks.

In Case 6, three people met with sought complementary skills and with a common objective to implement a circular economy with new technological developments around an existing biogas plant, in order to keep it profitable. The entrepreneurs were thus discussing about closing loops, circular economy, individual and common companies' demands and supplies, and how to create and use synergies. The joint business was founded in 2016 with the ambition to attract investors and partners like the public utility for electricity and for the drying of herbs via locally produced heat. The ambition was to create 'modules' to be marketed such as algae and humus mainly via a technology development hub, followed by the production of fruit, vegetables and fish locally in a $CO_2$ neutral manner by the use of biological nutrient cycles.

The aim in Case 7 was to bring people from different sectors together and inform them about value-adding valorisation opportunities for cereal by-products. In 2015, the actual joint association was created collecting by-products of various cereals for different applications of hulled grain such as rice, spelt, buckwheat and barley in a new sector, in particular the building sector. This association has become a catalyst attracting many individual actors because it has developed quality schemes, a portfolio of technical characteristics, treatments and construction procedures, and networks of actors; in addition, the know-how is continuously updated thanks to cooperation with nearby research centres. It is thus working as an intermediate between two usually separate sectors, namely, agriculture and construction.

Case 8 is the only public initiative with the objective to cluster different public and private actors for sustainable development and circular economy practices in a rural area. It was initially based on a local cluster of small organic food enterprises. With the increasing demands for sustainability and circular economy, including the valorisation of urban food waste and agricultural by-products, the cluster was reoriented and expanded. It now covers also biogas production and waste treatment, benefiting from financial support of local public, commercial and environmental bodies. The initiative is original in the sense that it brings various actors with different orientations together under the circular economy header.

From these cases, it can be concluded that circular BMI can be triggered by diverse case-specific reasons, either by economic, environmental and/or social objectives or a combination of those, or because of legal obligations. But all cases have in common that they

aim to convert agricultural waste into value added products (bio-materials, food, fertilisers, feed and bio-energy) and to efficiently use all resources from the agricultural production (by-products, water and energy). Very often, this is done by bringing together complementary knowledge, resources, novel (bio-)technological know-how and in particular also actors. Innovative cross-sector and/or public-private cooperation as well as local clustering of actors have been evolving allowing jointly co-creating circular economy concepts.

### 4.2 | The business ecosystem: An overall view on stakeholders involved and external drivers

Regarding the types of *stakeholders* directly involved or concerned by initiatives turning agricultural waste into value, the case studies show that their variety and scope is rather broad. They encompass direct local actors such as farmers that deliver agricultural residues or buy bio-fertilisers, associated processing companies, various types of suppliers, grid operators, consumers, wholesalers, members of an association or cooperative, public actors, local residents, employees, financial partners or investors and research institutes. External stakeholders are in several cases (Cases 2, 3, 4 and 5) also international public and private interest groups willing to learn via cooperation or consulting from the European businesses. Challenges (regarding stakeholders) concern above all awareness and education campaigns, particularly towards local residents often being against biogas or biorefinery installations due to odour and noise emissions or fear of health risks (Cases 1, 3, 4 and 6). In order to convince and/or involve suppliers, members, wholesalers, consumers and residents, reliability, product quality and a good and transparent communication are expected and important. Also, local benefits and participatory actions with residents may overcome these barriers.

Results from the business ecosystem level analysis including general trends and drivers are described at a political, legal, economic, social, technological and environmental level.

The *political* level in terms of public national bio- or circular economy strategies and policies plays a crucial role for developing and maintaining agricultural waste valorisation activities. In particular, biogas production is strongly depending on incentives and subsidies, for example, in form of feed-in tariffs (Germany, e.g. Case 1)—being limited to 20 years and constantly decreasing, or co-financing for the construction of biogas plants (France, Case 8) or moving from subsidies for agricultural waste to urban waste (Italy, topic in discussion, e.g. Case 2). Closely related to the political level are *legal* conditions that define the rules and boundary conditions for agricultural waste recovery, management and valorisation pathways. For example, the removal of the obligation to deliver wine by-products to a distillery in France in 2014 has an impact on the waste quantities to be collected (e.g. Case 4), or in Italy, it is legally not allowed to mix agricultural waste with food waste. In Germany, the Renewable Energy Sources Act in 2012 has impacted the biogas production, as the use of maize as feedstock for anaerobic digestion has been limited to 60%. At an *economic* level, the demand and general performance of markets for the existing or potentially entering materials, products or services, competitiveness in terms of quantities and prices, long-term investments in technological facilities (e.g. Case 3) or an agri-logistic network (Case 5) are determining conditions. Here, actors in all countries indicate that is it not only necessary to analyse existing market trends but also estimate future developments (e.g. market opportunities, environmental restrictions and social perceptions). The *social* level concerns, for example, the implication of the civil society and awareness raising for bio-based products and services, something which is only in its infancy stage. First examples are the (bio-)energy villages (Case 1) and the co-construction of houses with biomaterials (Case 7, France). In contrast, *technological* conditions for agricultural waste conversion into biogas are in general rather well developed and mature technologies are available on the markets, but continuous improvement and learning by users (e.g. for biogas installations) is needed (e.g. Cases 1, 6 and 8). The technological conditions for agricultural waste conversion in a cascading manner for multiple and diversified end-products are less well developed; at laboratory or pilot scale, first potential technological concepts are elaborated (Cases 2, 3, 4 and 6). However, mature technologies at appropriate scales and targeted at a wide range of functional properties of products are still to be researched and explored (authors, 2020). At the *environmental* level, agricultural waste and by-products partly suffer from a high sensitivity towards climate change and extreme weather conditions like elevated temperatures, periodic flooding and extended periods of dryness (e.g. wine by-products and livestock—manure). Also, soil conditions are impacting the agricultural waste conversion strategy or valorisation pathways like for organic production (Case 8).

