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The Contribution of Geographical Certification Programs to Farm Income and Rural Economies: The Case of Pecorino Siciliano PDO

Emanuele Schimmenti, Enrico Viola, Cassandra Funsten and Valeria Borsellino *

Department of Agricultural, Food and Forest Sciences, Università degli Studi di Palermo, 90128 Palermo, Italy; emanuele.schimmenti@unipa.it (E.S.); enricoviola1811@gmail.com (E.V.); cassandra.funsten@unipa.it (C.F.)
* Correspondence: valeria.borsellino@unipa.it (V.B.)

Abstract: This study attempts to measure the capacity of the EU geographical certification scheme to positively influence the price of certified products and the incomes of their producers. A comparison of the economic results of two cheese-producing dairy farm enterprises with different business strategies and locations within the Sicilian hinterlands is performed in order to determine the transformation value of each dairy's sheep milk into pecorino cheese (with and without the Protected Designation of Origin, or PDO, certification) and the related joint products (ricotta). The economic convenience of the total transformation of sheep milk into Pecorino Siciliano PDO and ricotta is also appraised. The results suggest that producing and commercializing Pecorino Siciliano PDO is a promising strategy for differentiating and promoting dairy farm products and improving the financial performance of producers, with foreseeable positive repercussions in the socioeconomically less favored rural areas where they are located.

Keywords: EU Protected Designation of Origin (PDO); cheese; production location; socioeconomic aspects; differentiation strategy; processing cost; value-added; price-cost margin; internal areas; transformation value

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1. Introduction

During the last few decades, the agricultural entrepreneur has operated in a rapidly and continuously changing socioeconomic context due to the globalization of trade, the reforms enacted by the Common Agricultural Policy (CAP) and changes in consumer behavior and tastes. Specifically, an increasing number of consumers attribute greater importance to the quality rather than to the quantity of the food in their diet [1,2]. With this outlook, the European Union (EU) has emitted intellectual property legislation since 1992 on the Geographic Indication (GI) of quality agri-food products with the aim of allowing consumers to purchase products with known geographical origins and well-defined organoleptic characteristics that are connected to the source of their raw materials and the way in which they are processed and transformed [3–5]. This legislation also aims to improve farmers' income, benefit rural economies and help retain the rural population [1].

Agricultural entrepreneurs have responded positively, adhering to the quality certification schemes that both protect them from illegal imitations and counterfeits and assure consumers of their locally-based origin and quality. In fact, significant growth has been observed over the last two decades in the number of products (which more than quintupled between 2000 and 2020) registered as Protected Designation of Origin (PDO), Protected Geographical Indication (PGI), and Traditional Specialty Guaranteed (TSG).

Italy is the leading producer in the EU with 834 registered products (309 food items and 525 wines) as of 31 October 2020, out of a total of 3082 [6]. Specifically, in the Italian food sector, there are 171 PDOs, 135 PGIs and 3 TSGs. Monetarily, the most important category is cheese, which in 2019 encompassed 58.9% of the sector's production value and

52.6% of the export value: in this regard, Grana Padano PDO and Parmigiano Reggiano PDO are the leaders [7]. In fact, between 1996 and November 2020, the EU recognized and protected 56 Made in Italy quality dairy products with its certified quality labels: 53 are PDOs, 2 are PGIs, and 1 is a TSG [6]. According to a recent report by the Italian "Consiglio per la Ricerca in Agricoltura e l'Analisi dell'Economia Agraria" (CREA) [8], in 2019, the production volume of PDO was 554,518 metric tons, equal to 41.8% of the national production volume of cheese. Furthermore, according to the latest "Istituto di Servizi per il Mercato Agricolo Alimentare" (ISMEA)-Qualivita report [9], the export value of products with quality labels in the Italian food sector was 3.82 billion euros in 2019. Finally, between June 2018–February 2019, there were 1.8 million total online references to the top 100 products (50 food and 50 wine) generated by almost 1 million authors on the web [10].

However, despite the ever-increasing interest for all that is Made in Italy, there are still several critical issues impeding GI policy from fully carrying out its objectives. A disparity remains between the small and large enterprises that produce certified PDO, PGI and TSG goods. Most are generally small, not very organized, even less united and confined to the local market. The legislation counteracts this fragmentation by requiring that applications for the registration and specification amendments of new GI products be made by an association of producers and processors working with the proposed product [1]. Although these associations have been able to organize information systems for managing and monitoring and have been able to efficiently support the protection, supervision, enhancement and promotion of some products protected by the GI certifications to some degree, in many cases, they are poorly structured and not very effective in the promotion and management activities for which they were established. Indeed, on the internal front, the enormous growth potential of the Italian sector of PDO, PGI and TSG products directly depends on its capacity to unify, organize and create a working system [10].

