



Geographical indications in cheese mountain areas: Opportunity or threat to landscape and environmental conservation? The case of Cabrales (Spain)

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ABSTRACT

This paper examines the impact of Geographical Indications in cheese mountain areas, exploring their potential to contribute to landscape and environmental sustainability by drawing on field work and documental evidences from Cabrales (Asturias, NW Spain). The Cabrales mountain, nestled in the Picos de Europa National Park, embraces a millenary culture linked to the elaboration of an intense flavor blue cheese. The commercial success of this cheese motivated, 40 years ago, the creation of the Cabrales Protected Designation of Origin (PDO). From that moment on, the implementation of certain control measures that affect the production process, together with the increase in demand, led to the disappearance of small producers and to the intensification of livestock management practices. Cheese producers took the opportunity that the PDO label gave them, and the PDO provided the context in which cheese production became an effective barrier against the degradation of the rural system. However, nowadays the intensification of livestock management practices constitutes the main threat to landscape and environmental conservation. Therefore, Local administrators and stakeholders should consider the need to reinforce the idea of a product whose quality is linked to environmental and landscape sustainability through the maintenance of the traditional extensive management practices.

1. Introduction

Asturias stands out as a cheese-producing region in Europe, with over 40 artisanal varieties that are fully recognized and in demand internationally (Rodríguez et al., 2000). Four of these varieties hold the Protected Designation of Origin (PDO) qualification; Cabrales cheese, whose regulations were approved in 1981, was the first to obtain it. PDOs, like Protected Geographical Indications (PGI), involve legal, economic, political, socio-cultural and environmental aspects (Garufi, 2015), and represent the first formal attempt to guarantee the geographical origin of an agri-food product (Sánchez-Hernández, 2009). These qualifications entail both the protection and the enhancement of food, and are applicable to items with distinct characteristics depending on the raw material, the environment in which it is obtained and the production methods. The result is a high-quality product which, because it is made of natural and culturally established components, can be associated with the territory in which it is produced. Like other Mediterranean countries, Spain has a long tradition of protecting agri-food products which, like olive oil, wine or Iberian ham, can be subject to significant changes in quality depending on natural and handling

variations.

Cheese is one of the foods that also required the earliest differentiation and protection worldwide, Roquefort being the first known precedent (Allaire et al., 2011). In Spain, according to the Ministry of Agriculture, Fisheries and Food, in 2020 there were 28 types of cheese officially recognized as being associated with a geographical area, representing 14% of protected products. Specifically, PDOs involve the strongest kind of geographical connection that can be established between a product and its environment. The cheeses produced within this framework comply with the standards laid down by the Regulatory Board, which must ensure that this connection is maintained. For instance, they are always made using milk produced by native or well-adapted breeds whose handling and feeding conditions are regulated (Espejo Marín, 2001). Therefore, these cheeses result from the efforts of deeply rooted communities who, by developing practices that respond to a tradition and that synthesize cultures that are highly adapted to specific natural conditions, generate high-quality products whose qualities are connected with a territory.

The territorial impact of these qualifications has aroused interest in the scientific community, resulting in noteworthy work in the field of

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economic geography, both internationally (Conneely & Mahon, 2015; Feagan, 2007; Marsden & Smith, 2005) and in Spain (Esteban, 2017; Galdós, 2004; Sánchez-Hernández, 2009). There has also been international reflection on its various repercussions on the landscape (Rippon, 2014; Volet et al., 2008; Willson et al., 2018); work that in Spain focused mainly on the wine industry (Alonso-González et al., 2017; Davidson, 2012; Fernández-Portela, 2012; Ruiz-Pulpón, 2013).

In the light of the above, our initial hypothesis is that the approval of the Cabrales PDO is a territorially-based phenomenon which, in turn, has had a significant geographical impact. With this article we intend to contribute to the analysis of the environmental and landscape effects of artisanal production within the PDO framework, using the case study offered by Cabrales cheese, by developing the following specific objectives: (i) to set forth the aspects according to which Cabrales cheese can be considered a product that is highly adapted to its environment; (ii) to examine the effects of the Cabrales PDO on production processes and, indirectly, on the environment; (iii) to examine the opportunities and threats with respect to the sustainable development of the PDO territory.

2. Material and methods

The investigation consisted of a first section in which information was obtained from interviews with the agents and institutions involved in the PDO territory, and another section in which data was extracted from field work and direct observation (Fig. 1). Fifty seven long semi-directed interviews (Supplementary Table 1) were conducted with inhabitants of the PDO territory: 26 of them were involved in the production of Cabrales cheese, while the rest (31) were not directly involved in cheese production. All of them were permanent inhabitants of the municipality of Cabrales. The main aim of these interviews was to learn about the changes in the production processes, as well as in the spaces in which the different stages of production take place. In the same way, interviews with people working in other sectors especially sought to investigate environmental changes/threats (Fig. 1). However, it should be considered that both groups live together and maintain very close relationships (in many cases family relationships), and that practically the entire population is directly or indirectly related to the cheese production. For this reason, the questions that have guided the interviews were the same for the different stakeholders (Supplementary Table 1).