Figure 2 summarises the main findings: external trends and drivers, stakeholders involved, internal drivers for innovation and innovations at the business model level.

## 5 | DISCUSSION AND IMPLICATIONS

Here, the results and their conceptual and management implications are discussed while coming back to the three questions from the introduction.

(i) With regard to the first question 'What types of circular business model innovations exist in the agricultural sector?', results indicate that business model innovation for a circular economy in this sector depends on various case-specific drivers (Figure 2), wherein the business ecosystem plays a crucial role, as earlier highlighted by Antikainen and Valkokari (2016). These drivers lead to different types of innovations for adding value to agricultural waste at the business level, concerning either the overall business model or single business model elements. Table 3 has shown that there are two ways of innovating the *overall business model*. The first are entirely new start-ups in the form of limited liability companies or an association, with proactive strategies and directly focusing on agricultural waste and by-product valorisation (Cases 2, 5 and 7); they all have already either a simple network structure itself or are embedded in a network. The second are business reconfigurations and evolutions from rather

classical farm or food processing activities to specialised companies and integrated business parks choosing for circular economy approaches (Cases 1, 3, 4, 6 and 8). The latter follow mainly accommodative strategies, as they change and improve the business model by addressing environmental and/or social objectives. However, Cases 3 and 6 can also partly be considered as proactive as they create new circular economy clusters. Concerning single *business model elements*, innovations were found in the form of new or higher value-added products, applications, materials or ingredients, all based on the principle to turn agricultural waste into new value propositions (Perey, Benn, Agarwal, & Edwards, 2018; Zucchella & Previtali, 2019). But there are also combined new value propositions (product, service and/or technology (platforms), via co-creating new partnerships and (public–private) cooperation with joint investments and for a better resource efficiency, new customers or distribution channels. Overall, technological often precede organisational and social innovations, but a combination is also increasingly appearing. The degrees of innovation for the cases are four times radical and three times incremental for both technological and organisational innovations, whereas there is only one radical social innovation. This is not surprising as within the domain of agricultural waste valorisation, technological developments at least for high-value adding conversion pathways are still ongoing and often not yet in mature stages or asking for scaling-up. However, also organisational innovation types are imperative to realise opportunities for agricultural waste valorisation since the complexities and diversities in resources, products, technologies and markets for individual companies are too substantial (Cases 1, 2, 3, 5, 6, 7 and 8). These then require follow-up joint technological (or even logistical and social) innovations to remain competitive in economic terms because social and environmental values are generally not compensating economic value today.

(ii) These observations lead us to a new conceptual framework (Figure 4) for discussing our second question: 'Is agribusiness model innovation for a circular bio-economy different from the linear economy?' This framework partly fills in the gap in circular BMI literature in the context of agriculture as mentioned by Barros et al. (2020).

A traditional linear agribusiness model can be positioned within three circles (Figure 3). The first and tiniest circle is the circle of 'control' in which the individual business is able to manage and steer its business strategy and operations. The second, somewhat larger circle, is the circle of influence in which the key customers, clients and consumers are situated. It is entitled 'circle of influence' due to the mutual exchanges and adaptations of actions. The largest circle is the circle of 'appreciation' of the wider ecosystem and contextual macro-environment; here, the wider social and economic trends and global agricultural and trade policies and laws are to be appreciated and accepted as the framework conditions for business operations.