This study focuses on a PDO product with great promise, Pecorino Siciliano, and is particularly interested in its ability to generate greater revenue for producers and positively impact its area of production. Although this cheese is among the first to be produced in Europe [11,12] and already obtained the Denomination of Origin for its highquality in 1955 in Italian law [13], followed by the PDO in 1996 [14], it remains underpromoted. While quality-certified pecorino certainly creates considerable value for its producer, in reality, there is a rather large percentage of uncertified product that acts as an important active asset since it is mostly sold as a fresh product and thus generates the immediate returns necessary to address daily operating costs. In fact, until the recent amendments of 21 September 2020 [15], the Pecorino Siciliano PDO Production Specification (PS) required a minimum ripening period of four months. This obviously entails direct costs related to the handling and storage of the wheels, as well as the spread of returns over time because the product remains in the enterprise for longer. However, a change in the economic-organizational framework of the enterprises producing Pecorino Siciliano is to be expected in the immediate future due to the aforementioned PS amendments, which now also allow the PDO certification for fresh Pecorino Siciliano, aged for just 20 days, as well as semi-aged cheese, in compliance with the traditional processing techniques. Specifically, it regards the description of the product, the production method, labeling, and the addition of articles that were not previously present such as proof of origin, connection with the geographical environment and inspection protocols (the definitive version of the PS is available at [16]).

While various approaches have been taken in evaluating the effectiveness of EU's GI policy and its impact on the various agents along the value chain (consumers, retailers, farmers, and processors as well as local area) [17,18], this study specifically focuses on how PDO labels "can be of considerable benefit to the rural economy, particularly in less-favored or remote areas, by improving the incomes of farmers . . . " (EC Reg. 510/2006 [1]). It aims to measure the economic effects generated by the PDO label in terms of price, revenue for producers (in this case, they are both the farmers and the processors) and the consequent distribution of that revenue along the value chain. Specifically, the producer's margin from

processing sheep milk into pecorino cheese (with and without the PDO certification), as well as its relative joint product (ricotta), is appraised by determining the transformation value, i.e., added value or price-cost margin from processing a commodity product, in two case studies with different business strategies. Furthermore, the economic results of a hypothetical scenario in which all of the product is processed into Pecorino Siciliano PDO (aged for at least four months) are also assessed for both cases. The two studied dairy farms are located in the Monti Sicani area, an internal part of southwestern Sicily (Italy), where the intensification of agricultural practices is not a viable option. However, increasing the amount of PDO certified product could be a more sustainable development solution in this socioeconomically less favored rural area.

The rest of the article is organized as follows: Section 2 reviews the normative regulations regarding the EU's GI labels and then reviews existing literature's documentation of the principle benefits gained from certifying the origin of products; Section 3 outlines the economic context of the sheep farming and pecorino industry in Italy, compares the different Italian PDO certified sheep cheeses, and finally focuses on Pecorino Siciliano PDO and its production in Sicily; Section 4 presents the study's methodological framework, describing the selection of the two case study enterprises, the procedure followed to collect data and the determination of the transformation value from processing their own milk into pecorino cheese; Section 5 illustrates the results while Section 6 discusses them; Section 7 concludes the study.

2. Adding Value to Agri-Food Products with Quality Labels

2.1. EU Regulations Regarding GI Labels

In an increasingly globalized and rapidly evolving market, agri-food enterprises must be able to adapt to new conditions in which consumers are ever more watchful, informed and aware of their personal purchasing choices (facilitated by mass media and the Internet). Furthermore, consumers are increasingly requesting quality and traditional and/or local products [2,5,19,20] with recognizable typical characteristics that are specifically connected to their geographic origin [21].

In response to these above-mentioned considerations, the agricultural and food sector has been looking for ways to make their products more recognizable for some time already. Producers that seek to preserve their traditions while keeping up with the development of innovative methods and raw materials have found strength and competitive advantage in the quality and variety of their agricultural products [17,21–23].

Thus, in 1992 the Council of the European Economic Community (EEC) first instituted the intellectual property rights regulations regarding the PDO, PGI and TSG protection schemes of agricultural and food products. These regulations were successively repealed and replaced, respectively, by Regulation (EC) no. 510/2006 and by Regulation (EC) no. 509/2006, which were then both substituted by Regulation (EU) no. 1151/2012 on the quality schemes of agricultural and food products.

It should be noted that these are "regulated" certification systems. Enterprises may adhere or not, but once they do, they must follow rules imposed by their respective entities (e.g., ISO, UNI, etc.). The relative labels can only be affixed when compliance with the PS has been verified.

For both PDOs and PGIs, quality comes from the connection between the product and its geographic area; however, the intensity of the relationship between the two elements differs. For the PDO, the characteristics and the creation of the product have a total connection with the geographic area that determines the characteristics of the product, while for PGIs, the connection is less stringent and based on the "reputation" of the geographical area. It follows that for PDO products, the entire production process must take place in the area identified by the PS, while for PGI products, some stages of production may take place outside of the interested area [23]. The TSG differs from the geographically based labels insomuch as it focuses on the traditional production process instead of on

the specific area of production; thus, these products are consolidated by tradition and guaranteed through European registration [4].

