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Sustainability in Farming Businesses: How Do Business Models Embrace the Principles of the Circular Economy?

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Abstract. In modern society, where sustainability is becoming increasingly important, many farming businesses are introducing circularity into their traditional business models through radical changes and innovative technology that bring a new way to do business. The production of biogas is an example of a circular business model that aims to produce renewable energy to reduce dependence on fossil fuels and to reach zero waste.
Our study aims to discover how a farming business implements circularity into its strategy and which practices are integrated into its traditional business model. This transition is possible through fundamental factors such as incentives and collaboration. We analysed Alfa's business model through a qualitative approach, applying the Business Model Canvas framework to represent its core and circular components.
Findings suggest that the traditional BMC framework's nine building blocks fall to fully capture the circular economy practices of a biogas plant, lacking a systemic perspective on circularity.

Keywords: agri-business, business model, sustainability, circular economy, biogas

1 Introduction

In recent years, the agricultural sector has changed to adopt more sustainable practices because environmental problems are becoming increasingly important (Swaffield et al., 2019). Circularity innovates business models and enhances productivity and profitability while contributing to ecological sustainability (Poponi et al., 2023). The final target is integrating sustainability into the company's business model (Evans et al., 2017) to face problems such as the energy crisis and dependence on fossil fuels that have become more important after the Russia-Ukraine war (Stempfle et al., 2022).
The evolution of business models towards circularity in farming business unfolds through iterative experimentation, learning, and adaptation processes: initially, firms engage in waste mapping exercises to identify sources of organic waste such as crop residues, animal manure, and food processing by-products (Hofmann and Knyphausen-Aufseβ, 2022). Technological innovations such as anaerobic digestion and biomass gasification convert organic waste into biogas, a renewable energy source, and other value-added products (Antoniou et al., 2019).
Collaborative partnerships among stakeholders such as farmers, technology providers, energy utilities, and policymakers are fundamental to integrating circularity into the firm. (Primdahl et al., 2013; Su et al., 2022). Moreover, for farming businesses, it could be possible to adopt the governance form of a

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cooperative (Schaltegger et al., 2016) or a public-private network (Karlsson et al., 2017; Karlsson et al., 2019; Evans et al., 2017), to reach profitability.
The shape of business models' evolution in farming businesses is influenced by external factors, including regulatory frameworks, market dynamics, and societal expectations (Su et al., 2022). Indeed, policy interventions such as renewable energy incentives, provided by EU legislature to farmers to invest in the renewable energy sector (Sgroi et al., 2018), and carbon pricing mechanisms are pivotal in investing in biogas plants and encourage circular economy initiatives in agriculture (Thrän et al., 2020).

This paper aims to examine, through a case study, how a farming business model evolves by implementing circular economy principles into its strategy.
A qualitative analysis is suitable for investigating this phenomenon. Indeed, using this approach can be particularly helpful in analysing how circularity is integrated into the business model of the investigated company. Few studies have adopted a case study approach to explore how sustainability is integrated into farming businesses. This leaves a gap in understanding the specific strategies and challenges involved. A qualitative approach and, specifically, case studies offer a detailed perspective, capturing the real-world application of sustainable practices.
Our research question is: *"Which components of circularity could be integrated within a traditional business model of a farming business?"*
The article continues as follows: section 2 presents the literature background with an explanation of concepts such as business models, business models for sustainability, circular economy, and circular business models; section 3 presents the analysis of the case study; section 4 uses the Business Model Canvas to analyse the case study; section 5 describes the discussion, while section 6 contains the conclusion of this study.

