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Diversified Farms as Models of Circular Agrifood: A Case Study

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Abstract

Circular economy (CE) has gained prominence in academic research in recent years. Case studies in circular economy have proven to be a useful way to learn about the main barriers and facilitators to implementing circular economy practices. Nevertheless, most of them are based on the manufacturing and energy sectors and technological solutions that are needed to achieve circularity. However, our paper presents the concept of circular economy applied to a diversified farm model. The aim is to discuss to what extent this model meets the circularity criteria that are promoted by the institutions, as well as the factors that favour and slow down the implementation of circularity in this type of farm. The case study analyzed is a family farm which has been making an innovative proposal for diversification in different links of the agri-food chain to "closing circles."

Keywords: circular agri-food, family farming, diversified farms, “masia”, case study

Les fermes diversifiées comme modèles d'agroalimentaire circulaire : une étude de cas

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Résumé

L'économie circulaire (EC) a pris de l'importance dans la recherche universitaire ces dernières années. Les études de cas sur l'économie circulaire se sont révélées être un moyen utile de connaître les principaux obstacles et facilitateurs à la mise en œuvre de pratiques d'économie circulaire. Néanmoins, la plupart d'entre eux s'appuient sur les secteurs manufacturier et énergétique et sur les solutions technologiques nécessaires pour parvenir à la circularité. Cependant, notre article présente le concept d'économie circulaire appliqué à un modèle agricole diversifié. L'objectif est de discuter dans quelle mesure ce modèle répond aux critères de circularité promus par les institutions, ainsi que les facteurs qui favorisent et ralentissent la mise en œuvre de la circularité dans ce type d'exploitation agricole. L'étude de cas analysée est une exploitation agricole familiale qui a fait une proposition innovante de diversification dans différents maillons de la chaîne agroalimentaire pour « fermer les cercles ».

Mots clés : agroalimentaire circulaire, agriculture familiale, exploitations diversifiées, « masia », étude de cas

1.0 Introduction

Circular economy has gained prominence in recent years in response to environmental problems resulting from conventional-linear production models. In fact, circular economy is presented as a counterpoint to a linear economic model. The circular model is characterized by 'grow-make-use-restore' as opposed to 'take-make-dispose' of today's linear economy (e.g., Ellen MacArthur Foundation [EMF], n.d; Blomsma & Brennan, 2017; Barros et al., 2020; Bjørnbet et al., 2021; Garcés-Ayerbe et al., 2019). This economic model ultimately tries to decouple economic growth from the consumption of finite resources (EMF, n.d).

Although this concept traces back to environmental and ecological economists and industrial ecology (Ghisellini et al., 2016), the most renowned definition of 'circular economy' was framed by the Ellen MacArthur Foundation, which characterizes circular economy as "one that is restorative and regenerative by design and aims to keep products, components, and materials at their highest utility and value at all times" (EMF, n.d, p. 2).

Several 'circular economy' definitions circulated after the one by EMF (e.g., Geissdoerfer et al., 2017; Kirchherr et al., 2017; Korhonen et al., 2018). Kirchherr et al. (2017), after analyzing 114 definitions and in an attempt to summarize all of them in just one, defined circular economy as:

> An economic system that is based on business models which replace the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes, thus operating at the micro level (products, companies, consumers), meso level (eco-industrial parks) and macro level (city, region, nation and beyond), with the aim to accomplish sustainable development, which implies creating environmental quality, economic prosperity and social equity, to the benefit of current and future generations (Kirchherr et al., 2017, p. 224–225).

In reference to the 4R (reduce, reuse, recycle and recover) framework, the authors caution against limiting the circular economy concept to 'recycling' and point out how in some cases there is little emphasis on 'reduction' as this could be detrimental to economic growth. Finally, they suggested doing more scholarly work detailing good circular economy practices to both sharpen the understanding of the circular economy concept and to help practitioners overcome barriers encountered while implementing.

Blomsma and Brennan (2017) consider circular economy an 'umbrella' concept and Korhonen et al. (2018) a 'contested' one. Other authors linked 'circular economy' to other concepts: Geissdoerfer et al. (2017) clarified differences and complementarities between circular economy and 'sustainability,' de Jesus and Mendoça (2018) linked it to 'eco-innovation,' Kirschherr (2022) distinguished between circular economy and 'post growth' circularity, and D'Amato and Korhonen (2021) integrated 'green economy,' circular economy and bioeconomy.

Abundant literature exists examining circular economic barriers and facilitators. Kirchherr et al. (2018) classified barriers to circular economy into four groups: (1) cultural, related to consumer and company values/behaviour; (2) regulatory,