On the other hand, direct observation of those places where the different stages of cheese production take place has been carried out. This information has been combined with the use of conventional and

aerial photography (photogrammetric flights between 1956 and 2003) and data from interviews, to obtain conclusions about the changes in production modes, and how these changes have been reflected in: a) the existence of different types of buildings for both livestock facilities and cheese factories; b) changes in the location of livestock facilities; c) differences in the type of livestock (traditional and foreign breeds) and in their management (intensive and extensive methods); d) differences in the location of the maturation caves, and in their internal arrangement. This allowed for link the adoption of certain management practices to the landscape and environmental changes after the implementation of the Cabrales PDO. Thus, another of the research objectives (understanding of differences in production sites, buildings, livestock management and environmental/landscape alterations) established in Fig. 1 is achieved. Both the interviews and the direct observation tasks in the field were entirely developed in the territory of the PDO (Fig. 2) between October 2018 and September 2020.

Data relating to the production, sales and promotion of cheese were requested from the Cabrales PDO Regulatory Board and by the Foundation for the Promotion and Diffusion of Cabrales Cheese (F.C.). The data relating to tourist activity in the municipality (tourism rates and accommodation places), offered by the Asturias Tourist Information System (SITA) and by the Cabrales City Council, have also been consulted. These data have been examined in order to know the economic impact of the cheese-making activity, and of other activities that are indirectly related to cheese production (especially tourism) in the territory of the PDO Cabrales. This information complements the previous one and allows establishing the repercussions of the possible incompatibilities between cheese production and other activities (tourism, residential, leisure) as well as making proposals to improve the possibilities of a balanced and sustainable territorial development in the PDO area. Finally, the information obtained in the interviews, the field work and from the data provided by the aforementioned institutions, has been related to the information contained in several bibliographic sources on the origins and evolution of the elaboration processes of Cabrales cheese.

3. A blue cheese born in the mountainous environment of the Picos de Europa

The history of this cheese has a deep connection with the territory in which it was created, mainly located in the council of Cabrales, and in three villages in the neighbouring council of Valle Altu de Peñamellera. These villages are located in some of the most rugged areas of the Picos

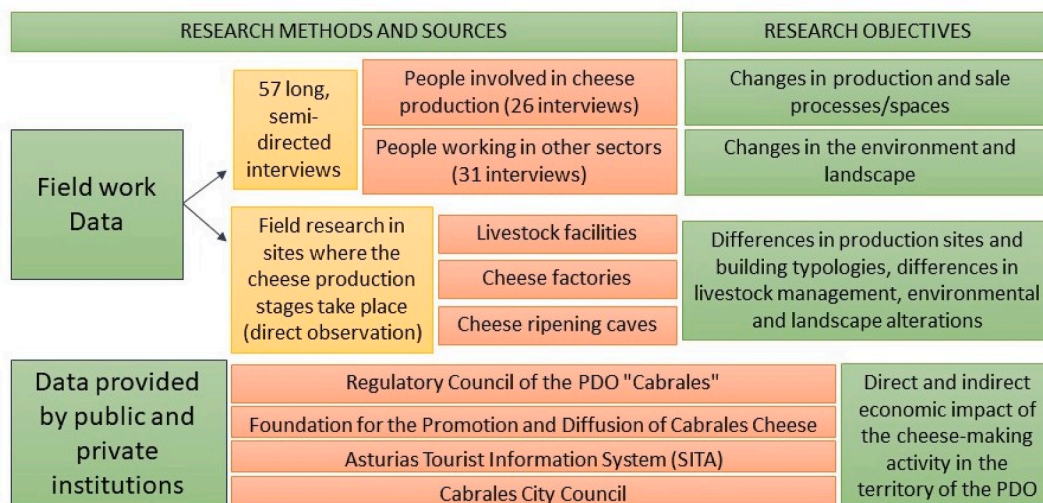


Fig. 1. Methodological procedure. Source: own work.



Fig. 2. Map of the Cabrales PDO area. This territory is located between the municipalities of Cabrales and Valle Alto of Peñamellera (formerly Peñamellera Alta), including the mountainous area of Picos de Europa to the south and the Sierra del Cuera mountain to the north. Source: own work.

de Europa and the Sierra del Cuera mountains (Fig. 2). The river Cares and some of its tributaries carved deep gorges interrupted by river meadows that delimit the main valley. Cabrales is mostly located in the area of the Picos de Europa National Park, which includes what in 1918 was declared the first Spanish National Park, extended in 1995 and also declared a Biosphere Reserve since 2003. Several limestone formations from the Carboniferous period dominate the rocks in this area, with well-developed karst relief and the presence of myriad endokarst cavities (Ruiz-Fernández et al., 2019). The climatic characteristics of this area are typical of the Atlantic mountains, with rainfall of 2500 mm a year in the highest sectors and average annual temperatures ranging between ~ 14 and 10°C in the mid-mountains. The abundance of caves, together with the humidity and temperature, have been decisive factors for cheese production in these mountains, as Cabrales is a blue cheese matured in natural caves.