Our findings indicate that new circular business models, corresponding to sustainable and circular bio-economy strategies, are changing the representation of the three circles (Figure 4). First, results suggest that the rather simple representation of the *control circle* should be adapted as many individual business models are to be integrally considered with complementary new key resources (agricultural waste, biotechnologies and complementary skills). Next, an *additional second circle* is now emerging in which joint activities and synergies with partners in a cluster are taken into account, leading to new value propositions (all cases). This means that the 'sharing' of business activities is now becoming the dominant circle of a circular business system, still incorporating many tiny small circles representing the individual business 'control' units; this zone we entitle 'co-creation zone'. The results show that co-creation is observed in joint, efficient handling of key resources, cascading processes for multiple resources and products (Cases 2, 3, 4 and 6), shared logistics and infrastructure (Cases 2, 3, 4, 5 and 6), common value propositions and agreements (all cases), new cross-sector partners and networks (Cases 2, 3, 5, 6, 7 and 8), joint (training) events, matching complementary knowledge and know-how (Cases 2, 3, 6, 7 and 8). The *third circle*—called 'influence'—also changes due to (i) a wider zone of influence of a cluster towards other multiple customers, channels and segments or clusters and markets as well as (ii) a joint responsibility for interactively reaching solutions for a circular and sustainable bio-economy. It is here where new value propositions connect to new opportunities, providing a kind of continuum between co-creation and influence. We therefore have made visible in Figure 4 that 'partners in a cluster', which are directly involved in the circular business model, and stakeholders, which are indirectly involved but still influence the business, mutually interact. This well aligns new value propositions and new, sustainable, opportunities.

Finally, the *fourth and largest circle* is in its overall meaning not modified. The wider political, legal, environmental and social context (the business eco-system) remains to be appreciated; however, it should be interpreted in a more sustainable way to foster both

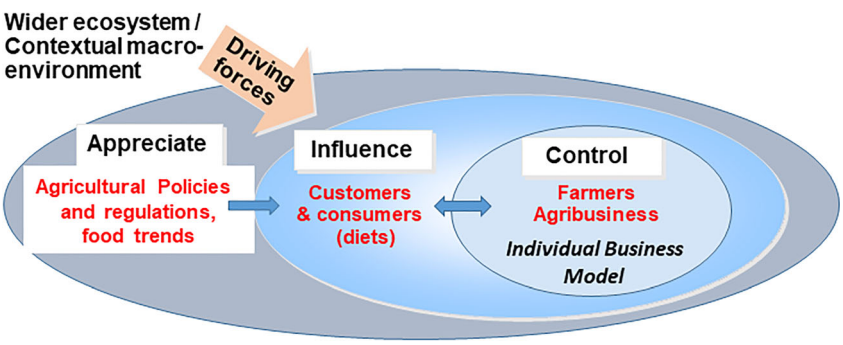



**FIGURE 3** Simplified scheme for (agri) business in a linear chain
Source: own design, inspired by Shell "Scenarios - an explorer's guide" (2008; www.shell.com/scenarios)