linked to regulations and public policies; (3) economic, related to factors determining economic viability; and (4) technological, the lack of technological solutions. Their paper pointed out that previous studies had indicated lacking technologies as the main barrier to circular models, and, consequently, policies proposed were based on increasing R&D resources for circular economy. However, their study, based on interviews with experts in the European Union (EU), stated that the main barriers to circular economy were cultural and particularly pointed out two elements: lack of interest of consumers and hesitant attitude of companies when it comes to implementing circularity in their production model. Also, a "lack of synergistic governmental interventions" appeared as an important barrier, and the authors suggested a change in public policy orientation. de Jesus and Mendoça (2018) reviewed previous studies on barriers and drivers of circular economy and differentiated between 'soft factors' and 'hard factors.' Soft factors refer to cultural and regulatory aspects, while hard factors are based on technology and economic aspects. The authors concluded that institutional framework is crucial for circular economy, but it needs to be coherent, avoiding misalignments, overlaps and contradictory incentives. Ranta et al. (2018) analyzed institutional aspects that may favour or hinder circular economy, making a comparative study of three case studies of manufacturing from China, the United States and Europe. They pointed out that regulatory changes are not enough to force change and that aspects such as certification, cultural and cognitive aspects also need to be considered. Garcés-Ayerbe et al. (2019) showed that firms implementing circular economy faced regulations, administrative processes and a lack of human resources as the main barriers. On the other side, firms which are not implementing circular economy felt economic barriers (such as financing) as the main obstacle to circular processes.

The concept of 'circularity' has also reached agri-food production. Nevertheless, most of the academic literature on circular economy focuses on the manufacturing sector. Kristensen et al. (2016) pointed out that the implications of the circular economy have not been fully explored in agri-food studies, and Velasco-Muñoz et al. (2021) noticed that the theoretical framework of circular economy had not been adapted to specificities of agriculture. Nevertheless, interest in circular agriculture in recent years has grown substantially as well as literature production (Barros et al., 2020; Esposito et al., 2020; Batlles-delaFuente et al., 2022). However, several authors claimed there was still a small number of articles on circular economy in agri-food and pointed out the need of further research on the field (i.e., Hamam et al., 2021).

In Europe, the promotion of circularity in agri-food is reflected in the *A new Circular Economy Action Plan for a cleaner and more competitive Europe* (European Commission, 2020a) but especially in the *Farm to Fork strategy for a fair, healthy and environmentally friendly food system*, which was presented by the European Commission in May 2020. This document states, "circular bio-based economy is still a largely untapped potential for farmers and their cooperatives" (European Commission, 2020b, p. 6), and it is announced in a very generic way that "the Commission will take action to scale-up and promote sustainable and socially responsible production methods and circular business models in food processing and retail" (European Commission, 2020b, p. 12). Following Jurgilevich et al. (2016), the implementation of circular economy in agri-food systems implies the reduction of food waste throughout the food system as well as changes in food consumption patterns and support to local food supply chains. According to the United Nations document *Circular agriculture for sustainable rural development*, circular agriculture is based on "using minimal amounts of external inputs, closing nutrients loops, regenerating soils, and minimizing the impact on the environment" (Helgason et al., 2021, p.2). The

report *Circularity in agriculture production* indicates that circular agriculture is the search for the right combination of ecological principles with new technologies, "with new partnerships, new economic models, and credible social services*"* (de Boer & Ittersum, 2018). Batlles-delaFuente et al. (2022) consider that circular economy is an appropriate framework for sustainable, restorative and regenerative agriculture. Castillo-Díaz et al. (2023) showed that in Spanish agricultural and livestock systems, there is an inversely proportional relationship between economic and environmental sustainability. In this context, circular agrifood principles could improve both by increasing efficiency and reducing the use of agricultural inputs.

In fact, the concept of 'circularity' as applied to agri-food encompasses diverse positions ranging from an 'adaptive' conception based on deploying technologies that minimize resource use and waste generation to more radical or 'alternative' proposals that imply significant changes in food production, trade and consumption patterns (Dagevos & de Lauwere, 2021). Several authors pointed out the need to look for suitable indicators to measure the degree of circularity in agri-food systems (Velasco-Muñoz et al., 2021; Poponi et al., 2022; Kristensen & Mosgaard, 2020).

The micro approach and the focus on elements that block or facilitate circularity are fundamental to defining public interventions that really impact firms' behaviour. But another gap on the literature on circular economy is the lack of empirical and case study research (e. g., Kirschherr et al, 2017; Garcés-Ayerbe et al., 2019; Bjørnbet et al., 2021; Yang et al., 2022).

Kirschherr et al. (2017) suggested doing more scholarly work detailing good circular economy practices to both sharpen the understanding of the circular economy concept and to help practitioners overcome barriers encountered while implementing. Recent literature reviews on circular economy, such as Bjørnbet et al. (2021) showed that although literature based on case studies increased in recent years, most of them are focused on manufacturing (i.e., Frishammar & Parida, 2019; Park et al., 2010). Zhu, Jia and Lin (2019) pointed out both the lack of empirical work at the micro level and the lack of research in circular practice in agriculture. Yang et al. (2022) found that research on circular agriculture is concentrated in natural sciences field, especially on technology innovations, and there is little research on social, political and economic aspects. Batlles-delaFuente et al. (2022) noted that most of the publications on circular agriculture were in the fields of Environmental Science and Energy, and there was little on Social Sciences and Business, Management and Accounting. The present paper wants to contribute to reducing both previously mentioned literature gaps: on the one hand, on circular agri-food (with a focus on social and economic aspects), on the other hand, on case studies at the micro level, that is, at the farm level. Furthermore, in our opinion, there is another relevant gap in the literature on circular agri-food: there is little emphasis on diversification strategies for circularity. The few case studies in circular farming are based on technological issues to improve efficiency (i.e., Tagarakis et al., 2021) and on the use of fruit and vegetable waste and energy generation (García-Madurga & Grillo-Mendez, 2023). However, they do not consider diversification as a strategy for increasing circularity, or if they do, there is a 'narrow' view of diversification limited to mixed farming (Helgason et al., 2021). To the best of our knowledge, there are no case studies on circular farming based on 'broad' diversification strategies. In fact, our case study embeds in one particular case, the dual approach of circular agriculture, that is, the circulary 'on-farm' and the circularity 'off-farm' (Nkansah-Dwamena, 2023).