In the Cabrales mountain, where places suitable for cultivation are relatively scarce, much of the area could so far only be used for grazing. Human beings adapted their practices to this environment in order to create a culture that would take advantage of any possible geographical opportunities. Therefore, cheese production has been a way of making the most of surplus milk since the Middle Ages. The first news about cheese manufacturing in the area dates back to the 13th century, the

same period as in other European mountains, like the Alps (Dalby, 2009; Grasseni, 2011).

In the Modern Age, cheese production was well established in Cabrales, although cheese specialization took place at the beginning of the 19th century, driven by the popularisation of blue cheese in Europe and following in the footsteps of Roquefort cheese. In fact, aside from the ancient tradition and the unique characteristics of the physical environment that sustain Cabrales cheese, there is a significant flow of knowledge imported from France that was combined with local knowledge, as has occurred with other artisan cheeses in Europe (Eriksson & Bull, 2017). Cabrales cheese was already remarkably successful in the mid-20th century. This led to the granting of the PDO to protect quality and prevent fraud in cheese sales. Production increased by more than 75% and has remained more or less stable since the beginning of the 21st century.

The Cabrales is a raw milk cheese, so production does not include a pasteurisation step. Furthermore, sheep's, cow's and goat's milk are used in different quantities, with no fixed proportions. Seasonally, or permanently, it can be made with only two types of milk, or even just one. Initially, production was based only on the milk of small livestock, while cow's milk was used preferentially for the production of butter since it was a more profitable product at first. This changed during the

19th century, when cheese started to be more highly valued. Today, cow's milk is the basis of production. Approximately 10 L of milk are needed to produce 1 kg of cheese, although this can vary depending on the cattle and the feed used. Cheese yield increases up to 40% when sheep and goat milk is used, adding variations such as the fat content, mildness or sharpness that characterise three-milk cheese.

Production process begins with milking. Subsequently, the milk is clotted in a bucket. In the past, coagulant enzymes came from the abomasum, one of the four stomach cavities of ruminants, particularly those of lactating sheep and goats. Nowadays, commercially available milk-clotting enzymes are commonly used, although both types (natural and commercial) are permitted in the Cabrales PDO specifications. Native starter cultures can be used, respecting the native microbiota and their relative proportions, seeking a balance with the endemic phages (thus taking care of biodiversity). The curd is separated from the whey and put into *arnios*, the containers in which the cheese is shaped. The curd is not pressed, so that the mould (micro-organisms of the *penicillium* genus) can penetrate better during the subsequent process (fermentation). Then the cheese is left on racks for three days to release the whey, and salt is added externally. In the airing room, a cold room where the cheese is dried, the microbial colonization processes begin, creating the first characteristic green specks on the cheese.

After two weeks the cheese is taken to the caves, where ripening is completed (Fig. 3). All Cabrales cheeses remain there for at least 60 days. The caves are formed in the rocky substratum of the Picos de Europa and the Sierra del Cuera. It is made up of extremely soluble limestone in which an extensive network of endokarst ducts has been generated. These ducts, known as *soplaos*, channel the air into the caves, which together with the temperature ($\approx 12\text{ }^{\circ}\text{C}$) and humidity ($>90\%$) helps the *penicillium* to spread and penetrate the cheese. Small rock shelters carved out of the limestone, known as cellars or *bodegas*, are also used. There is therefore an evident connection between the characteristic rocky substratum of this region and traditional agri-food activities – in this case, cheese-making.

Before it is sold, the cheese is packaged in greenish aluminium foil with the inscription “PDO Cabrales”, including a label numbered by the Regulatory Board and a label that can be personalized by each producer. This system makes it possible to protect and identify an authentic piece of Cabrales cheese, and has replaced the traditional wrapping made from leaves of the sycamore (*Acer pseudoplatanus*) tree. These leaves were used due to their abundance and size which minimised the time needed to wrap the cheeses, while also representing a further connection between this cheese and its environment. They were substituted not only for health and hygiene reasons, but also due to the fraud associated with the proliferation of cheeses wrapped in leaves that were sold as Cabrales.



Fig. 3. Traditional cave, with the cheeses maturing on wooden shelves. Source: own work.

4. Implementation of the PDO Cabrales: consequences for the production system, the traditional landscape and the environment

4.1. Higher production, fewer producers and productive specialization

The declaration and implementation of the Cabrales PDO entailed the successive introduction of measures: the first of these, with significant territorial implications, stemmed from the need to stop making the cheese in domestic kitchens or shepherds' huts and to start manufacturing it in cheese dairies with the appropriate equipment and hygiene conditions. To this must be added bacteriological, traceability and milk quality controls that are enforced periodically. These logical requirements meant that the number of producers gradually decreased from 140 in 1989 to 100 in 1990 and 81 in 1995, and is now less than forty. So, production has gradually focused on a few producers (Table 1) who have significantly increased their cheese production capacity, since the creation of the PDO has also meant that cheese production has soared due to its higher profitability.