2.2. Documented Benefits Gained from GI Certification

The establishment of the PDOs, PGIs and TSGs satisfies the needs of those consumers that prefer quality over quantity [1,2], as well as providing them with clear and concise information such as the origin of the product [24]. The PSs provide consumers with specific information on each product's conformity to a system of rules determining its quality, thereby signaling the product's credence attributes and diminishing consumer transaction costs from asymmetric information [17,25]. Producer organizations and the production areas also benefit enormously from GI labels. This enhancement allows the promotion of quality products with defined characteristics, the diversification of agricultural production, fair, competitive conditions between branded products, greater competitiveness (differentiation strategy) and commercial advantages (exclusive use of the GI denomination) compared to standard products [24,26,27]. Furthermore, the benefits derived from the certification of each product contribute to repaying the individual producer for the costs incurred. These benefits include the possibility of selling the product at a premium price; defense against unfair competition; the use of the label obtained through certification as a differentiation tool; the stabilization of commercial relationships; the development of new channels and markets; the possibility of using collective marketing; the guarantee to consumers regarding the product's local origin, traditional methods and quality [17,24,28–32]. More generally, the adhesion to a label by an agri-food enterprise ensures the recognition of the product in the market and allows for a series of unquestionably advantageous results to occur in every phase of the value chain, from primary production to transformation [17,26,29].

Consumer benefits have mainly been studied in the literature by measuring willingness to pay (WTP) [17]. Although most studies show a positive correlation between WTP and GI labels, the literature shows that the extent of that correlation depends on many factors, including geographic region investigated, consumer residence in relation to production area [33], consumer demographic, awareness of GI labels and product type. The resilience and survival of enterprises producing GI products particularly depend on their ability to adapt their sales strategy. For example, during the ongoing COVID-19 pandemic, enterprises that have been able to shift their marketing strategy to online and social promotion channels have been able to weather the storm better. While some products were severely impacted by the suspension of the hotel, restaurant and catering (HoReCa) sector, other products have increased their sales thanks to a heightened consumer focus on health, preference for smaller neighborhood and niche market retailers over mass-market retailers (MMRs) because they are closer to home and less crowded, as well as direct-sale through delivery and online purchase [8].

Agricultural and food enterprises, particularly small ones, find "typical" products particularly useful in recovering premium value lost over time due to the rise of industry and modern distribution [34]. These enterprises are able to monetize this premium value if they can make the consumer perceive the particular qualities of their supply [5]. This recognition by the consumer of the characteristics that differentiate and create surplus value usually occurs through consumer acculturation towards the typical product and its intangible components. This process, in fact, should not be limited to an awareness of the existence of a product, but above all, must include an awareness of its characteristics and appreciation of the benefits that it provides [35,36]. If such awareness exists, PDO certification has been shown to sometimes result in a higher profit margin for processed dairy products than Organic certification because it involves lower material costs [37] for producers.

However, by itself, EU quality scheme adherence does not automatically allow agribusinesses to differentiate their product and improve their competitive position [38], nor obviously, does it make it possible to resolve the infrastructural problems and consequential

limited access to the market that is still so widespread in many components of the agricultural system [39]. The majority of enterprises that operate within the systems connected to the production of typical products are small-medium in size and are often oriented towards marketing on local channels. In these cases, the presence of a PDO-PGI does not carry a particularly informative or guarantee value because other mechanisms are involved (trust, geographic and cultural proximity) [26]. On the contrary, GI schemes seem to be more promising and efficient instruments for those enterprises that operate on distant/modern channels [40]. The decisive factor is the way in which the single business that uses the GI manages to connect with the downstream phases of the supply chain, especially in cases where the product is subject to processing, and the mechanisms by which any benefits obtained on the final market are distributed among the participants in the supply chain itself. Therefore, a capacity for collective organization through Consortia and other forms of associations remains a fundamental element for the real success of geographical indications [28,30,40–43].

Producers of every PDO and PGI product must be united in a group or association in order to propose a new product or amend PSs [27]. Although not mandatory, most GI products maintain their producer groups [18]. In Italy, they are usually formed into Consortia, which are recognized by the National Government as the official representatives of the producers of a GI product if its members make up at least 2/3 of producers and they have an appropriate statute [44,45]. Individual producers are not obligated to join and can independently certify their products; however, Consortia membership provides many benefits. Protection Consortia are increasingly the fundamental element ensuring the surveillance, support and safeguarding of the product. The Consortia also play an important role in the enhancement of the quality and distinctive characteristics of products, carrying out informative, promotional, marketing and communication initiatives to transfer both economic and socio-cultural knowledge of the PDO and PGI production model [26,42], promoting the certified products themselves and, through these, the history and beauty of their geographic areas, the farms that operate there, the gastronomy, tourism and all other related activities [17]. In Italy, they have also been observed to be effective in spreading best practices regarding environmental sustainability and wellbeing by participating in research projects, modifying PSs and organizing and promoting training and education initiatives [46]. For producers themselves, they are often quite influential in reducing costs through collective negotiation, thereby increasing the producers' margin of the price premium gained through GI adherence [18,47].