Based on an extensive case study on the Cal Rovira farm in Catalonia, Spain, this paper explores how diversification contributes to enhancing circularity. The example of Cal Rovira shows the willingness of a family farm to integrate different elements of circularity in its production and business strategy. This willingness became the motto of the new family business: 'Closing circles' ('Tancant cercles' in Catalan). Cal Rovira is now a group of companies acting in a coordinated manner in different links of the food chain. In the implementation of its strategy, the farm has been confronted with elements that made circularity easier and elements that made it more difficult. From the analysis of these elements, policy implications can be drawn to help facilitate progress towards a circular agrifood model.

In short, the article aims to analyze the transformation process of an agri-food business towards increased circularity. The long-term analysis (from 2000 to 2023) has allowed us to observe the enablers and barriers that have accompanied the whole process. It can contribute to better understand the relationship between diversification and circularity in the agri-food sector and its policy implications.

The article is structured as follows: Section 2 details the methodology and data. Section 3 presents results based on our case study. The following section (4) discusses the findings and ends with conclusions and policy implications (section 5).

2.0 Material and Methods

The research was conducted as a case study. According to Gerring (2004), a case study is "an in-depth study of a single unit (a relatively bounded phenomenon) where the scholar's aim is to elucidate features of a larger class of similar phenomena" (p. 341). This methodology provides tools to answer 'how' and 'why' questions about a contemporary event within its real-life context (Yin, 2009). It gives the researcher a deeper understanding of the exploring subject (Dyer & Wilkins, 1991). Several authors agree that this method is appropriate for conducting qualitative, applied "in-depth" research in a real-world context (Yin, 2009; Gerring, 2004; Wellner & Pierce-Friedman; 2022, Crowe et al., 2019).

Nevertheless, this methodology has some limitations, which we are aware of. Some of them have been pointed out by Yin (2009), among others, and are applicable to our case study: results coming from a single case study cannot be generalized, and there is a researcher bias which can interfere with the study (i.e., conducting the interviews) and, finally, a specific case study is difficult to replicate. Data triangulation can be used to increase the validity of the gathered data (Stake, 1995) and mitigate the lack of rigour when undertaking case study research (Crowe et al., 2019). In our case study, we used data source and investigator triangulation to improve the validity and rigour of our research.

This paper looks at a diversified farm in Catalonia. It is an intrinsic case study, that is, according to Crowe et al. (2019), a case study selected because of its uniqueness, not because it is representative of other cases. It is a single-unit case with time tracking for more than 20 years. Since 2000, this is from the very beginning of the 'Closing circles' project, the team has been able to talk several times with the farm managers and to conduct several interviews with people linked to the farm and other companies of the group. Furthermore, the team undertook interviews with other neighbour farmers and, as the farm has benefited

several times from LEADER[1] program aids to finance its diversification strategy, they also interviewed rural development officers in the region.

Most of the interviews were unstructured to adapt to the evolution of farm activities. That has allowed us to register the farm operating changes and to follow the complete process from the beginning to the current situation, knowing the main difficulties faced in implementing the initiative. The interviews were conducted in person, except the ones conducted during the COVID-19 pandemic. The interviews were not recorded (notes were taken) to facilitate a comfortable environment with interviewees that would allow them to express their true opinions and visions.

Besides these interviews, team members visited Cal Rovira farm several times. During those visits, they were able to directly observe how people conduct their work on the farm and the interactions between the farm's family owners with direct consumers and customers, other farmers and local officers. The team members received kind support from the farm's owners during the entire research process. At least two authors participated in all interviews and visits to prevent bias. In the last visit to Cal Rovira, the most exhaustive one, all four authors participated. After the interviews and visits, the researchers shared and discussed their notes and impressions, ensuring the triangulation process.

Other data for undertaking the Cal Rovira have come from secondary sources such as the website of Cal Rovira, media interviews to the Rovira's family as well as reviews of the environmental regulatory framework and rural development programs in the region.

3.0 Results: Circularity at a Diversified Farm

The farm we analyzed in the case study, Cal Rovira, has been reformulating its production system since the late 1990s. Their proposal combines elements of the traditional model of agricultural production in the region, the "masia"[2][3] (Catalan farmhouse), with the new alternatives of production and commercialization of agricultural products known as 'alternative food networks' (Renting et al., 2003). They called this strategy *Tancant cercles* [closing circles]. This initiative showed up when concepts of circular economy or circular business model where not yet popular. Closing circles became the motto of the family business, much more than just a slogan, Rovira family refers to it as "Our philosophy of producing" or even "a way of life."

In this section, we first describe the case study, considering the business and productive conglomerate as well as its main assets. Next, we analyse the extent of its circularity and how this circularity has been implemented, highlighting the main barriers they faced during the process.