Another of the most recent consequences consists in greater manufacturing specialization within the cheese production chain (Table 1). Although the figure of the dairy farmer and cheesemaker still remains, there are now farms specializing in the production and sale of milk to be processed into cheese, as well as cheese dairies that do not have their own milk. With the consolidation of the PDO and increased demand, milk from the PDO territory went from being sold largely to regional dairy companies to being used exclusively for cheese production, thus increasing its price. The higher profitability of cheese has been a constant in Spain since the 1990s thanks to the fact that the production process adds value to the milk, especially cow's milk (Espejo Marín, 2001). In the case of Cabrales cheese, this phenomenon has enabled the

Table 1

Short- and long-term economic and territorial consequences of the declaration of the PDO Cabrales.

Direct causes	Short-term consequences	Long-term consequences
Increased demands (production, preservation, presentation and storage)	Disappearance of small producers	Concentration of production in a smaller number of cheese dairies Changes in the configuration, as well as in the location of the cheese dairies Changes in the configuration, as well as in the location of linked buildings (livestock buildings)
Increase in the prestige and demand of the product	Increase in total annual production (until reaching equilibrium)	Environmental issues (waste management) Possible incompatibility of uses, especially in the towns (rural tourism) and in the National Park area Reuse of spaces. For example, old mines as maturation caves.
	Increase in the price of milk	Cow's milk is used only in the production of cheeses Productive specialization within the cheese production chain itself
	Intensification of production in lowland areas, and conservation of traditional management in highland areas	Production differentiation (generally on a larger scale in the lowlands, on a smaller scale and often aimed at generating a higher quality product in higher altitude villages)

Source: own work.

production chain to be subdivided by generating significant added value due to scarcity in relation to demand, since the PDO is limited both in terms of area and of production capacity. Consequently, considering the milk production that can be achieved in the PDO's territory, maximum production volume has already been reached.

4.2. Changes in the location and in internal/external configuration of cheese dairies and attached buildings

The requirements mentioned above also resulted in changes in the external and internal configurations of cheese dairies, as well as their location (Table 2). At present, two typologies coexist. The first cheese dairies, which came into existence since the PDO was introduced, consisted of a unit made up of a building attached to the dwelling, with a small area and usually only one floor (Fig. 4). Inside (sometimes also outside, under a roofed area) there is a cooling tank where milk is kept until it is curdled, a heated curdling room containing is a stainless steel vat and shelves used to complete the process of draining off the whey and salting the cheeses. The third element is the airing room, which must be kept cool.

In recent years, taking advantage of European funding, free-standing cheese dairies have appeared where selling is complemented by tasting and guided tours explaining the production process (Fig. 5A and B). These cheese dairies may be organized over two floors, and when they are located in the urban centres the building typologies often seek to be attractive and in harmony with the environment, following traditional building standards. While older cheese dairies tend to be located in the centre and next to dwellings, more recent ones tend to be in the outskirts, attached to livestock farming premises.

With regard to complementary buildings, in recent cheese dairies the optimisation of the artisanal production process has led some to have large cold-storage rooms that from part of the main building. However, in the older dairies, the cold-storage rooms are not always present, and



Fig. 4. Traditional cheese factory in Arenas de Cabrales. Source: own work.



Fig. 5. Modern cheese factories linked to tourist activity. (A) In Arenas de Cabrales, with a store attached to a cutting-edge livestock shed; (B) In Sotres (the building adopts the shape and color of Cabrales cheese). Source: own work.

Table 2
Changes in cheese dairies after the declaration of the PDO.

	Early established cheese dairies	Late established cheese dairies
Location	In the town centre	Outside the town (especially when they are linked to the livestock shed itself) or in the centre (when they are linked to tourist activity)
Architectural typology	Attached to the owners' homes or exempt but in the immediate vicinity. One or, at most, two floors. Sometimes the house is located on the upper floor and the cheese factory on the lower floor	Independent buildings. Usually two floors. Some include a basement. Sometimes they appear linked to recently built livestock buildings
Size	Smaller surface (20–60 m ²). Generally 20–30 m ² .	Larger surface (60–100 m ²)
Internal configuration	Organization in the departments that allow the basic stages of production. Little storage capacity, or an increase in it from the construction or reuse of exempt buildings in the town itself	In addition to the productive departments, there may be others such as a store and a tasting area.
Activities	Preparation and sale. Occasional visits	Storage inside the dairy itself, large capacity cold rooms
Preferential link to standard or "reserve" production	Mainly standard production	Standard and reserve

Source: own work.

are usually free-standing buildings. As for buildings to house the livestock, small sheds of a traditional typology coexist in the centre. They have gradually been replaced by warehouses in the periphery of urban centres, capable of housing several dozen cows. This spatial segregation results from the need to comply with certain sanitary standards and to make compatible the different uses that occur in the villages of the PDO, including tourism and residential. However, there are still small sheds in town centres that are far from complying with these standards, especially with regard to the treatment of animal waste (Fig. 6).



Fig. 6. Traditional stable with solid livestock waste container inside a village (A). These containers are periodically replaced and sent to the Ortiuguero de Cabrales Livestock Waste Plant (B). Source: own work.