In the literature, the benefits from GI labels perceived by producers (farmers and processors) have been measured according to appraisals related to prices and costs, case-study analysis of cost-benefit analysis [44], as well as evaluations of economic efficiency [17]. Price-cost margin and the price premium gained are particularly informative indicators regarding the economic convenience of GI certification for producers, although there is high variability among studies so far [17,18,29]. The capacity of GI certification to render enterprises more resilient to the ups and downs of the market has also been studied by looking at survival rates compared to non-GI firms [17,48]. In addition, unlike standard MMR products, GI labels seem to concentrate more revenue upstream, with producers receiving a higher percentage of revenue (as opposed to distributors and retailers) compared to similar non-GI products [18].

Finally, the GIs favor the continuity of the rural population in inland areas by improving farmers' income [17,26,28,29,41,49]. In fact, the protection of local specialties also generates positive effects for the entire connected production system by retaining resources within the rural area, contributing to the consolidation of local social capital and providing input towards the endogenous sustainable development of local areas [17,26,28,30,49].

In the literature, this has been studied by measuring the number of farming and processing enterprises in an area, labor productivity, and total value-added to a given production area or national territory [17] or by using sustainability indicators [50].

3. The Economic Context of the Sheep-Farming Supply Chain

3.1. Pecorino Cheese in General

According to Eurostat data referring to 2019 [51], Italy is the leading producer in the EU with 77.9 thousand metric tons of sheep milk cheeses (equal to 33.7% of the EU-28 total); followed by Spain and France (respectively, 30.3% and 27.9%), which are the countries with which Italian domestic products mainly compete in foreign markets. 42.7% of Italy's production is certified as PDO and PGI (33.2 thousand metric tons) [52].

In Italy, about 7.0 million sheep [53] were reared in 87,250 farms [54] in 2019. They are mainly found in Sardinia (45.9% of the total), Lazio (10.7%), Sicily (9.6%) and Tuscany (5.2%), followed by the regions of Calabria, Basilicata, Campania, Abruzzo and Apulia (together they represent 16.2%). About 468 thousand metric tons of sheep milk are obtained annually from national farms [55]. Milk is mainly produced in Sardinia (68.9%), Tuscany (14.1%), Sicily (5.9%) and Lazio (5.4%) [56].

Pecorino Romano PDO, with a production of 26.9 thousand metric tons in 2019, represents 34.6% of the national sheep milk cheese and 81.1% of the PDO-PGI sheep milk cheese [52], making it the most widespread Italian sheep cheese and internationally traded sheep cheese in the world market. For this reason, historically, its price regulates that of all sheep milk in Italy. The price of sheep milk sold to produce Pecorino Romano fluctuates according to a cyclical trend of overproduction when there are high market prices and a price drop when the market is subsequently flooded (i.e., the cobweb model). This is indicative of a reactive speculative market lacking strategy or controls. Specifically, the average price of sheep milk in Italy has changed in recent years from €0.85/L in 2014 to €1.05/L in 2016 [49] to subsequently descending to €0.56/L at the beginning of 2019. Indeed, the protest of Sardinian shepherds who preferred pouring their milk on the street rather than receiving an unfair price for it received substantial media and political attention in 2019 [57]. The protests eventually resulted in a meeting between the Italian Minister of Agriculture and the European Minister of Agriculture in order to solicit a response from the European Commission [58]. The Commission's response amounted to suggesting that the producers better organize themselves to negotiate better prices and manage the supply of PDO-labeled cheeses, as well as applying for grant and relief aid available through EU agricultural and crisis policies. In the end, the problem was addressed through Italian State intervention for the withdrawal of excess Pecorino Romano PDO from the market and a simultaneous agreement between the parties involved on the price of milk [57].

Again, in 2020, the COVID-19 pandemic slowed internal consumption and international export, creating another surplus of unsold product and price stagnation that was addressed by national measures to rebalance the market by purchasing cheese to be redistributed to the poor, regional buyouts in Sardinia and EU support funds to aid producers in storing their cheese [8,59–61]. This time, the Pecorino Romano Consortium supported cheese producers by backing the processing of all of the collected milk, including that meant for fresher cheeses, into Pecorino Romano PDO. More than 15% more milk was used to produce more than 14.7% more Pecorino Romano PDO cheese than during the previous year. This strategy aimed to prevent a market destabilization like that of the previous year by assuring that the milk was transformed into a more shelf-stable product. The strategy seemed to work, with new international markets and domestic in-house consumption compensating for the drop in United States exports and HoReCa consumption [8], and the price rising to between €7.30/kg and €7.55/kg in respect to €6.60/kg to €6.88/kg in 2019 [57].

To avoid further crises in the sheep milk sector, it would be advisable to implement actions aimed at improving the competitiveness of producers and favoring the development of the Italian sheep milk supply chain. These include the regulation of the production of Pecorino Romano PDO to protect farmers from the dramatic price fluctuations caused by excessive product specialization and accentuated dependence on the North American market [49,57]. At the same time, better efficiency of farms and greater differentiation and promotion of all national Pecorino [57], and in particular of PDO/PGI products, could

guarantee employment and wellbeing in rural areas subject to depopulation due to the lack of alternative production activities [49,60,62].