2 Literature Background

Early business models were invented at the end of the 20th Century, following the Internet boom and the spread of new forms of businesses, such as e-commerce (Schaltegger et al., 2016).
There are different definitions of BMs linked above all the strategy literature. The BM has three critical components: (i) the value proposition, which is the set of products or services that the company desires to sell to its customers; (ii) the value creation and delivery system, which indicates the method used by the company to create and deliver value to its customers, and (iii) the value capture, which regards how a company generates revenue and profit from its business. (Richardson, 2008).
According to Osterwalder 2004 (Osterwalder, 2004, p. 42), a BM can be divided into four areas: (i) product, which regards the firm's business and its value proposition; (ii) customer interface, which regards the company's customers, the distribution channels and relationships; (iii) infrastructure management, which includes logistics and infrastructural aspects and partnerships; (iv) financial aspects, regarding the revenue model and the cost structure.
Further research by Osterwalder and Pigneur (2010) focuses on the division of a BM into nine building blocks: (i) value proposition, (ii) customer relationship, (iii) customer segment, (iv) channel, (v) key activities, (vi) key resources, (vii) key partners, (viii) cost structures, and (ix) revenue stream. This is the Business Model Canvas Framework. The value proposition includes the products or services the firm offers, customer relationships, and customer segments; value creation and delivery include key activities, resources, partners, and channels; value capture consists of cost structures and revenue streams.
Schaltegger et al. (2016) introduced the business model for sustainability concept that is defined as "*A business model for sustainability helps describing, analyzing, managing, and communicating (i) a company's sustainable value proposition to its customers, and all other stakeholders, (ii) how it creates and delivers this value, (iii) and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organisational boundaries.*"

The main aim of a BMfS is to achieve economic profit while considering social and environmental issues; moreover, another target is to grant a long-term competitive advantage that allows the generation of environmental and social benefits (Karlsson et al., 2019).
The value should be created for customers, shareholders, and a broader range of stakeholders (Schaltegger et al., 2016). Stakeholders are an essential key to reaching sustainability: it is important to create a good relationship with them by satisfying their needs and aligning their interests with those of the firm. Furthermore, to reach SBMs, society and nature must be treated as stakeholders. Integrating sustainability into BMs means introducing the concept of "network," which can be defined as a group of organisations that come together to achieve a common goal that they are not able to reach singularly, so each member of the network has to rethink its goals to reach a bigger one (Evans et al., 2017). It is crucial to create a network with private and public actors above all in the biogas sector because, often, SMEs lack sufficient resources such as money, skills, know-how, expertise, and competencies to create the biogas plant and to introduce innovations (Karlsson et al., 2017). Creating new governance forms, such as cooperatives or partnerships, could help to maximise profits (Schaltegger et al., 2016).
Circular Economy is "*an industrial economy that is restorative by intention and design*" (Ellen MacArthur Foundation, 2013). CE is based on a closed-loop idea in which the objective is reducing waste by maximising the utility of materials, components, and products (Donner et al., 2020). Its goal is to ensure economic development while protecting the environment and saving resources with the 3R principles: reduction, reuse, and recycling (Zhu et al., 2019). For a company, implementing CE means replacing the existing business model with another innovation, and it is necessary to involve all actors within the supply chain (Donner et al., 2020).
The growing importance of CE in recent years has led to the birth of the Circular Business Models (CBMs) concept, which can be considered a sub-category of sustainable business models that implement CE principles. (Bocken et al., 2014). Bocken et al. (2016) define CBMs as "*business model strategies suited for the move to a circular economy [based on the] taxonomy of slowing, closing, and narrowing resource loops*".
According to Linder and Williander (2017), CBMs simultaneously include the concept of closed-loop chains with recycling, reuse, and manufacturing.
The Circular Business Model differs from the traditional Business Model due to its goals: the first aims to close the energy and material loops while ensuring financial feasibility and granting long-term sustainability. Profits are essential for the firm but not the priority (Donner et al., 2020). Moreover, unlike traditional BM, the value proposition in CBM could include social and environmental values (Kanda et al., 2021). Biogas is relevant as photovoltaic and wind power for energy distribution in rural areas (Sica et al., 2023). Biogas also has drawbacks because it can cause social opposition due to bad smells, land pollution, or competition with food production (Cavicchi, 2016).
Once a BM's architecture is defined, it is challenging for a firm to change it. According to Bocken et al. (2016), "*the move to a circular economy model is an example of a radical change, which will require a new way of thinking and doing business. The more radical the technical or product innovation, the more challenging and the likelihood that changes are required to the traditional business model*". However, to face future challenges of today's dynamic environment, it is necessary to be flexible and adopt changes in BMs (Bocken et al., 2014).
A recent trend in the transition towards circularity in farming businesses is the introduction of biogas or biomethane. Biogas plants can provide socio-economic, environmental, and technological benefits by allowing the circular transition to rural areas, creating new local business opportunities, and generating societal value. Moreover, biogas produces (i) digestate, (ii) electricity energy, and (iii) thermal energy (Stempfle et al., 2022).
Coordination is an essential element that allows the circular transition: indeed, when there are many stakeholders at different stages of the supply chain, coordination and collaboration are essential between partners; otherwise, there could be problems in decision-making (Stempfle et al., 2022).
Feiz et al. (2022) analyse some key factors that should be considered for the site selection of biogas plants. Primary factors are (i) feedstock supply, (ii) digestate demand, (iii) biogas demand, (iv) CO_2