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[1] LEADER is a community-led local development program for European Union rural areas.

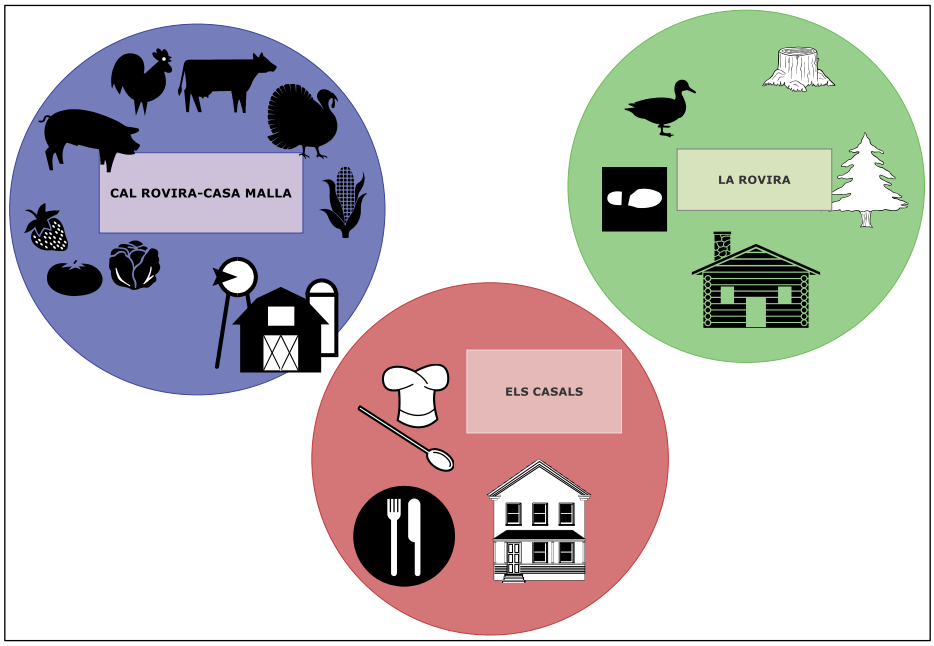
[2] The traditional *masia*, translated as 'Catalan farmhouse' (Serra i Clota, 2016), was an example of a diversified farm quite popular in Catalonia, Aragon and the south of France. It was an economic unit that usually comprised of croplands, vegetable gardens, access to water and forest, livestock pens and one or several houses where people lived. Although its origins were in the 11th century, it was called masia from the 15th century onwards (Serra i Clota, 2016). It constituted a largely self-sufficient economic unit. The masia was indivisible and inherited by a single member of the family. The tenants of the masia were, quite often, one or several sharecroppers [*masovers*] and they were different from the actual landowners. In the same masia, several nuclear families lived together, often the relatives of the owner and the sharecroppers.

3.1 Cal Rovira Farm: Basic Elements

Cal Rovira is in Berguedà county in Catalonia and has its origins in two *masies* which have belonged to the Rovira family for centuries. Huge forest fires in the 1990s seriously affected Rovira masies, and sharecroppers left. That was a turning point in Rovira family: sons and daughters, then living in the city and working in professional activities not related to farming, came back to their country home to rebuild the damaged masies and to start a new business with 'closing circles' as business philosophy.

Cal Rovira currently integrates a wide range of agri-food companies and activities, as well as catering and hotel activities. These activities can be grouped into three groups, as shown in Figure 1.

Figure 1. Cal Rovira activities.



Source: Authors.

The first one is Cal Rovira-Casa Malla which is the operational base of this conglomerate. It is the main group of buildings, with the big family house built at the end of the 19th century and with stables, a livestock processing facility, a greenhouse, an oilseed mill, a feed mill and an orchard. The farmland is around 250 hectares dedicated to crops (barley, wheat and rapeseed) and pastures, and livestock (pigs, poultry and cows). There are also more than 100 hectares of forest.

El Casals was a sharecropper's home and nowadays has become an acclaimed restaurant and a charming hotel with nine rooms. The Rovira family is also involved with two other restaurants in Barcelona: Sagàs and 'Pork…boig per tu' —both of a more popular nature.

Finally, La Rovira, another sharecropper's house, is today an agrotourism setting surrounded by forests owned by the family.

The closing circles strategy has led to a high degree of diversification (see Table 1).

Table 1. Economic Activities of Cal Rovira

Agricultural activity	**Livestock activity**	**Forestry activity**	**Manufacturing activity**	**Services**
Cereals	Pigs, closed cycle	Energy (wood)	Feed	Catering
Oilseeds	Beef, cattle	Pastures	Rapeseed oil and powder	Hotel accommodation
Grassland for pastures	Poultry	Mushrooms	Fresh meat	Accommodation in agrotourism
Vegetable garden (open air)	Organic manure	Hunting	Sausages	Guided tours
Vegetable garden (greenhouse)			Canned pâté	Leisure activities in the forest
				Online sales
				Rental of agricultural machinery

The business is carried out by five brothers and sisters and some of their relatives. In total, there are eight family members fully employed in the family business. The farm, meat workroom and feed mill employ ten salaried workers. The *Els Casals* restaurant and the hotel have 11–12 employees.