4.3. Emergence of differences in the cheese production and its products: cheese of “El Valle” and cheese of “Los Puertos”

Although the production process always takes place in a similar way, based on certain variations among producers we could establish two modes of production. These two modes of production occur in different areas and respond to distinct ways of managing the environment, giving rise to different territorial arrangements. This results in two cheeses with different tastes and average quality (Table 3). Therefore, as happens with other cheese varieties (Folgado-Fernández et al., 2017), there is a difference between the production of *Los Puertos* (a term used in the Picos de Europa area to refer to the highland towns), and that of the

lowland towns (*El Valle*). In the former, the livestock farming system is extensive or semi-extensive, with transterminant management (seasonal movement of livestock over short distances) and a predominance of native breeds (Fig. 7A and B). The milk of native breeds contains high levels of protein, something generally considered an advantage when producing cheese (Eriksson & Pettitt, 2020). In this case, the livestock is confined only during the coldest months, while roaming the highlands in freedom during the summer. The most intensive use is reserved for cows.

In *El Valle*, on the other hand, production is intensive, involving larger numbers of livestock and using breeds that produce large



Fig. 7. (A) Cows and calves of the brown-alpine or Ratina breed in the Valfrú pasture (semi-intensive system). (B) Herd of native goat grazing in the Sierra de Portudera (extensive rearing). Source: own work.

Table 3

Differences in the forms of management and production between El Valle and Los Puertos. Source: own work.

	Cheese production in low-lands (<i>El Valle</i>)	Cheese production in high-lands (<i>Los Puertos</i>)
Cattle hut	Mainly foreign breeds (Friesian cow, Alpine goat, Murcian goat). Reintroduction of Xalda sheep (native), linked rather to meat production.	Native or well adapted breeds to mountain environments (Brown-alpine or Ratina cow, Carranzana and Lacha sheep, and Pyrenean goat).
Livestock management	Higher milk production Intensive farming (confined livestock).	Semi-extensive or extensive farming. Livestock is confined only in the winter months, and seasonal transterminance is maintained.
Milking	Automated milking in all livestock.	Manual milking in sheeps and goats, automated in cows.
Origin of milk	Use of three, two or, frequently, a single type of milk (cow's).	Use of three types of milk (sheep, goat and cow) during the productive season for sheeps and goats.
Linked buildings	Large size and capacity livestock buildings, with optimized means.	Use of small traditional livestock buildings in the towns and in the winter grazing areas, and sometimes livestock farms in the vicinity of the towns.
Ripening caves	Community caves of great size and capacity, generally equipped, frequently, with vehicular access.	Individual caves, or shared by few producers. Generally small in size and capacity, poorly equipped, sometimes with difficult access.
Ripening time	Fast (with a minimum of 60 days).	Slow
Business model	Initially familiar, with the emergence of large agri-food companies such as “Central Lechera Asturiana”.	Familiar
Resulting product	PDO “Cabrales” cheese (standard)	PDO “Cabrales” cheese (standard and reserve)

Source: own work.

quantities of milk and are continuously housed in sheds. The cattle breeds best adapted to mountain environments, such as brown-alpine or Ratina cows (which produce less milk but with a higher fat content), are replaced by others like Friesians (Fig. 8). Similarly, native breeds of goats and sheeps have also been replaced by more productive breeds like Murcian and Alpine goats, which remain confined all year round. This kind of formula, however, usually involves cows, since sheep and goat farms linked to cheese production have much longer work routines due to the higher the number of animals to be milked (Hostiou et al., 2020). In *Los Puertos*, on the other hand, herds of native goats are farmed semi-extensively. The building types associated with these two handling models are also different: *El Valle* system often includes modern livestock sheds in the periphery of town centres, while in *Los Puertos* the most there are small sheds usually built from indigenous materials (stone, wood and traditional tile).

In addition, the maturing caves are of vital importance in the production of this cheese. In the higher sectors of the PDO territory, we find the highest caves, occupied by a very limited number of producers. They are barely converted spaces, located in places that are very difficult to reach (Fig. 9A, B and 9C). In caves at higher altitudes and with lower average temperatures, the cheese ferments more slowly, and this is where the best cheese is produced. For this reason, north-facing caves are usually considered more suited to the production of high-quality cheese. Among those having these characteristics, the caves of Teyedu, located at an altitude of 1100 m, are of particular importance. In *El Valle* there are caves with large production capacities which are shared by many cheese dairies, such as the Cares cave in Arenas. In this case, they are natural caves that have undergone more extensive conversion than those previously mentioned, are organized on one or two floors and equipped with mobile shelves, concrete floors, electricity and running water.

The high profitability and resulting increase in production since the creation of the PDO, led to the reuse of certain spaces like abandoned mines. The mineralization associated with the Carboniferous limestones of the Picos de Europa, made it possible to extract lead, copper, iron, nickel, fluorite, barite, manganese, zinc, cobalt and silver in mines that closed down in the mid-20th century (Ruiz-Fernández, 2006). These mines have optimum air circulation inside, since it was necessary to build vents in order to carry out mining operations. Therefore, the *soplaos* (blowholes) of natural caves were in these cases replaced by ventilation chimneys (Suárez-Antuña et al., 2005), reproducing the optimum environment for ripening. The Boriza mine in Poo de Cabrales and the Trestayeu mine north of Arenas de Cabrales are good examples of this reuse. In localities such as Tielve and Sotres, the most productive in the highlands, the quality of their products is due to the fact that they



Fig. 8. Friesian cow, a non-native breed in intensive housing (zero grazing) system, and being milked by a robot. Source: own work.

generally follow the production model of *Los Puertos*. The resulting product is highly valued both in the market and in specific competitions. Due to this, some cheese dairies decided to diversify their production, selling part of it to intermediary companies in the Asturian agri-food sector while another part, of the reserve type, is sold on a smaller scale in their dairies or to retailers. Selling prices range from 9 to 12 euros a kilogramme for intermediary companies and 25 to 40 for reserve products.