demand, (v) available infrastructure, (vi) existing industries, (vii) land-use and zoning, (ix) socio-political factors.
Brudermann et al. (2015), through a standard SWOT analysis, have identified the biogas plants' strengths, weaknesses, opportunities, and threats. We focus our attention on strengths factors that are: (i) additional source of income, (ii) reduced energy costs through self-provision, (iii) utilisation of available resources, and (iv) recovery of fermentation residuals in agriculture.

3 Research method

The study is based on a qualitative approach through the presentation of a case study, the analysis of interviews and company documentation (e.g. organisational chart, balance sheet, projects).
The interviews were conducted between 2023 and 2024 and involved company representatives and external expert consultants.The interviews were conducted between 2023 and 2024 and involved company representatives and external expert consultants. The participants were carefully selected based on their technical experience within the company Alfa and their understanding of sustainability phenomena. Four interviews were conducted, amounting to approximately five hours, ensuring a thorough exploration of the topic from multiple perspectives.
Each interview was recorded and transcribed for subsequent analysis.
The analysis was carried out through the application of the Business Model Canvas framework by Osterwalder and Pigneur (2010) by coding the information in the interviews and documents with the characteristics of each building block.
Furthermore, the emerging themes in the literature relating to the circular economy were coded to intercept how circularity enters the business model of the Alfa company.
This analysis was conducted through an iterative process between the different researchers, who first analysed and coded the materials independently and, subsequently, through a comparison meeting, verified the consistency of the coded information (Krippendorff, 2004).
Finally, the information was summarised in keywords that populated the BMC building blocks.

3.1 Analysis of the case study

The firm analysed is Alfa, an agricultural company located in Veneto, a region in Northern Italy. It was built more than 50 years ago, and its main activity was livestock breeding and cultivation to produce fodder. Alfa is a consortium owned by a holding, which is the primary customer of Alfa, and its principal business regards the slaughter and the sale of meat.
According to the interviewee, around 2011/2012, "*the company needed modernisation, renovation of the stables*, *and fixed costs were higher than before while profits were low.*" So, "*partners decided to invest in renewable resources such as photovoltaic system on the roofs of the stables and a 1 MW biogas plant between 2011/2012. Furthermore, at the end of 2012, another biogas plant and another photovoltaic system were added*." Feeding the biogas plant uses manure, sewage, and a second harvest of corn and triticale. At the end of 2012, Alfa founded another one-megawatt biogas plant with a dimension larger than the first one, and it is alimented by feedstock like those used in the other plant. Using the manure of chickens, rabbits, and turkeys is also possible. Alfa gets manures from its cattle breeding and those of its partners.
Alfa has identified waste streams derived from agriculture and valorised them through technological innovation. Indeed, through the anaerobic digestion process, the firm has transformed wastes into energy and digestate. The production of electric energy reduces the company's dependence on fossil fuels and fluctuations in energy price; instead, the digestate, comparable to a high-quality fertiliser, allows Alfa to save money because its adoption reduces the use of chemical fertiliser and generates revenue from sales.
Alfa is designing for the future by merging its two biogas plants into one and converting them into biomethane plants due to the end of the duration of incentives for biogas plants.