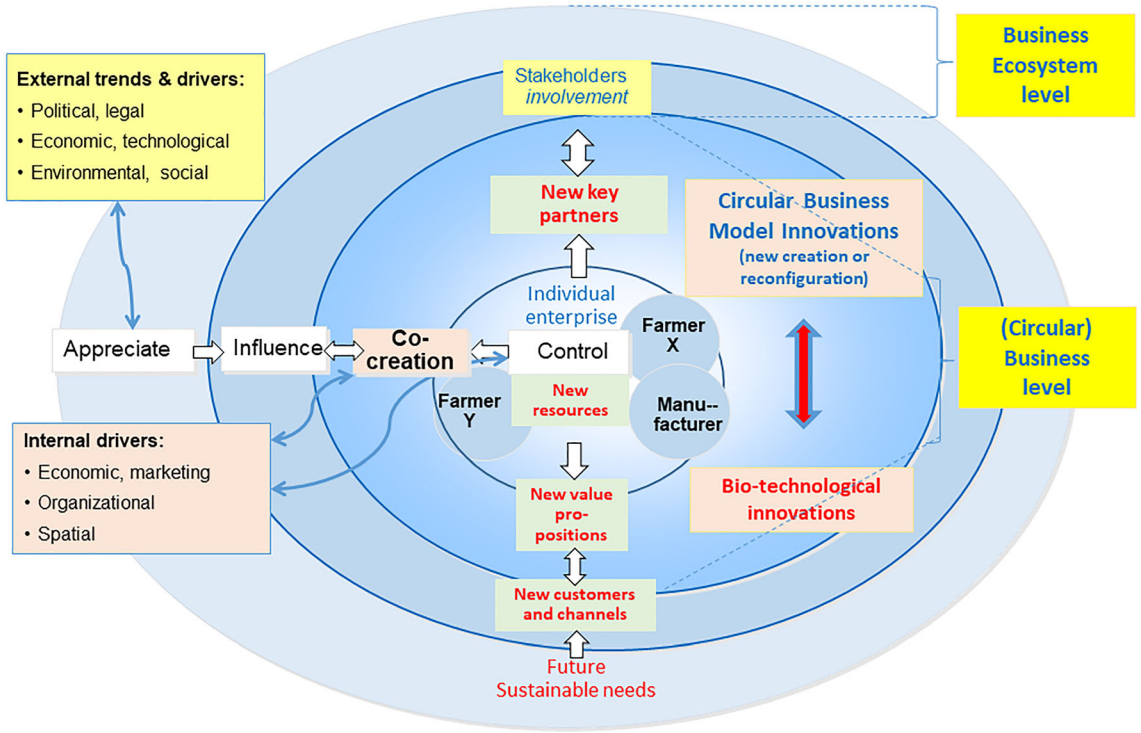



**FIGURE 4** New conceptual framework for Circular Business Model Innovation in the agrifood domain
Source: own design

economic development and preserving natural resources. For example, the limits or uncertainties about biogas subsidies are an external driver for innovation, which seems to be appreciated (accepted) by firms (Cases 1 and 2), innovating their business model towards new 'green' products (e.g. targeted fertilisers), new markets and/or a new 'intermediate' organisational type (e.g. consultancy and pilot-scale offerings). However, this institutional-legal driver can also be considered as an opportunity to adapt, by heading towards a new clustered circular business model with organisational-technological innovations locally (Case 6, 8 and Case 3, at a larger scale). Environmental drivers can have a similar effect, leading to new collaborations and synergies between different local actors (Case 5). Also a 'sharing or co-creation by nature' business model such as a cooperative (Case 4) can be driven by changing environmental conditions, like periods of extreme droughts negatively impacting production yields, or the need to stay competitive and resilient in case of insufficient available local resources. Giving just responses to environmental and social challenges is not given for granted and may need time to mature; economic robustness is not yet always reached (Cases 7 and 8). Hence, business model adaption and/or innovation for more circularity because of external changes is far from trivial due to many more uncertainties and options in products, markets, regulations and actors as compared with changing linear chains.

Figure 4 shows the new conceptual framework for circular business model innovations connected to bio-technological innovations in the agrifood sector, in which the co-creation zone is emerging. The main findings (cf. Figure 2) are here integrated.

The proposed new circular business model conceptual framework reflects well the results of our case studies on circular business model innovation in the agricultural sector, in particular for an efficient usage of new resources. It helps in clarifying insights from former studies on circular economy and sustainable business model innovation, highlighting the increased importance of the wider ecosystem and the more complex interactions between the macro- and micro-level (Antikainen & Valkokari, 2016), but also the meso-level of cooperation and partnerships (e.g. Boons & Lüdeke-Freund, 2013). On the other hand, it becomes evident that the implementation of circular bioeconomy at the business model level is often still immature, although various businesses show the need and/or willingness to jointly adapt and innovate in order to switch the linear to a circular logic. The described cases are relatively recent evolutions; hence, circular BMI can indeed be considered as recent field of research (Ferasso et al., 2020).

(iii) Our third question 'What would be needed for more radical innovations in the agrifood domain leading to more circularity?' is also challenging and very much depending on local playing grounds, regulations, incentives, actors, resources, products and local-to-global markets. Even more, it asks for 'dynamic capability' to cope with major external environment changes as outlined by Zott et al. (2011) and Teece (2018). For local circularity in the agrifood domain, downsizing of technologies for in-field application, capability of handling agricultural resources variability and mixed scales (in volumes and in potential market values), new entrepreneurship and interventions of intermediates, new public-private cooperation models and in some

cases connections with local or nearby communities seem important (Cases 2, 6, 7 and 8). Consequently, as compared with linear chains focusing on a straightforward main product or value proposition, here, both the organisational and the technological complexity are substantially enlarged. In order to avoid chaos and well steer business, leadership is asked next to shared ambitions and a well-organised management process for changing or developing a new business model. More diverse market-focused, flexible, eco-friendly technological innovations as compared with technologies for high throughput, high volume, single resource orientations are looked for (Cases 1, 2, 3 and 4). This also asks for social and organisational innovations—as well as product and technology innovations—that are redesigned such that applicability could be maintained and handled after first, second, third and so forth usages; even suppliers become clients and vice versa, hence the underlined interactivity (double arrow) between these in Figure 4. This is fully in line with the circular economy defined by EMF (2015) as 'an industrial system that is restorative or regenerative by intention and design'. New organisational networks and technology innovations are needed for large-scale re-usage of energy and water, however, need to go together with logistic innovations (Cases 3 and 5). The social innovation dimension is less visible but may require involvement of citizens at local level. We summarise the main management recommendations and potential implications in the following Table 4.