3.2 Closing Circles Strategy

3.2.1. Closing circles between crops and livestock. Traditionally, livestock farming has been the main activity of the farm. Currently, pigs, cattle and poultry make up the livestock production.

In the process of modernizing the farm, the owners stated that they had two options. The first was to expand the pig farm under an intensive industrial model, specialized and with heavy use of external purchases, basing profitability on economies of scale. This is the predominant model: industrial livestock production through integration contracts has been extremely popular in the region. The second model, which has prevailed on the farm, has maintained a small number of animals, makes maximum use of the farm's available resources (fodder, grains, etc.) and contains a wide variety of activities, thus taking advantage of economies of scope.

The farm's livestock production has benefited from the availability of croplands. The cereal production is processed into feed for livestock feeding. The feed is produced in the farm's mill, so that control over animal feed is obtained (70–80% of livestock feed comes from the farm itself). As the owners point out, this fact allows them to "give priority to quality-oriented food production with a clear objective: to breed healthy, balanced animals with a potentially high taste value" (personal communication, April 25, 2021).

Two important ingredients in animal nutrition are gatoux and rapeseed cake, both produced by the company Roviroli S.L. located on the farm with whom they are the main partners. Roviroli S.L. produces rapeseed oil, rapeseed cake and gatoux. The company required heavy investment and the need to seek external partners and suppliers. The company uses rapeseed and sunflower oil from partners but also buys from external suppliers (mainly other farmers in the region) to make facilities profitable. Its production volume is high, and part of its production is exported.

Farm livestock also benefits from large pastures. The farm has 110 cows and two bulls for meat production. They are kept for half a year on pasture and half a year in the interior installations of the farm. The poultry and pigs are also small-sized. The poultry consists of around 500 chickens, and the pig farm is a closed cycle with 80 sows. As mentioned, Rovira's wanted to avoid pig specialisation that is so common in the region. As the owners explain: "The philosophy of the family includes the will to preserve and modernise productive activities beyond pig production, and by renouncing to a hyper-specialisation in production, it facilitates an integral use of the productive resources of the farm" (personal communication, May 11, 2022). Farm livestock provide slurry and manure which allows a reduction in the use of chemical fertilisers, thus closing circles between crop and livestock production.

3.2.2. Closing circles between livestock and meat production. Poultry and cattle are sold alive to local slaughterhouses and butchers. However, pig production is the economic base of the farm. Around 33 pigs are slaughtered each week in a nearby slaughterhouse. In 2007, they built the meat processing facilities, which allowed them to close the circle of livestock production by obtaining fresh meat and sausages on the same farm. Currently, they are producing a wide range of products, including some Catalan traditional sausages (*butifarra del perol, bull blanc, butifarra catalana*, etc.), cured (*fuet, sobrassada*, ham, etc.) and fresh (pork loin, ribs, etc,), among which sobrassada and *pâté* have become the flagships of their meat production. As the owners point out, they seek to recover "authentic flavours" by means of a traditional production process that is the result of generations of experience. They start from a philosophy of zero waste: all parts of the pig are used (bones included). The recovery of some traditional products leads to that, since they are based on the use of the less noble parts (tongue, etc.). Their products have positioned themselves on the market as quality products associated with artisanal and traditional production. Despite this, they have not renounced the adoption of modern technologies, which they consider to have been important in improving their production.

3.2.3. Closing circles between food production, catering and consumption. The opening of Els Casals restaurant in 1999 widened the circle, promoting new complementarities and diverse ways of using resources. The uniqueness of the restaurant is that it bases most of its supplies (80%) on products generated by the farm.

The catering industry is becoming a demanding customer for farm products. It demands high-quality products and greater diversity. This demand led to an expansion of the vegetable garden (initially oriented towards self-consumption) from 2004 onwards, introducing new varieties and products. The greenhouse was built to ensure year-round production.

In meat processing, a wide range of artisan pork products is offered. Also, the highest quality beef and poultry products are produced for the Els Casals restaurant. As a result of this commitment to quality, the Els Casals restaurant has been awarded a Michelin star.

However, the commitment to a high-quality restaurant was not enough to valorize the entire meat production of the farm. This led the Rovira family to diversify its restaurant offer with the opening of two restaurants in a popular neighbourhood of Barcelona. The restaurant offer is perfectly segmented: a high-end restaurant, Els Casals, and two restaurants specializing in meat and pork products at more popular prices (Sagàs and Pork...boig per tu). This segmentation makes it possible to make the most of the entire meat production

and minimize waste while at the same time making the products known to a wide segment of potential consumers, such as tourists.

Although most of their production (70–75%) is sold to the restaurant trade (not only in their own restaurants but also to other restaurants in the region), the circle of agricultural and meat production is also closed through broader marketing. The Rovira family has opted for ways that escape the conventional circuits (i.e., they do not sell through supermarkets) and have preferred local shops and butchers (approximately 20% of their production is marketed this way). Especially with the COVID-19 crisis, they have boosted their online sales through their website and joint marketing initiatives with other producers. However, they estimate that this only accounts for 4–5% of their total sales. The need to offer a standardized product (in terms of size, weight, etc.) and, consequently, more processing and distribution tasks have slowed down their commitment to this marketing channel. Avoiding food waste is also very present in this phase and the company collaborates with local associations and the Food Bank.