Indeed, PDO sheep milk cheeses play an important role in the international cheese trade and have a growing international market [49]. In 2019, just over a quarter of pecorino cheeses produced in Italy were sent abroad (about 21 thousand metric tons and 158 million euros in value). National exports show a marked preference for the US market, which absorbs about 65.0% of the quantities exported, followed by Germany, Poland and France (respectively with 7.9%, 4.5% and 4.1%) [60].

3.2. An Overview of the Italian PDO Sheep Milk Cheeses

Almost every region or province in Italy has its own sheep milk cheese, especially in the central and southern parts, made from raw or pasteurized ewe's milk. Most of these cheeses are called "pecorino" after the Italian word for sheep, and follow similar traditional production processes. Additional ingredients may include natural or whey cultures, lamb, kid, calf or vegetable rennet, and basic rind treatments such as olive oil, wax or anti-molding agents. The curd is generally cooked minimally, and these cheeses are matured for varying amounts of time (i.e., the same pecorino is sold at different maturation stages). Table cheeses are fresher, i.e., matured for less time, and have milder flavors. Grating cheeses are more mature and take on a more pronounced piquant flavor [63].

While the production process of these cheeses is similar, except for Vastedda della Valle del Belice PDO (which undergoes a kneading process similar to mozzarella), each local pecorino has its own distinctive terroir, i.e., characteristics coming from the unique environment of its specific locality. Indeed, the concept of terroir is at the heart of the GI labels, and the PSs must include a description of each product's link with its production area [4]. All of the Italian PDO pecorinos make a note of the pasture lands' influence on the cheese characteristics and require the majority of the sheep's diet to be from natural pasture. Indeed, some PSs requires that the cheese be produced during a particular season so as to assure the botanical composition and phenological stage of the plant community making up the sheep pasture (Pecorino Romano PDO and Pecorino Toscano PDO). Furthermore, for all of these cheeses, the milk, rennet and eventual probiotic cultures must come from animals bred within the production area, and some cheeses require only specific landraces to be used (Fiore Sardo PDO, Pecorino di Filiano PDO, Piacentinu Ennese PDO and Pecorino delle Balze Volterrane PDO). Some cheeses are flavored with local products; most distinctively, Piacentinu Ennese PDO contains locally grown saffron, and Pecorino delle Balze Volterrane PDO is coagulated with vegetable rennet derived from wild cardoon blossoms (*Cynaria cardunculus*). Often, terroir also comes into play during the cheese maturation cycle, which may involve traditional reed or wooden equipment (Canestrato Pugliese PDO, Pecorino Siciliano PDO, Pecorino Crotonese PDO), maturation in underground limestone caves (Pecorino delle Balze Volterrane PDO), smoking or rind treatment with ash from Mediterranean shrubs or orchard prunings (Fiore Sardo PDO and Pecorino Filiano PDO). Table A1 in Appendix A shows a comparison of the Italian PDO labeled 100% sheep milk cheeses, showing their registration date, allowed types, and product characteristics, as well as their market size and impact.

In terms of industrial organization and marketing, most Italian sheep cheese PDOs are mature unconcentrated products from small-scale producers working in remote rural locations and have active producers' groups (categories from [18], Table A1). Indeed, as many of the PSs points out, these cheeses are produced in mountainous areas that are unsuitable for other crops or livestock and thus are often the cornerstone of their areas' local economies [64].

Pecorino Romano PDO deserves special mention because, unlike the other pecorinos, it is produced on a large-scale, with long distribution channels. The other Italian PDO labeled sheep milk cheeses are produced on a much smaller scale with national-local distribution channels. Pecorino Romano is by far the most produced Italian PDO labeled sheep milk cheese, with 26,939 metric tons produced in 2019 [52], making up 34.6% of

all national sheep milk cheese and 81.1% of the PDO-PGI sheep's milk cheese [52]. As mentioned above, its price has historically regulated that of sheep milk [49]. Pecorino Romano PDO makes up two-thirds of exports on average [60,65], and this dependence on the international market is what creates such extreme price volatility. Unlike the undulating production volumes and consequential price variations observed for Pecorino Romano, the smaller Pecorino's have shown more constant growth, both in volume and in price; Pecorino Sardo PDO and Pecorino Siciliano PDO have both shown particularly steady growth since 2014 [52].

3.3. The Production of Sicilian PDO Sheep Milk Cheeses

The most recent Italian cheese to enter the EU register of GIs is Provola dei Nebrodi PDO (23/09/2020), which, joining the Piacentinu Ennese PDO, Vastedda della Valle del Belice PDO, the Pecorino Siciliano PDO and the Ragusano PDO, makes for 5 Sicilian cheeses [45]. Although they currently contribute modest production volumes (from 30 to 200 metric tons according to the product) to the total production of national PDO/PGI/TSG cheese products and are much less well-known than cheeses such as Parmigiano Reggiano PDO, Grana Padano PDO, Pecorino Romano PDO, etc., dairy products have always represented an important source of livelihood for the economy of Sicily's inland areas [66]. Growth in the production of Sicilian PDO cheeses that are recognizable and appreciated outside of local borders could create a boost for socioeconomic activities connected to the Region, as well as act as important driving forces for the economy of their local production areas.