4 Findings

Alfa, with the adoption of the biogas plant, has changed its previous Business Model by introducing circular economy practices in different ways: (i) the use of animal slurry and fodder waste as the biogas plant's feedstock that allows the creation of electric energy; (ii) the company uses the energy created to operate the system and the excess of power produced is sold to get further revenues; (iii) the use of residual digestate as a soil improver after returning part of it to suppliers as payment.
Alfa has the idea of converting the biogas plant into biomethane, and it wants to add a new experimental plant to transform the digestate into fertiliser. However, some regulatory and other market barriers exist to marketing fertiliser obtained from digestate.

4.1 Analysis of Alfa's Business Model Canvas

Through the interview, we have taken major information about the company and put it into the Business Model Canvas' nine building blocks.
Table 1 contains Alfa Business Model Canvas with its core and circular components of the BM.

Table 1 – Alfa Business Model Canvas: core and circular components of the BM

BMC Building blocks	**Core business characteristics**	**Circular economy-related characteristics**
Value Proposition	Sale of livestock	-Valorisation of animal slurry -Production of biogas -Carbon-negative cycle
Customer relationship	The related company that processes and sells meat	//
Customer segments	Butchers (associated company)	-Energy companies -Digestate buyers
Channels	Direct relationship	//
Key partners	-Livestock suppliers -Members who provide fodder	Suppliers of semi-finished products for supplying the biogas plant
Key activities	-Livestock breeding -Crops for fodder	Redistribution of the digestate
Key resources	-Land -Livestock -Technology	//
Costs	-Purchase of animals -Animal management (stables, medicines, welfare) -Land rental	Digestate spreading cost
Revenues	-Animals for sale -Public financing	-Savings on energy produced by a biogas plant -Sale of part of the digestate

Source: our production.

In the following sub-paragraphs we propose a more analytical explanation of how circularity practices are reported in the business model of the Alfa company:

Value proposition
Initially, Alfa's core business was regarded only as the sale of livestock; indeed, Alfa was born as an agricultural cooperative in 1967 and aimed to valorise agricultural products from breeders. The

interviewee said, "*Without livestock, there would be no biogas plants, and probably, without biogas plants, there would be no livestock farming left*", to emphasise the relationship between livestock and biogas plants. Then, when Alfa decided to install two biogas plants, the value proposition expanded. Now it includes (i) the valorisation of animal slurry, giving it a new value, as it is used as the feedstock of the digester in the production of biogas; (ii) the production of biogas, which is a source of renewable energy that does not exploit fossil fuels; and (iii) the creation of a carbon negative cycle that allows reducing CO_2 and CH_4 emissions. Alfa's brand is "biogas well done", which aims to decarbonise the atmosphere.

Customer relationship
Alfa continues to relate to Beta, the company that processes and sells meat.

Customer segments
Firstly, Alfa's major customers were butchers; now, with the installation of biogas plants, there are other customers such as (i) energy companies to whom Alfa sells electricity energy, and (ii) digestate buyers.

Channels
The channel principally used by Alfa is a direct relationship.

Key partners
Originally, partners were livestock suppliers and members who provided fodder to Alfa; now, there are also suppliers of semi-finished products for supplying the biogas plant. Beta has been Alfa's only client for some years. Alfa chose one butcher (Beta) over other local butchers for simplicity and better management. The interviewee said, "*We allocate all our production to a butcher, but this butcher does not command because it does not become a customer who has the exclusivity but becomes a partner who brings capital*".

Key activities
Before implementing circularity, Alfa's principal activities were livestock breeding and crops for fodder; now, it deals with redistribution of the digestate, which is used as a soil improver, and it allows the firm to do a double harvest so that it can exploit the soil all year.

Key resources
Alfa's major resources are land, livestock, and technology. The last investment in technology regards the Pivot, an irrigation system. It is an underground well where water is injected into the pipe, then sprayed in the fields with sprinklers located every three meters in a pipe that is 450 meters long.

Costs
Farming businesses involve costs regarding the purchase of animals, animal management (stables, medicines, welfare), and land rental. Moreover, Alfa must pay to transport animal slurry to the biogas plant. The part of digestate that is not sold but spreads to the companies that provided manure to Alfa leads to transport and spread costs.