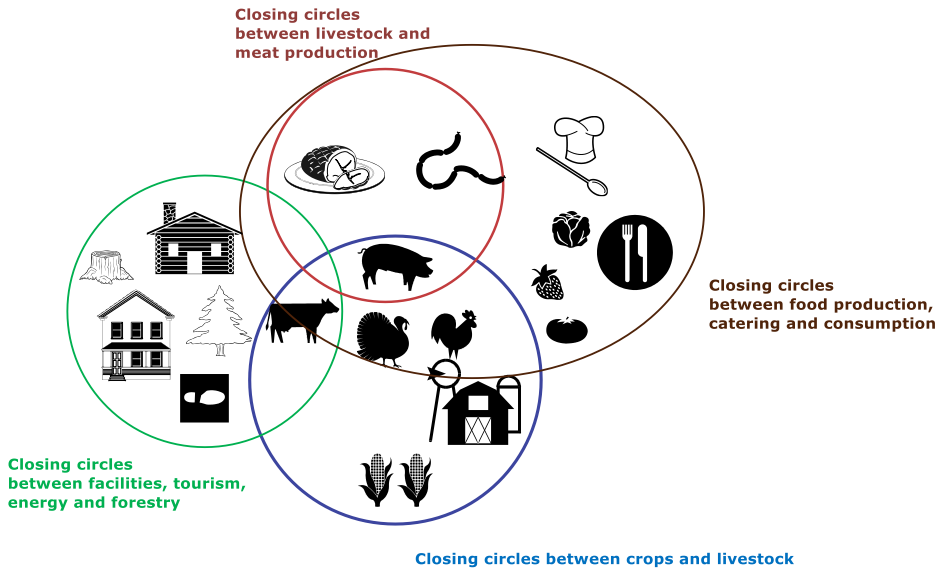
With catering and direct sales, the circle is complete. As they point out, "And, in the end, our products lay on the table where this circle is finally closed" (personal communication, April 25, 2021).

3.2.4. Closing circles between facilities and tourism, energy, forestry and other services. The idea of circularity implicit in 'closing circles' includes the idea of valuing all the farm assets, including facilities and machinery. The sharecroppers' old houses have been transformed into accommodation facilities: a rural tourism house and a small hotel. Tourist activities allow the valorization of the rest of the facilities: guided tours and activities are offered on the farm, walks in the forest, etc. All the buildings are equipped with solar panels to provide energy. Agricultural machinery is as well valorized, and they offer services to other farms.

The surrounding forests are also taken advantage of by providing the main source of energy for the buildings (firewood), as well as mushrooms and hunting products, which are used in the restaurant. The herds of cows entering the forest, contributes to the clearing of the forest and the prevention of possible fires.

Figure 2 summarizes the several 'closing circles' strategies we have identified.

Figure 2: Closing circles strategies.



Source: Authors.

4.0 Discussion

In the previous section, we described the circularity strategy implemented by Cal Rovira, a strategy similar to that of other farms that are opting for productive diversification and alternative marketing channels. However, is this conceptualisation of circularity in line with the circularity that appears in the academic literature and that is being promoted from the institutional sphere? To assess that, we will check whether Cal Rovira meets the criteria of circularity.

4.1. Cal Rovira 'Closing Circles' and 'Circularity'

In 2020, the Spanish Government established circularity criteria for the agri-food sector as part of its strategy to boost the circular economy in a document called 'Spanish Circular Economy Strategy' (Ministerio para la Transición Ecológica y el Reto Demográfico, Gobierno de España [MITECO], 2020). The following table summarizes which elements of circularity set out in the Spanish Strategy for the agrifood sector Cal Rovira complies with. As can be seen, Cal Rovira meets most of the circularity criteria.

Table 2. *Cal Rovira's Circularity According to the Circularity Criteria of the Spanish Circular Economy Strategy*

Circularity criteria of the Spanish Strategy	**Accomplishment check**
Reduction of food waste	X
Minimisation of gas emissions	-
Reduction of chemical use	X
Efficient use of water	-
Waste recovery	X
Improved input efficiency (use of by-products, recycled materials...)	X
Soil conservation and biodiversity	X

Cal Rovira's strategy is based on the principles of achieving greater efficiency in the use of inputs, promoting the use of recycled materials and secondary raw materials and the reduction of non-valued waste, avoiding the generation of waste, which consequently leads to a reduction in food waste. These three principles—efficiency, resource recovery, and avoiding food waste—have always been at the core of the traditional masia, so these elements seem to be fulfilled naturally as a consequence of the production and managing model of the farms themselves.

Similarly, by carrying out agricultural, livestock and forestry activities in parallel, they reduce the use of chemical products and improve soil conservation and biodiversity. Tourism use and the commitment to a differentiated quality product require compliance with these principles. The crops are GMO-free, and it uses a hybrid production system that incorporates aspects of organic and conventional farming based on its own experience. A plant defence advisory service is helping them to reduce and improve the use of chemicals.

The farm has three wells and uses groundwater for its agricultural activity. The owners indicated that they have not carried out any specific actions aimed at improving water efficiency or minimising gas emissions, but they have been investing in energy efficiency, using available forest resources and installing solar panels on all buildings.