**TABLE 4** Management recommendations and implications, in particular for the agrifood sector

| No. | Recommendations | Potential management implications |
|---|---|---|
| 1 | Investing in and learning from circular BMI case studies in different external settings/areas, both in agrifood and other sectors related to the wider bio-economy (Tables 1, 2 and 3) | Putting in place management processes that analyse how business models evolve under various external & internal factors, in particular also considering seasonality, heterogeneity of agricultural resources, quality decay and so forth. |
| 2 | Exploiting case studies with other stakeholders in the bio-economy, either directly involved or impacted by valorising co-products and waste, for getting insights while utilising a common framework (Figures 1 and 2) | Motivating stakeholders to be involved in reaching appropriate circular BMI in the bio-economy via a generic approach and a common framework. |
| 3 | Exploiting the conceptual framework (Figure 4) to consistently explore and optimise sustainable bio-economy system approaches as compared with linear chains (Figure 3) | A continuous monitoring of outcomes for guiding and optimising next actions to most efficiently utilise natural resources. |
| 4 | Creating a European-wide or even global platform for sharing best practices in circular business model innovations in the bio-economy | Creating a management learning network across Europe for circular BMI and how to avoid wasting natural resources. |

## 6 | CONCLUSION

In this article, eight different European business cases, contributing to the transition to a circular and sustainable bio-economy via agricultural waste and by-product valorisation, have been studied regarding their drivers and elements of business model innovation.

Insights from the case studies highlight that business model innovations for a circular bio-economy in the agrifood sector are depending on various drivers and elements. They have to appreciate the (i) macro-environmental institutional and legal conditions and market trends, (ii) are driven by economic, environmental or social objectives or a combination of those, but are especially strongly linked to (iii) other actors often from different sectors seeking synergies and (iv) value co-creation via combined organisational and technological innovations (Figure 4). These links between different action levels (Barreiro-Gen & Lozano, 2020) and between business model and technological innovations (Ferasso et al., 2020) have not been clearly shown before in literature on circular economy business models, possibly due to the new area of research (Pieroni et al., 2019).

Our results also indicate that business models in the agrifood domain are obliged to innovate themselves towards new configurations in order to close material loops and switch to a circular economy. These new configurations should incorporate both organisational and technological innovations in order to handle the increased complexity of dealing with diverse resources and sustainable needs. Radical innovations are thus needed addressing concomitantly economic, environmental and social challenges, but also to handle the complexities. Until now, radical technological and organisational innovations in the agrifood sector are still rare; they have often difficulties reaching marketable scales and becoming economically viable. Fully closing cycles for agri-resources and creating value for (new) markets via cascading pathways for all main and co-products is far from easy. Hence, business model innovation should concern innovations of the business concept itself, including both radical technological and organisational innovations in which the relations between new technology developments, business change and new ways of cooperation arise.

### ACKNOWLEDGEMENTS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement no. 688338. The authors especially thank the colleagues from WP5 who contributed to the data collection and the enterprises for the interviews.

## REFERENCES


Amit, R., & Zott, C. (2012). Creating value through business model innovation. *MIT Sloan Management Review*, *53*, 41–49.

Antikainen, M., & Valkokari, K. (2016). A framework for sustainable circular business model innovation. *Technology Innovation Management Review*, *6*(7), 5–12. http://timreview.ca/article/1000, https://doi.org/10.22215/timreview/1000

Barreiro-Gen, M., & Lozano, R. (2020). How circular is the circular economy? Analysing the implementation of circular economy in organisations. *Business Strategy and the Environment*, *29*, 3484–3494. https://doi.org/10.1002/bse.2590

Barros, M. V., Salvador, R., de Francisco, A. C., & Piekarski, C. M. (2020). Mapping of research lines on circular economy practices in agriculture: From waste to energy. *Renewable and Sustainable Energy Reviews*, *131*, 109958. https://doi.org/10.1016/j.rser.2020.109958

Berg, B. L. (2009). An introduction to content analysis. In B. L. Berg (Ed.), *Qualitative research methods for the social sciences* (pp. 1–15). Boston: Allyn and Bacon.

Birkin, F., Polesie, T., & Lewis, L. (2009). A new business model for sustainable development: An exploratory study using the theory of constraints in Nordic organizations. *Business Strategy and the Environment*, *18*(5), 277–290. https://doi.org/10.1002/bse.581

Bocken, N., Strupeit, L., Whalen, K., & Nußholz, J. (2019). A review and evaluation of circular business model innovation tools. *Sustainability*, *11*(8), 2210. https://doi.org/10.3390/su11082210

Bocken, N. M., De Pauw, I., Bakker, C., & Van Der Grinten, B. (2016). Product design and business model strategies for a circular economy. *Journal of Industrial and Production Engineering*, *33*(5), 308–320. https://doi.org/10.1080/21681015.2016.1172124

Bocken, N. M., & Geradts, T. H. (2020). Barriers and drivers to sustainable business model innovation: Organization design and dynamic capabilities. *Long Range Planning*, *53*(4), 101950. https://doi.org/10.1016/j.lrp.2019.101950

Bocken, N. M. P., Short, S. W., Rana, P., & Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, *65*, 42–56. https://doi.org/10.1016/j.jclepro.2013.11.039

Boons, F., & Lüdeke-Freund, F. (2013). Business models for sustainable innovation: State-of-the-art and steps towards a research agenda. *Journal of Cleaner Production*, *45*, 9–19. https://doi.org/10.1016/j.jclepro.2012.07.007