Revenues
Before installing biogas plants, revenues come from selling animals and public financing.
With the introduction of circularity, the principal source of revenue comes from selling energy produced by the production of biogas: each biogas plant of Alfa produces 1000 KW of energy per hour; about 6-7% of this energy is self-consumed by the company to operate the system and to cover utility expenses, while 93-94% is fed into the electricity grid. The firm's second source of revenue is from sales to other companies, and it sells approximately 11% of the digestate, a soil improver whose quality is better than

that of manure and sewage. Instead, the rest of the digestate is spread to the companies that supply manure to Alfa. This leads to spread and transport costs for Alfa.
Regarding revenues from the sale of energy compared to the proceeds from the sale of animals, the interviewee said, "*Last year, the company turnover was 25 million euros: the biogas plant affects 2,2 million, and the photovoltaic system affects 500 thousand euros*".

4.2 Key factors and critical issues of Alfa

Some key factors of the business model that have favoured the implementation of circularity in Alfa regard: (i) the availability of animal slurry at a distance not excessive from the biogas plant that makes transport cost not too expensive, (ii) the presence of incentives essential to cover installation and other costs, (iii) the presence of European intervention such as the Common Agricultural Policy (PAC), (iv) the availability of infrastructure such as electricity grid, necessary to sell the energy produced by the biogas plant, and (v) the location of the biogas plant, far from cities so that the problem of bad smell is avoided.
Instead, some critical aspects that have made difficulty the implementation of circular economy practices regard: (i) it is not always convenient to invest in biogas, (ii) the limited time incentives led to the biogas plant's future uncertainty, and (iii) the strong dependence from the company on financing. As regards the first point, the interview allowed us to understand that nowadays, it is no longer convenient to install a biogas plant: the interviewee said, "*Nowadays, for companies with characteristics like our firm, it is tough to build a biogas plant because the electricity energy produced from the biogas now is non financed as in the past.* […] *Biomethane is spreading* […] *Currently, it is more convenient to produce gas (biomethane) rather than transform it into electric energy*." "*Today, with electric prices such as 8 or 11 cents, with the medium of last ten years (excluding last year), it is impossible to pay plant maintenance. Instead, if we produce biomethane, this is possible because there is a question of certification* […]." Secondly, concerning the incentives, it is important to remember they were granted to meet the 2020 climate change objectives. The incentives last 15 years; Alfa received them in 2012, so from 2027, it may have to convert its plants into biomethane or not; however, it may be necessary to adapt to new future regulations. Thirdly, Alfa's future depends on the intervention of the European Commission with PAC (Common Agricultural Policy). Indeed, the interviewee said, "*There are some years in which, probably the major number of years, if there had not been the PAC, the company would not survive in the medium-long term*." Furthermore, according to some entrepreneurs and colleagues of the interviewee, "*Sometimes you can think that the agricultural company is almost an investee company because, without public funding, the farm would not survive.*"

5 Discussion

Introducing biogas plants in the business model allows Alfa to introduce and improve circular economy practices, such as animal slurry and fodder waste, giving them a new way to be used; otherwise, they would have been disposed of. Furthermore, implementing circularity allows self-produced energy to sell the energy overproduced and the creation of a soil improver that reduces the use of chemical substances, sources of pollution, and emissions.
Farm farming businesses reduce their environmental footprint, diversify revenue streams, and enhance resilience to market fluctuations by valorising waste streams.
Alfa did not limit itself to introducing traditional components typical of farming businesses. However, it has also exploited innovative technology to introduce the pilot plant. This specific plant creates by-products such as pure nitrogen and pure sulphur and enriches digestate to make it a high-quality fertiliser.
As Antoniou et al. (2019) explain, the creation of the biogas plant allows the recycling of animal slurry and the reusing of the digestate, and in this way, it grants zero waste.