Of the 5 Sicilian PDO cheeses currently recognized by the EU, Ragusano PDO and Provola dei Nebrodi PDO are made from cow milk, while Pecorino Siciliano PDO, Piacentinu Ennese PDO and Vastedda della Valle del Belice PDO are all made with sheep milk [67].

For these three pecorino cheeses, a growing trend in production can be observed, even if the quantities produced remain modest. More specifically, based on data provided by the "Istituto Zooprofilattico Sperimentale della Sicilia" (the certifying entity), the production of Vastedda della Valle del Belice PDO went from 6.9 metric tons in 2008 to 30.5 metric tons in 2019 [68]; a positive trend also occurred for the Piacentinu Ennese PDO, which rose from 31 metric tons in 2016 to a production of almost 35 metric tons in 2019 [69]. According to the data provided by the certifying agency, the "Consorzio per la Ricerca nel Settore della Filiera Lattiero-Casearia" (CoRFilaC), the production of Pecorino Siciliano PDO went from 0.4 metric tons in 2002 to 61.5 metric tons in 2019 (Figure 1) [70–72].

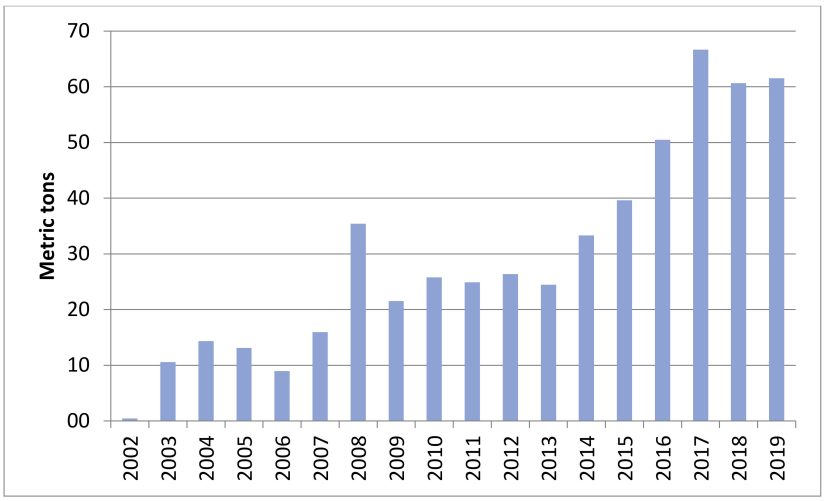

Figure 1. Evolution of the production of Pecorino Siciliano Protected PDO, 2002–2019 (metric tons). Source: our elaboration of CoRFilaC data.

3.4. Pecorino Siciliano PDO

Sicilian pecorino, the oldest known cheese produced in Europe [11,12], was among the first cheeses (together with Fontina, Gorgonzola, Grana Padano, Parmigiano Reggiano and Pecorino Romano) to benefit from the recognition of Denomination of Origin under Italian law in 1955 [13]. Afterward, in 1996 the EU approved the PDO label, recognizing Pecorino Siciliano its register of denominations [14].

The PDO label guarantees a connection between Pecorino Siciliano PDO, the place of origin and the traditional methods of production. The PS (recently modified by the Commission Implementing Regulation (EU) 2020/1338 of 21 September 2020 [15], with the definitive version found in Italian here [16]) delineates the characteristics of the product, the area of production, the proof of origin, the cheesemaking methods, the connection with the environment, the labeling and the presentation of the cheese, as well as the identifying logo. More specifically, the PS describes Pecorino Siciliano PDO as a cylindrical cheese with flat or slightly concave surfaces. It is made with a semi-cooked curd, obtained from raw whole sheep milk of various breeds or their hybrids coming from farms located in the Sicilian Region. According to the new PS, it is released for consumption in three categories: "fresh" (aged for 20–30 days); "semi-mature" (aged from 60–90 days); and "mature" (aged for at least 120 days). In any case, it contains no less than 40% fat of dry matter and may also contain black peppercorns in the first two categories. The diameter of the flat face must be between 10 cm and 30 cm, and the height of the side (heel) must be between 10 and 25 cm. It must weigh between 3 and 14 kg, according to the size of the wheel. The use of rennet in a paste made from Sicilian lambs transfers a set of enzymes to the cheese that develops aromas and flavors that are not found in other pecorino cheeses. The fragrance is that characteristic of sheep cheese; the flavor is sweet with strong grassy notes and slightly peppery in the "pepato" variant, and characteristically spicy for more mature cheeses.

The crust (edible in the fresh cheeses) is white, straw yellow or golden depending on the degree of aging and bears the marks of the reed basket in which it was formed. The matrix is compact, with a few small eyes; the "pepato" variant also has black peppercorns. The color varies according to the maturation: from white to straw yellow in fresh cheeses and from straw yellow to bright yellow in semi-aged cheeses, and straw yellow in aged cheeses. A casein stamp assures the traceability of the product: the stamp is pressed into each cheese wheel showing the denomination "Pecorino Siciliano DOP" and identifying the production serial number as well as a specific number attributed by the EC to the producing dairy. This assures that the product can be fully tracked throughout the supply chain.