Boons, F., & McMeekin, A. (Eds.) (2019). *Handbook of sustainable innovation*. Cheltenham: Edward Elgar Publishing. https://doi.org/10.4337/9781788112574

Brown, P. J., & Bajada, C. (2018). An economic model of circular supply network dynamics: Toward an understanding of performance measurement in the context of multiple stakeholders. *Business Strategy and the Environment*, *27*(5), 643–655. https://doi.org/10.1002/bse.2069

Bucherer, E., Eisert, U., & Gassmann, O. (2012). Towards systematic business model innovation: Lessons from product innovation management. *Creativity and Innovation Management*, *21*(2), 183–198. https://doi.org/10.1111/j.1467-8691.2012.00637

Casadesus-Masanell, R., & Ricart, J. E. (2010). From strategy to business models and onto tactics. *Long Range Planning*, *43*(2–3), 195–215. https://doi.org/10.1016/j.lrp.2010.01.004

Centobelli, P., Cerchione, R., Chiaroni, D., Del Vecchio, P., & Urbinati, A. (2020). Designing business models in circular economy: A systematic literature review and research agenda. *Business Strategy and the Environment*, *29*(4), 1734–1749. https://doi.org/10.1002/bse.2466

De Giacomo, M. R., & Bleischwitz, R. (2020). Business models for environmental sustainability: Contemporary shortcomings and some perspectives. *Business Strategy and the Environment*, *29*, 3352–3369. https://doi.org/10.1002/bse.2576

De Massis, A., & Kotlar, J. (2014). The case study method in family business research: Guidelines for qualitative scholarship. *Journal of Family Business Strategy*, *5*(1), 15–29. https://doi.org/10.1016/j.jfbs.2014.01.007

De Reuver, M., Bouwman, H., & MacInnes, I. (2009). Business models dynamics for start-ups and innovating e-businesses. *International Journal of Electronic Business*, *7*(3), 269–286. https://doi.org/10.1504/IJEB.2009.026530

Donner, M., Gohier, R., & De Vries, H. (2020). A new circular business model typology for creating value from agro-waste. *Science of the Total Environment*, *716*, 137065. https://doi.org/10.1016/j.scitotenv.2020.137065

Ehret, M., Kashyap, V., & Wirtz, J. (2013). Business models: Impact on business markets and opportunities for marketing research. *Industrial Marketing Management*, *42*(5), 649–655. https://doi.org/10.1016/j.indmarman.2013.06.003

Elkington, J. (1998). *Cannibals with forks: The triple bottom line of 21st century business* (p. 416). Gabriola Island, B.C., Canada: New Society Publishers.

Ellen MacArthur Foundation. (2013). Towards the circular economy. Economic and business rationale for an accelerated transition. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf. Last accessed on 29/08/2019

Ellen MacArthur Foundation. (2015). Growth within: A circular economy vision for a competitive Europe. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Growth-Within_July15.pdf. Last accessed on 29/08/2019

Esposito, B., Sessa, M. R., Sica, D., & Malandrino, O. (2020). Towards circular economy in the Agri-food sector. A systematic literature review. *Sustainability*, *12*(18), 7401. https://doi.org/10.3390/su12187401

Evans, S., Vladimirova, D., Holgado, M., Van Fossen, K., Yang, M., Silva, E. A., & Barlow, C. Y. (2017). Business model innovation for sustainability: Towards a unified perspective for creation of sustainable business models. *Business Strategy and the Environment*, *26*(5), 597–608. https://doi.org/10.1002/bse.1939

Ferasso, M., Beliaeva, T., Kraus, S., Clauss, T., & Ribeiro-Soriano, D. (2020). Circular economy business models: The state of research and avenues ahead. *Business Strategy and the Environment*, *29*, 3006–3024. https://doi.org/10.1002/bse.2554

Ferreira, F. N. H., Proença, J. F., Spencer, R., & Cova, B. (2013). The transition from products to solutions: External business model fit and dynamics. *Industrial Marketing Management*, *42*(7), 1093–1101. https://doi.org/10.1016/j.indmarman.2013.07.010

Food and Agricultural Organisation of the United Nations. (2015). *Food wastage footprint & climate change*. Rome: UN FAO. http://www.fao.org/3/a-bb144e.pdf. Last accessed on 17/03/2020

FoodDrinkEurope. (2020). FoodDrinkEurope statement on the circular economy action plan. https://www.fooddrinkeurope.eu/news/statement/fooddrinkeurope-statement-circular-economy-action-plan/. Last accessed on 16/07/2020

Foss, N. J., & Saebi, T. (2017). Fifteen years of research on business model innovation: How far have we come, and where should we go? *Journal of Management*, *43*(1), 200–227. https://doi.org/10.1177/0149206316675927