Other circularity criteria that seem to be appropriate for analyzing circularity in the agri-food sector are those presented by Erisman and Verhoeven (2020) and cited in the publication from Dagevos and de Lauwere (2021). These criteria go beyond the above and include aspects such as animal welfare and contribution to rural economy. According to them, we can see that the Cal Rovira strategy meets most of the circularity criteria presented.

Table 3. *Cal Rovira's 'Circularity' According to Erisman and Verhoeven's Circularity Criteria*

Circularity criteria, according to Erisman and Verhoeven (2020)	**Accomplishment check**
Soil preservation	X
Closing nutrient cycles	X
Reduction of greenhouse gasses and ammoniac	-
Producing sustainable energy	X
Maintenance of biodiversity	X
Nature conservation	X
Animal welfare	X
Animal Health	X
Using residual flows from the food industry	X
Contribution to regional economy and vitality of the rural area	X

Cal Rovira farms meet high animal welfare standards: sows undergo a gestation period in loose-house systems onto a bed of straw, and breeding and transition farms are also equipped with beds of straw. Livestock is slaughtered in a nearby refrigerated slaughterhouse. Neighbourhood farmers interviewed have reported co-operation and linkages with Cal Rovira in several ways: crop providers, machinery sharers, and feed buyers. Local officers interviewed pointed out that Els Casals restaurant has become a tourist attraction for the region, and it can be said that Cal Rovira businesses model has inspired other local farmers who have opted for diversification strategies.

4.2 Facilitating and Hindering Factors of Circularity

The circularity strategy has benefited from the agro-livestock-forestry nature of the Rovira family farmhouses, with a wide range of assets (forests, arable land, pastures, buildings, etc.) and productions (vegetable garden, cereals, fodder, poultry, pigs, cattle, etc.) together with the human capital provided by the members of the family. In this particular case, the prior existence of a diversified family farm with extensive assets is the main factor facilitating circularity.

This fact has made it possible to overcome some of the barriers to circularity cited in the literature. First, the economic barriers given that, although investments have been substantial (rehabilitation of farmhouses, meat processing plant, animal feed factory, etc.), acquiring land or buildings has not been necessary. These assets have also facilitated access to financing. However, some diversification strategies (rapeseed oil, restaurants in Barcelona) have required the participation of external investors.

Second, productive diversification makes it possible to diversify risks: losses of some activities can be offset by profits of others. Activities of questionable economic profitability can be preserved because they contribute to strengthening the group's identity and the company's motto, thus becoming an intangible asset. Circularity is achieved within the company itself, eluding risk linked to larger agri-food circular supply chains (Krstić et al., 2024). Everything is valorized in the production network itself. This model minimizes transaction costs and avoids difficulties and uncertainty linked to commercialization of by-products and waste that other modes of circularity entail.

Some authors include the lack of consumer awareness or interest among economic barriers. The slogan 'closing circles' that appears on all products evokes the idea of circularity. But the brand's success lies in reinforcing circularity with other values, such as quality, artisanal production as well as proximity.

The diversified family farm model also overcomes some cultural barriers. On the one hand, there is no need to look for external collaborators to guarantee circularity, and family ties facilitate trust solidarity and the sharing of common values. There is also a strong will to maintain the farm, which has been family property for generations. This will is giving emotional wealth and stability to the initiative. The family is well known in the area, has actively participated in farmers union, maintains good relations with the local authorities, and this social recognition makes it easier for them to associate with other farms or partners in their process of diversification of activities.

Other cultural barriers cited are difficulties in internalising the concept of circularity in business behaviour as well as the hesitant attitude of companies when it comes to implementing circularity. In this case, diversification and revival of the farmhouse model naturally integrate the concept of circularity, making it a tangible concept. Making circularity the motto of the family business maintains this idea in all productive activities developed.

Finally, as illustrated by the case presented by Zhu et al. (2019), to be profitable, a circular business must build upon several production pathways, and entrepreneurship is needed to find them. This entrepreneurial character to seek diversification activities that allow closing circles is also evident in the Rovira's case.

Technological barriers are not relevant here. Circularity is not obtained through complex and expensive recycling technologies but through the recovery of the traditional model and the valorization of the products on the farm itself. Although the meat processing plant, the oilseed mill, and the animal feed plant use modern technologies, those are not key elements in achieving circularity.

According to the interviews conducted, the main barriers faced by this model are regulatory barriers. Regulations and administrative procedures are designed for highly specialized farms with a high use of external inputs. The small-scale and highly diversified production model forces them to combine different legal forms depending on the productive activity (e.g., community of property for farming activities and Roviroli as a limited company). This results in a substantial increase in administrative formalities, increasing bureaucratic costs. Inconsistencies and misalignments in the regulatory framework are more evident for this type of farm. Administrative complexity discourages new investments and collaboration with other farms. As the interviewees stated, circularity needs more flexible administrative and regulatory systems. From the point of view of public administrations, it is difficult to define public interventions that fit this farming model.

On the other hand, the increase in environmental and animal welfare regulations, certifications, etc., has not entailed additional costs or onerous adaptations to the farm, given that the production model was already adapted to many of these requirements.