5. Opportunities and threats for territorial development

5.1. Main development chance: linking the landscape, local production and tourism

In Spain, the preamble to Law 6/2015 on PDOs and GIs states that these constitute “a structuring instrument in the development and sustainability of rural fabrics”. Their implementation is certainly usually connected to a significant economic multiplier effect by encouraging the development of parallel activities (Bérard & Marchenay, 2000), among which the diversification linked to tourism stands out (Fernández-Portela, 2012; Fusté-Forné, 2015). In fact, when the promotion of tourism is associated with PDOs, it can offer a high-quality product that also complements agricultural income (Vázquez de la Torre et al., 2014). The creation of authentic experiences in rural environments is often transferred to gastronomy tourism and specifically to cheese gastronomy. In certain regions of Spain, we can speak of a type of tourism associated with the consumption of cheese and promoted through events, specific places and itineraries that, in turn, are a way of adding value to the landscape heritage connected to agricultural activity (Fusté, 2015; Molleví & Fusté, 2016).

In Asturias, gastronomy tourism has been gaining strength for years, and cheese, along with beans and cider, is a key product (Feo Parrondo, 2005). In the case of Cabrales, a council where rural tourism has considerable weight, it seemed logical to take advantage of this multiplier effect. This justified the creation of the Cabrales Foundation (C.F) in 2000, one of whose main functions is the promotion of the physical, cultural, ethnographic and gastronomic aspects that are representative of the territory of the Cabrales PDO. One of the activities regulated by the C.F is a guided visit to a cave-exhibition located in Arenas de Cabrales, next to the river Cares, which receives approximately 30,000 visitors a year, according to data from the foundation. During this visit the history of this food and its production process are explained, culminating with a tasting session. Likewise, at least five of the 29 cheese dairies in the PDO offer the possibility of visiting their facilities for an explanation of the production process and to taste their products. In other cases, cheese dairies offer this service in an unplanned manner. Another way that tourism activities are linked to cheese gastronomy are events such as the Cabrales Cheese Contest. This as successful and well-established initiative that has had 49 editions, with a certain innovative spirit that has resulted in the gradual incorporation of related activities and artisanal themes. It includes a prize-giving ceremony and tasting sessions. Usually about 20 Cabrales cheese producers participate in the event and, by invitation, a delegation representing another Spanish PDO.

Regarding the design of itineraries, the “Cheese and Cider Route”, promoted by two local entrepreneurs based in Asiegu, unifies the gastronomic, landscape and ethnographic values of the territory of the Cabrales PDO. This itinerary associates the quality of local products offered in the *chigre*,¹ a village restaurant, with the ways they are made and the landscape they originate from. This proposal is a response to the idea of the rural landscape and its traditional products as a result of the interaction between natural and anthropic elements that are combined

¹ A term used in Asturias to describe a place where cider is traditionally dispensed, and where other products are commonly sold.



Fig. 9. Traditional and unconditioned caves of H.orcadiellu (A), and Teyedu (B and C), in the highest sectors of the PDO. Source: own work.

to form “heritage in the making” (Lekakis & Dragouni, 2020). In the current context of globalization, regional gastronomic identity becomes relevant, and the opportunity to taste a product in its place of origin is a valuable contact and a way of adding to our knowledge about the culture we are visiting (Mak et al., 2012; Kim and Eves 2012).

Moreover, these initiatives are of particular interest as options for the future because using local products adds value to the region’s hospitality offer (Molleví & Fusté, 2016). Routes that connect enclaves representing the different stages of the production process, or that associate different artisanal production methods, enable agri-food products to become resources that contribute to the development of tourism which, in turn, enables these products to be promoted (Armesto & Gómez, 2004). In addition, these itineraries can combine visits to artisanal cheese dairies with the discovery of surroundings of natural or cultural interest.

Currently, the only initiative of this kind in Cabrales is the above-mentioned one in Asiegu; however, the expansion of this strategy is feasible in a territory such as the Cabrales PDO, located in the heart of the Picos de Europa National Park. This is one of the main karst massifs in the world, that also preserves traces of glacial activity (Ruiz-Fernández & García-Hernández, 2018) and whose value in terms of landscape is also connected to the human interaction with the environment. For all these reasons, this National Park is visited by over two million people a year (SITA, 2017). To this we must add its wealth of fauna, especially fish as the Cares river is highly valued for trout and salmon fishing, both nationally and internationally (Utanda, 2003).

Therefore, the natural worth of the Picos de Europa is a significant driver for the development of the area under study. If we add the development of the artisan production and the existence of traditional shops and *chigres*, the design and promotion of new routes that associate the artisanal products with the landscape that sustains them, and, at the same time, connect different types of artisan production with traditional trade, should constitute a future challenge to be addressed.