The new voluntary Consortium for the protection of Pecorino Siciliano PDO is a nonprofit organization that brings together breeders, producers and ripeners with the intent of protecting the denomination of origin of the Pecorino Siciliano PDO. The Consortium was recognized and authorized by the Minister of Agricultural, Food and Forestry Policy (MiPAAF for Ministero delle Politiche Agricole, Alimentari e Forestali), with DM 15,640 of 5 March 2018, to carry out supervisory functions (previously the voluntary protection Consortium of the Pecorino Siciliano PDO was recognized by the DDG of 5/03/2005, and confirmed with the successive decree of 11 April 2008, of 13 June 2011 and of 3 September 2014).

In 2020, the Consortium was composed of 21 members that were involved in various aspects of the production of Pecorino Siciliano PDO [73]: in fact, there are members that are exclusively breeders, cheese-makers and ripeners, as well as members that participate in all of the production phases of the cheese. The members operate in the following Sicilian provinces: 6 in Trapani, 5 in Palermo, 4 in Agrigento, 3 in Ragusa, 2 in Enna and 1 in Messina.

4. Materials and Methods

4.1. Selection of the Case Studies, Data Collection and Analysis

In order to measure the capacity of the PDO label to generate economic effects in terms of value-added to the certified product, the economic convenience of the transformation

(i.e., processing) of sheep milk into both PDO certified and non-certified pecorino cheese and ricotta are appraised. With this aim, 7 cheese-producing dairy farms were selected from the 15 members of the Pecorino Siciliano PDO Consortium in 2018. At the time of the study, the selected dairy farms carried out all phases of the production chain, i.e., animal husbandry, cheesemaking and cheese ripening (while the other enterprises in the Consortium only carried out one or two phases). Apart from budget and time restrictions, the choice of this approach was motivated by the opportunity to collect information along the entire chain of actions necessary to obtain the PDO certified product; thus, it was preferred to concentrate the analysis on these farms in order to obtain a deeper understanding of the ability of Pecorino Siciliano PDO to improve the financial performance of its producers. These seven farms are mostly located in the western part of the island of Sicily. At this point, since GI labels can benefit the rural economy, particularly in less-favored areas [1], the investigation was focused on an inland rural part of Sicily with a vocation for extensive agriculture and animal breeding, which is very representative of the traditional agriculture of the Sicilian hinterland. Specifically, the selected area is the Monti Sicani area, where the provinces of Palermo and Agrigento meet, in the southwestern part of the island (Figure 2).

Figure 2. Location of the Monte Sicani and companies 1 and 2.

The definition contained in the "Strategia Nazionale per le Aree Interne" (SNAI) [74] summarizes the specific qualities of an "internal area" as follows: an area that is significantly distant from centers offering essential services (instruction, health and mobility), but rich in important natural and environmental resources as well as valuable cultural heritage. In fact, a good part of the towns located in the Monte Sicani area is within the "Terre Sicane" internal area [75], in the "rural areas with development problems" defined by the "Programma di Sviluppo Rurale (PSR) Sicilia 2014–2020" [76] and in disadvantaged zones, according to Reg. (UE) 1305/13, art. 32 [77]. This inland rural part of Sicily is characterized by few employment opportunities, low incomes, and long-distances from services and infrastructure [62], as well as increased vulnerability to critical geographic (hydrogeological instability, loss of Utilized Agricultural Area (UAA) and demographic problems (depopulation, aging) [74]. Thus, the Monti Sicani area is a perfect example of the contrast between fragile town infrastructure rooted in sociodemographic conditions, poor transport connections and a lack of school and hospital services and uncontaminated healthy rural landscapes and under-used systems of natural, agricultural and livestock resources holding enormous potential for local development [63] that is so characteristic of inland Sicily.

Apart from its representativeness, the Monte Sicani area was chosen for this study because it boasts the presence of two agri-food districts ("Le Vie dei Formaggi Distretto Rurale" of the Monti Sicani and the "Distretto Produttivo Siciliano Lattiero Caseario") [78], and it is associated with two other agri-food products with EU quality labels: the Ribera Orange PDO and the Bivona Peach PGI. Thus, by leveraging the aforementioned agricultural and cultural capital, the Monti Sicani area could experiment with sustainable models of wellbeing, centered on the relationship between the land and the local community, on a "slow" pace of life, and on the capacity to combine historic traditions with new technology harmoniously in the landscape [63]. Considering the area's conditions, increasing the quantity of PDO certified products—which would involve the continuation of production traditions that have been handed down in families from one generation to the next—could lead to an improvement in the economic results of single farms as well as sustainable development of the Monti Sicani area as a whole.

Once PDO cheese producing dairy farms within the study area were individuated, the owners were contacted to ask whether they would be willing to participate in the study. Of the three contacted farms, only two chose to participate.