Geissdoerfer, M., Savaget, P., Bocken, N. M., & Hultink, E. J. (2017). The circular economy–a new sustainability paradigm? *Journal of Cleaner Production*, *143*, 757–768. https://doi.org/10.1016/j.jclepro.2016.12.048

Geissdoerfer, M., Vladimirova, D., & Evans, S. (2018). Sustainable business model innovation: A review. *Journal of Cleaner Production*, *198*, 401–416. https://doi.org/10.1016/j.jclepro.2018.06.240

Ghisellini, P., Cialani, C., & Ulgiati, S. (2016). A review on circular economy: The expected transition to a balanced interplay of environmental and economic systems. *Journal of Cleaner Production*, *114*, 11–32. https://doi.org/10.1016/j.jclepro.2015.09.007

Homrich, A. S., Galvao, G., Abadia, L. G., & Carvalho, M. M. (2018). The circular economy umbrella: Trends and gaps on integrating pathways. *Journal of Cleaner Production*, *175*, 525–543. https://doi.org/10.1016/j.jclepro.2017.11.064

Jurgilevich, A., Birge, T., Kentala-Lehtonen, J., Korhonen-Kurki, K., Pietikäinen, J., Saikku, L., & Schösler, H. (2016). Transition towards circular economy in the food system. *Sustainability*, *8*(1), 69. https://doi.org/10.3390/su8010069

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, *127*, 221–232. https://doi.org/10.1016/j.resconrec.2017.09.005

Korhonen, J., Honkasalo, A., & Seppälä, J. (2018). Circular economy: The concept and its limitations. *Ecological Economics*, *143*, 37–46. https://doi.org/10.1016/j.jclepro.2017.12.111

Krippendorff, K. (2004). *Content analysis: An introduction to its methodology*. Thousand Oaks, CA.: Sage.

Linder, M., & Williander, M. (2017). Circular business model innovation: Inherent uncertainties. *Business Strategy and the Environment*, *26*(2), 182–196. https://doi.org/10.1002/bse.1906

Lopez, F. J. D., Bastein, T., & Tukker, A. (2019). Business model innovation for resource-efficiency, circularity and cleaner production: What 143 cases tell us. *Ecological Economics*, *155*, 20–35. https://doi.org/10.1016/j.ecolecon.2018.03.009

Lüdeke-Freund, F. (2020). Sustainable entrepreneurship, innovation, and business models: Integrative framework and propositions for future research. *Business Strategy and the Environment*, *29*(2), 665–681. https://doi.org/10.1002/bse.2396

Lüdeke-Freund, F., Gold, S., & Bocken, N. M. (2019). A review and typology of circular economy business model patterns. *Journal of Industrial Ecology*, *23*(1), 36–61. https://doi.org/10.1111/jiec.12763

Magretta, J. (2002). Why business models matter. *Harvard Business Review*, *80*, 3–8.

Massa, L., & Tucci, C. L. (2013). Business model innovation. *The Oxford Handbook of Innovation Management*, *20*(18), 420–441.

Mentink, B. (2014). Circular business model innovation: a process framework and a tool for business model innovation in a circular economy. Master thesis, University of Leiden, NL. https://repository.tudelft.nl/islandora/object/uuid%3Ac2554c91-8aaf-4fdd-91b7-4ca08e8ea621. Last accessed on 31/07/2020.

Mitchell, D., & Coles, C. (2003). The ultimate competitive advantage of continuing business model innovation. *Journal of Business Strategy*, *24*(5), 15–21. https://doi.org/10.1108/02756660310504924

Murray, A., Skene, K., & Haynes, K. (2017). The circular economy: An interdisciplinary exploration of the concept and application in a global context. *Journal of Business Ethics*, *140*(3), 369–380. https://doi.org/10.1007/s10551-015-2693-2

Nußholz, J. L. (2017). Circular business models: Defining a concept and framing an emerging research field. *Sustainability*, *9*(10), 1–16. https://doi.org/10.3390/su9101810

Organisation for Economic Co-operation and Development. (1997). *Glossary of environment statistics, studies in methods*. Series F, No. 67. New York: United Nations.

Osterwalder, A., & Pigneur, Y. (2010). *Business model generation: A handbook for visionaries, game changers, and challengers*. Hoboken, New Jersey: John Wiley & Sons.

Pateli, A. G., & Giaglis, G. M. (2005). Technology innovation-induced business model change: A contingency approach. *Journal of Organizational Change Management*, *18*(2), 167–183. https://doi.org/10.1108/09534810510589589

Perey, R., Benn, S., Agarwal, R., & Edwards, M. (2018). The place of waste: Changing business value for the circular economy. *Business Strategy and the Environment*, *27*(5), 631–642. https://doi.org/10.1002/bse.2068

Pieroni, M. P., McAloone, T., & Pigosso, D. A. (2019). Business model innovation for circular economy and sustainability: A review of approaches. *Journal of Cleaner Production*, *215*, 198–216. https://doi.org/10.1016/j.jclepro.2019.01.036

Pucihar, A., Lenart, G., Kljajić Borštnar, M., Vidmar, D., & Marolt, M. (2019). Drivers and outcomes of business model innovation—Micro, small and medium-sized enterprises perspective. *Sustainability*, *11*(2), 344. https://doi.org/10.3390/su11020344

RESEDA. (2017). Enquête 2017 - Gisements et valorisations des coproduits des industries agroalimentaires.