5.0 Conclusions and Policy Implications

The traditional masia model combines livestock, agricultural, and forestry production and seeking self-sufficiency, contains many of the elements that we have seen in the different definitions of circular agriculture. The farm's production model implied the complementarity of activities, seeking to optimize resource yields and minimizing system risks, as indicated in the Ellen MacArthur Foundation's definition. In addition, the management of self-sufficiency favoured reuse and recycling as a mechanism to minimize external dependence.

The strategy followed by the Rovira family involves re-inventing the farmhouse and adapting it to present conditions to make it viable while maintaining and reinforcing some existing features of circularity. To this end, while trying to conserve traditional activities (forest care, cattle grazing, etc.), not always financially rewarded, new activities have been created and modernized (meat processing facilities, rapeseed mill, rural tourism, gastronomic restaurants, etc.) and innovative marketing circuits have been developed (online sales). Farm assets continue to be the basis of the group's activities. However, diversification and circularity have deepened (the crops and the mill allow them to produce most of their livestock feed, and restaurants are a good target for part of their vegetable and meat production).

Commitment to diversification has made it possible to reduce non-valued waste to a minimum. Every output becomes an input at some stage of the production process until it becomes a final consumer product. From the oil mill, all the final residues are used as straw for the pig farm, the cake is used for animal feed, in the workshop, pâtés are made valorizing animal parts that are difficult to market, the forest provides energy, mushrooms, and so on and so forth.

Conceptually, Cal Rovira's circularity strategy can be considered as an alternative to conventional farming modernization strategy and the search for viability based on specialization and economies of scale. In contrast to these two elements, it opts for diversification and economies of scope. At the same time, unlike other alternative strategies, our case study is faced with a strong commitment to technology while making it compatible with traditional elements.

Some of the barriers to circularity are reduced in this model. In our case, the prior existence of a diversified family farm with extensive assets is the main factor facilitating circularity. Diversification makes it possible to overcome some of the economic and cultural barriers cited in the literature. Technological barriers are not relevant to this circularity model. Regulatory barriers are the most relevant because current legislation does not consider the exceptional nature of this type of farm, which translates into high administrative costs that may discourage this type of initiative. Nor are there any proposals to encourage this farming model. On the other hand, the fact that most transactions are carried out on the farm itself reduces transaction costs.

This case study allows us to note some relevant aspects of the conceptualization of circularity. Firstly, our case study shows an example of circularity, which is understood as the valorization of all the farm assets and 'closing circles' as finding value for all the products and by-products in the same business conglomerate. A question remains: Is it easier to close the loop at the micro-scale (firm) than at the meso/macro-scale (county, region)? Cal Rovira

demonstrates that micro-scale levels of a circular economy could be cost-effective and overcome some of the difficulties of meso/macro programmes.

Secondly, circularity is an intangible asset that goes beyond pure short-term economic profit (i.e., the preservation of traditional activities, albeit without economic benefit). Circularity thus requires a 'holistic approach', going far beyond the simple sum of each activity's profitability.

Circularity implies collaboration, communication, shared values and trust. The question remains whether this is easier to achieve in a family business than in other types of business. Circularity is innovation, not just modernization, but finding new activities to 'close circles' (e.g., accommodation, rapeseed factory, restaurants) and alternative marketing channels (local networks, online, restaurants, etc.). This requires a certain entrepreneurial spirit.

Some policy recommendations can be derived from our case study. There is a bias in circular economy policies: they focus on the meso and macro levels (not the micro level) and mainly on manufacturing sectors. Previous research on circular economy schemes at the regional level in rural areas in Catalonia faces difficulties in succeeding, and according to some interviewed policymakers, the agrifood sector presents increased difficulties (i.e., farm dispersion). Due to this, promoting diversified farms could be a complementary strategy to foster circularity strategies in rural areas. As mentioned, regulatory barriers could be one of the main obstacles to diversified farms, which face a lot of paperwork because they conduct several activities in the same business. Adapting regulations to diversified farms could be a way to remove these barriers. Another conclusion of our case study is the need for financial support for diversification strategies. The LEADER program has been useful, but more funding is needed to finance this kind of project.

Finally, diversified farms should be promoted not just for circularity advantages (environmental aspects). Recent experiences as COVID-19 and the war in the Ukraine have showed that diversified farms are more resilient and less risky in uncertain situations (less dependence of external inputs, less dependence of international trade). As self-sufficiency is coming back to the domestic political agenda, diversified farms seem more adequate to achieve this goal.

We do not want to finish without insisting on the limitations of our study. As mentioned, case studies face some limitations. In our case study, it is clear that there are scalability problems and difficulties in replicating the model of Cal Rovira: the existence of a previous masia and several assets and the family's commitment to the new business are facts that do not come easily. However, interviews with external agents (public officials, neighbouring farmers, etc.) give a glimpse of similar initiatives, but on a smaller scale, appearing in the region (imitation effect) and that Cal Rovira's collaborations with other neighbouring farms have fostered changes to higher circularity in those farms.

We are also aware of our bias as researchers, nevertheless, we are four researchers with quite different opinions about farming models (resulting in interesting discussions among ourselves), which diminishes the bias. Finally, it is not possible to generalize the conclusions coming from a particular case study.

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