The goal to achieve would be to compound all the benefits that the PDO territory obtains from the visits it receives by widening its distribution and diversifying its sources. However, given that the area already

receives a large number of visits, the aim would not be to increase them because when tourism becomes the main source of income in rural areas there is a high probability of saturation that is incompatible with landscape and environmental sustainability in the long run (Vázquez de la Torre et al., 2014). The saturation that occurred in the area during the holiday period following the COVID-19 pandemic lockdown is a good example of the harmful effects that mass tourism can have in a rural area. Accordingly, it does not seem convenient turn the concept of terroir connected to cheese production into a commodity fetish (Paxson, 2010), or forget the principles of sustainable development.

It is necessary to promote tourism that associates cheese with traditional landscapes and activities to be preserved. Many studies have highlighted the importance of certified product systems incorporating quality attributes together with environmental and landscape sustainability (Sanz-Cañada & Macías-Vázquez, 2005). In the case of Cabrales, encouraging more selective and culturally oriented activities, such as the mentioned Cheese and Cider Route (in which local products are related to the territorial values that give them a basis) and connecting them with overnight stays and consumption, seems the best way to enrich the tourist experience while promoting a sustainable tourism development in which, care for the landscape and the environment, become the main tourist hallmark of the PDO territory.

5.2. Threats that must be addressed to achieve sustainable development

The high livestock density associated with large-scale milk production creates a serious problem with animal waste (slurry and manure), that in past decades was dumped directly into rivers. In fact, until a decade ago it was still common practice to flush and liquefy all the waste from livestock sheds with abundant water which would then go into the sewage system without prior treatment. Nowadays, the waste is disposed of in septic tanks and, at major dumping sites (like the Duje river), dumping has practically disappeared. Nevertheless, this practice remains residually. The continued existence of small sheds in centres is also problematic, as they do not possess the necessary facilities for

selective waste collection and, in some cases, continue to dispose of waste directly into the sewage system. It is interesting to consider how, despite the improvements implemented, better waste management is still necessary for the development of alternative activities where the stocking rate is high, as shown by the comparative experience of the main towns in the PDO area: those towns with a higher stocking rate have hardly seen the development of tourist activity compared to those with lower stocking rates. Beyond the local impacts, the discharges can affect the fauna and hinder the development of other leisure activities (for example, fishing for certain species), and may threaten the entire tourist experience in the area. Thus, in order to make livestock farming compatible with the booming tourist activity in the council,² sheds located in the population centres will have to leave in the short term, as required by the Cabrales town council.

Furthermore, measures have been put in place, such as the construction of a solid waste treatment plant in the town of Ortiguera: the solid part (manure) is periodically collected from the sheds and subsequently turned into compost (Fig. 6B). However, this measure has not completely solved the problem, since the plant is not able to take in all the solid waste from the area, and no solution has yet been found for the liquid part. In addition, the manure arrives with a high liquid content, which prolongs its transformation into compost and makes the process more expensive.

Lastly, the disposal of untreated whey, which in the past was used for human or animal consumption, is a practice in decline. Nonetheless, given the high level of biological hazards posed by this waste and the risks it entails, for example, for the fish population (Valencia & Ramírez, 2009), it is a problem that requires the implementation of specific policies. In the village of Tielve, an initiative is currently underway that points the way forward: The waste generated by several of its cheese dairies is given to a pig farm in the neighbouring municipality of Valle Altu de Peñamellera, for animal feed. At least one cheese factory in Asiegu also passes on whey to the same pig farm. Thus, the positive dynamics generated by cheese production are reinforced, combining environmental and economic sustainability. Other possible solutions could involve using whey to generate by-products that can be used as fuel, or to manufacture food (Durán-Padilla, 2015; Hannibal, 2015).

Regarding the enhancement of the landscape aspects that differentiate the PDO's territory, several issues should be mentioned. Certain buildings used for livestock, especially outside town centres (livestock sheds), are not generally in keeping with traditional architecture and significantly impact the landscape. It is also worth mentioning that land reparcelling in several town centres in Cabrales, which has represented a significant advance in terms of profitability of the holdings, has also resulted in significant standardisation of the landscape due to the loss of the original plots and traditional paths. To this we must add the impact of multiple vehicle accessways to sheds, caves and pastures, as well as the use of non-traditional fencing like metal mesh, which is also impassable for wildlife.

Furthermore, feeding confined livestock with non-local pasture (surplus straw from cereal production of another Spanish provinces), also undermines the notion of sustainable development. First to uphold authenticity and uniqueness of the Cabrales cheese, as Biodiversity is an important factor of distinctiveness in PDO products, strongly related to "terroir". Secondly, from the perspective of landscape, because it reduces the extent to which cheese production contributes to maintaining the pastures that form part of the Picos de Europa landscape. Furthermore, grazing combats shrub encroachment and therefore not only preserves the landscape of mountain areas, but also reduces the likelihood of fires (Álvarez-Martínez et al., 2016; Nadal-Romero et al., 2018; Lasanta et al., 2018). In the case of herds dedicated to dairy production, certain grazing strategies are necessary to be efficient in controlling plant

colonization and changes in the landscape, also offering economic and social advantages for farmers, as has been proven in the case of the Roquefort milk producers (Quetier et al., 2005). Moreover, the maintenance of traditional transhumance systems is beneficial from the environmental perspective, both for the pastures and for the herds (Ntassiou et al., 2018).