This case study shows that the success and the profitability of a biogas plant depend on different factors, such as a good relationship based on trust and collaboration between the different actors such as Alfa, the owner Beta, farmers, actors that deal with the transport of animal slurry, fodder and digestate. Some critical factors have been discussed in the literature: for example, Sgroi et al. (2018) affirmed that incentives are fundamental; instead, Feiz et al. (2022) discussed the relevance of the distance between biogas plant and livestock breeding, which should be short and not over 40 km; otherwise transport cost become too expensive, and biogas production is not profitable.
This analysis links the farming business model to the circularity components and enables its representation in the nine BM Canvas building blocks in Table 1. The elements of circularity are principally linked to value proposition and value capture (cost structure and revenue streams), which have undergone major changes concerning the traditional business model. These building blocks should be valued and paid attention to while implementing a circular business model. In this case study, a radical change occurred from Alfa's livestock breeding core activity to the production of biogas, as emerged from the different concepts indicated by the definition of the circular business model of Bocken et al. (2016), who specified "*the move to a circular economy model is an example of a radical change, which will require a new way of thinking and doing business. The more radical the technical or product innovation, the more challenging and the greater the likelihood that changes are required to the traditional business model*". Moreover, the implementation of circular economy practices finalised to reach zero waste has represented a new way of thinking and doing business, and this is possible through the adoption of technical innovation, such as the anaerobic digestion process.
Another relevant aspect concerns the fact that there should be efficient supply chain planning in the business model because the firm must be careful to have and choose partners close to the biogas plant from the beginning to the end of its life; otherwise, this causes high transport costs.
The transition into a circular economy represents a way to generate renewable energy and photovoltaic power (Sica et al., 2023). Alfa exploits the electric energy produced by biogas plants; indeed, it invests thermal energy only to warm up the management process, while it should use it for ethical projects such as warming schools, municipal swimming pools, and older adults' homes (Stempfle et al., 2022).
Fortunately, as Alfa is located far from cities, there is no problem of bad smell, so social oppositions are avoided (Cavicchi, 2016).
In Alfa, partners collaborate and are well coordinated even because Beta's owner controls them. In this way, there are no coordination issues (Stempfle et al., 2022).
Feiz et al. (2022) analysed key factors include feedstock supply, digestate demand, biogas demand, available infrastructure, and sociopolitical factors, which are important for Alfa's success.
The strength factors identified by Brudermann et al. (2015) coincide with Alfa's and represent the advantages of investing in biogas.
Nowadays, it is not convenient for other farming businesses with characteristics like Alfa to invest in biogas because the electric energy produced by biogas plants is not financed as in 2012. Instead, these firms should invest in biomethane, an important renewable energy resource in the transport sector. Italy is the European leader in the area of natural gas vehicles. However, converting biogas into biomethane requires subsidies as the production costs are not yet competitive with the price of natural gas. (Bentivoglio et al., 2022).

6 Conclusion

This analysis has brought a new case study by showing the characteristics of circularity included in a traditional business model. In our research, we have highlighted the building blocks of a circular business model compared to those of a traditional business model. A consideration regarding the Business Model Canvas is that it is difficult to represent the circular economy practices of a biogas plant in the traditional nine building blocks framework because a systemic vision is missing in the representation of the business model. Indeed, these blocks represent some elements, but they do not focus on others. For example, it does not highlight the loops generated by resources management

(livestock slurry) and activities (biogas and energy creation and redistribution of digestate) integrated into the circular value proposition.
From a practical perspective this paper contribute to show how a farming business, by implementing circularity and adopting innovative technologies, can introduce a new sustainable way of doing business, which represents an additional source of income. Using biogas plants can enrich and transform a farming business's business model to allow better resource exploitation.This study is limited by its reliance on a single case, which provides in-depth understanding but may not fully capture the diversity of experiences or challenges faced in other similar contexts.
For future research, the following studies could analyse case studies or multiplied cases to compare the circular practices and understand if others did not emerge from our findings. It could be interesting to analyse situations in which some farming businesses create a cooperative to implement circularity and explore the differences, challenges and opportunities derived from collaborating with more farming businesses to become more sustainable.
Moreover, this study emphasises the transformative potential of business model innovation in agricultural firms, particularly in circular economy principles for biogas and energy production from waste.
It could offer valuable insights for managers and practitioners to promote sustainable development in the agricultural sector. The study will continue to analyse the implications of introducing the experimental pilot plant. Finally, this study continues to analyse the possible further impacts on the business model.

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