Rood, T., Muilwijk, H., & Westhoek, H. (2017). Food for the circular economy. PBL Netherlands Environmental Assessment Agency. https://www.pbl.nl/sites/default/files/cms/publicaties/PBL-2017-Food-for-the-circular-economy-2878.pdf. Last accessed on 29/08/2019.

Schaltegger, S., Hansen, E. G., & Lüdeke-Freund, F. (2016). Business models for sustainability: Origins, present research, and future avenues. *Organization & Environment*, *29*(1), 3–10. https://doi.org/10.1177/1086026615599806

Schaltegger, S., Lüdeke-Freund, F., & Hansen, E. G. (2012). Business cases for sustainability: The role of business model innovation for corporate sustainability. *International Journal of Innovation and Sustainable Development*, *6*(2), 95–119. https://doi.org/10.1504/IJISD.2012.046944

Science Advice for Policy by European Academies. (2020). A sustainable food system for the European Union. https://www.sapea.info/topics/sustainable-food/. Last accessed on 29/07/2020.

Souto, J. E. (2015). Business model innovation and business concept innovation as the context of incremental innovation and radical innovation. *Tourism Management*, *51*, 142–155. https://doi.org/10.1016/j.tourman.2015.05.017

Stewart, R., & Niero, M. (2018). Circular economy in corporate sustainability strategies: A review of corporate sustainability reports in the fast-moving consumer goods sector. *Business Strategy and the Environment*, *27*(7), 1005–1022. https://doi.org/10.1002/bse.2048

Stubbs, W., & Cocklin, C. (2008). Conceptualizing a "sustainability business model". *Organization & Environment*, *21*(2), 103–127. https://doi.org/10.1177/1086026608318042

Taran, Y., Boer, H., & Lindgren, P. (2015). A business model innovation typology. *Decision Sciences*, *46*(2), 301–331.

Teece, D. J. (2010). Business models, business strategy and innovation. *Long Range Planning*, *43*(2–3), 172–194. https://doi.org/10.1016/j.lrp.2009.07.003

Teece, D. J. (2018). Business models and dynamic capabilities. *Long Range Planning*, *51*(1), 40–49. https://doi.org/10.1016/j.lrp.2009.07.003

Todeschini, B. V., Cortimiglia, M. N., Callegaro-de-Menezes, D., & Ghezzi, A. (2017). Innovative and sustainable business models in the fashion industry: Entrepreneurial drivers, opportunities, and challenges. *Business Horizons*, *60*(6), 759–770. https://doi.org/10.1016/j.bushor.2017.07.003

Ünal, E., Urbinati, A., Chiaroni, D., & Manzini, R. (2019). Value creation in circular business models: The case of a US small medium enterprise in the building sector. *Resources, Conservation and Recycling*, *146*, 291–307. https://doi.org/10.1016/j.resconrec.2018.12.034

Velenturf, A. P., Archer, S. A., Gomes, H. I., Christgen, B., Lag-Brotons, A. J., & Purnell, P. (2019). Circular economy and the matter of integrated resources. *Science of the Total Environment*, *689*, 963–969. https://doi.org/10.1016/j.scitotenv.2019.06.449

Venkata Mohan, S. V., Nikhil, G. N., Chiranjeevi, P., Reddy, C. N., Rohit, M. V., Kumar, A. N., & Sarkar, O. (2016). Waste biorefinery models towards sustainable circular bio-economy: Critical review and future perspectives. *Bioresource Technology*, *215*(2–12), 2–12. https://doi.org/10.1016/j.biortech.2016.03.130

Voss, C., Tsikriktsis, N., & Frohlich, M. (2010). Case research in operations management. *International Journal of Operations & Production Management*, *22*(2), 195–219. https://doi.org/10.1108/01443570210414329

Yin, R. K. (2009). *Case study research: Design and methods (applied social research methods)*. London and Singapore: Sage.

Zott, C., Amit, R., & Massa, L. (2011). The business model: Recent developments and future research. *Journal of Management*, *37*(4), 1019–1042. https://doi.org/10.1177/0149206311406265

Zucchella, A., & Previtali, P. (2019). Circular business models for sustainable development: A "waste is food" restorative ecosystem. *Business Strategy and the Environment*, *28*(2), 274–285. https://doi.org/10.1002/bse.2

**How to cite this article:** Donner M, de Vries H. How to innovate business models for a circular bio-economy? *Bus Strat Env*. 2021;1–16. https://doi.org/10.1002/bse.2725