For these reasons, the continuity of these extensive farming formulas is important for the conservation of the landscape in mountain areas. And not only their continuity, but also the enhancement of their value as a factor that is inseparable from the product, both are necessary to prevent prevailing neoliberal rationales from favouring the appropriation of collective symbolic capital by large business groups which go on to exploit local resources in more profitable, albeit less sustainable, ways (Macías-Vázquez & Alonso-González, 2015).

Nevertheless, certain factors represent a threat to the continuity of this activity, among them the predation of livestock by protected species such as the Iberian wolf. It is true that, regardless of the existence of predators, international literature demonstrates that pastoral activities have reduced in recent decades throughout Western Europe (Olsson et al., 2000; Rosa-García et al., 2013). Various studies, some of them carried out in Spain, show that the fact that young people find employment in livestock farming unattractive makes it difficult for traditional livestock systems to endure (Bernués et al., 2011; Hostiou et al., 2020). However, the growing presence of the Iberian wolf since the early 1990s in Asturias should also be considered, as it has led to progressively greater damage, particularly affecting extensive livestock farming (García-Hernández et al., 2019; González-Díaz et al., 2019, 2020; Petterson et al., 2021). In fact, in Picos de Europa the livestock sector considers wolf predation to be one of its main problems (González-Álvarez, 2015). To protect small livestock when they are not housed in sheds, especially native breeds, electric fences are often put up. This need for protection is combined with problems inherent to the activity, such as mobility difficulties or the loss of animals due to falls, thus threatening the survival of grazing. Sheep numbers in the area fell by more than 80% between 2005 and 2010 (Mateo-Tomás & Olea, 2010). Due to this, current prospects are not good for traditional livestock farming on which higher quality, value-added cheese production, depends.

6. Conclusions

The territorial impact of the PDO Cabrales declaration derives, first of all, from the required implementation of control measures in the production process. The increase in the requirements regarding the production, conservation, presentation and storage of cheese, forced the progressive disappearance of small producers and determined the concentration of production in a smaller number of cheese factories. This caused changes in the configuration of buildings linked to production and currently there are two types of factories coexisting in the PDO territory: one in the town and attached to the house, older, smaller surface, in which only production and sale tasks are carried out, and another located outside the town and apart from the housing, more recent, larger surface, in which activities related to tourism are also carried out.

Second, the increase in the prestige and dissemination of the product brought with it an increased commercial demand. This caused an increase in the price of the PDO milk, allowing the appearance of independent farms from the cheese factories. The increase in production prompted the conditioning of the ripening caves and the reuse of abandoned productive spaces for curing cheese, such as old mines. Moreover, the increased demand for cheese also explains the differentiation of production: On a larger scale and linked to intensive management practices in the lowlands, while in the highlands (where a more exclusive and higher quality product is generated), the extensive practices are preserved.

Threats to the long-term sustainable development of the territory

² According to the latest SITA report (2020), Cabrales, a completely rural municipality, accumulates 2680 accommodation places.

arise from the aforementioned issues. The increase in waste generation, both from livestock and from the cheese-making process, constitutes the main environmental problem to be managed. On the other hand, feeding livestock from imported feed and straw partially undermines the idea that supports the creation of the PDO by reducing the degree to which the development of the cheese-making activity contributes to the maintenance of the traditional landscape. In addition, non-traditional buildings and the multiplication of driveways to caves or livestock areas also have a visual impact. There is, therefore, a certain incompatibility between the increasing intensification of production and the maintenance of landscape values.

However, in the highlands cheese-making has become a carrier of stability in the evolution of the traditional agrarian system. This helped to maintain land planning according to evolved historical patterns, thus preventing its degradation. In this sense, extensive or semi-extensive management practices are associated with the maintenance of traditional buildings, the breeding of native breeds and the conservation of high altitude pastures. In addition, extensive production is linked to a superior quality cheese that increases the prestige of the brand, benefiting the entire production. The tourist promotion of the natural and cultural landscapes that sustain the production of Cabrales cheese, is emerging as one of the best future options for the development of the PDO territory. Therefore, stakeholders and decision makers must consider the aforementioned incompatibilities, reinforcing the idea of a product whose quality is linked to environmental and landscape sustainability through the maintenance of the traditional management practices.

Considering that the extensive herds have gradually diminished, perhaps one of the main values of the Cabrales PDO, the one that upholds the highest standards of quality and landscape and gastronomic uniqueness, is in danger. In this sense, the Regulatory Board for the Cabrales PDO should assess the need to renew its specifications introducing new rules to avoid those practices that undermine the essence of the PDO, and driving those practices that have confirmed their effectiveness in guaranteeing a sustainable use of the PDO territory and protecting its landscape coherence: extensive or semi-extensive management practices.

Declaration of competing interest

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

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.apgeog.2022.102753>.

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