These two dairy farms are of quite different dimensions and modus operandi, with the obvious exception of the Pecorino Siciliano PDO cheesemaking process stipulated by the PS and reflect the two prevailing kinds of companies in the Consortium that participate in the entire cheesemaking process. One of the two farms was run by the president of the Consortium at the time of the study (2018).

The study involved three visits to each dairy farm, with each visit requiring between one and three hours, to collect the technical-economic data necessary to determine both the revenue as well as the transformation cost of processing in-house sheep milk to cheese products, including Pecorino Siciliano PDO. Follow-up questions, clarifying specific issues or uncovered topics, were subsequently delivered through telephone calls or e-mails. The whole data collection process occurred in various moments during the period from October 2018–February 2019 and regarded the solar year of 2018. During this time, the PDO label could only be applied to products with a maturation of at least four months.

Based on previous research carried out on other products (e.g., [78]), an ad hoc interview schedule [79] was drafted and administered via a semi-structured face-to-face interview to the owners of the two companies. The interview schedule includes closed questions and open-ended questions and is composed of four sections. The first includes questions to collect general information (company size, product specialization, legal form, the start of the company, year registered with the Protection Consortium, crops and livestock present, and the production of any certified organic goods).

The second section examines the kinds of buildings on the premises and their respective sizes and layouts; the equipment in each dairy; the vehicle fleet; the practices used; employee hierarchy, distribution and education level, the involvement (or not) of third-party consultants such as marketing experts, lawyers or accountants; the possible use of EU funds, the advantages received by certifying the product and any issues encountered.

The third section addresses the collection of balance sheet items that contribute to the value of the processed product (cheese products), specifically: the number and breed of the sheep raised; the number of heads on average in production; the maximum working capacity of the processing plant; the quantity of milk obtained on the farm and any quantity destined for sale or purchase; data on cheese production and ricotta and its selling price through various channels.

The fourth section looks at the processing costs of the milk in the cheese: costs tied to electricity consumption; water; fuel; rennet; salt; everyday materials; packaging and labeling costs, administrative costs for the PDO certification; daily working hours necessary for the cheesemaking process; costs regarding the ripening of the products, including social obligations and the total duties and taxes paid.

The interview schedule concludes by asking for the personal considerations of the owners regarding the current situation of the industry in the area and their thoughts on future prospects for development in the sector.

The analysis methodology is made up of three steps. The first involves detailed profiling of the two dairy farms, describing their history and organization as well as their operations. The second includes a farm-level technical and economic analysis. The collected technical and economic farm management data were processed in MS Excel in order to calculate the revenues and production costs as well as the economic convenience of processing the milk into pecorino and ricotta. The third step was to synthesize and reflect on the statements of the respondents.

4.2. Method of Calculating the Transformation Value of Processing Sheep Milk

This paper bases its methodology on the Italian school of valuation's transformation value, with the specific procedure taken from [80]. The value of an economic asset takes on different economic bases (i.e., standards) according to the purpose for which a valuation is performed (the practical needs of the valuation) [81]. Thus, the economic bases are valuation methods that are chosen by the valuation expert according to the characteristics of a certain asset. Italian valuation considers transformation value to be one of the six core economic bases (called "aspetti" or aspects in Italian texts) of an asset: market value, cost value, transformation value, complementary value, capitalization value and substitution value. International valuation standards (IVS), which are based on British and American conventions, do not specifically name transformation value. However, they do consider various derivative values, including a similar albeit broader concept called "fair value", or rather "the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date" [81,82].

Specifically, the transformation value of an asset is the net value obtained from its transformation into other goods and is equal to the difference between the market value of all of the goods that are obtained or are obtainable through transformation and the expenses sustained or sustainable for the transformation itself. Transformation value (and the consequent transformation value/unit, or transformation price) is particularly informative for the valuation of land or buildings as well as the economic convenience of transforming raw materials into processed goods. In this second case, the valuation of transformation value and price can be viewed as a form of value chain assessment. In fact, the Italian methodology of transformation value appraisal could be particularly informative for sustainable value chain assessment.

According to the general principles of valuation, both the positive and negative items of the transformation must be calculated with the current values at the time of the assessment and on the assumption that the conditions and data are assumed to remain valid. In practice, the transformation value of a given economic asset is determined by means of an income statement, in which the transformation products are calculated on the basis of the market price as a revenue component (returns or positive element) and as a cost element (losses or negative element) of all the expenses, with reference to a pure entrepreneur (a theoretical figure that procures all production factors externally). This makes the economic results obtained from different entrepreneurs comparable despite the possibly different production factors that are actually owned by them, necessary to carry out the transformation itself.

In summary, the expenses connected to the transformation process of a given good are (Table 1) [83]:

- Depreciation quota (reintegration, maintenance and insurance expenses) of involved fixed capital (non-current assets);
- Miscellaneous expenses for the purchase of materials and third-party services except for the object of transformation;
- Duties, taxes and provisions (social obligations);
- Payment for manual and intellectual labor;

- Interest payable on fixed capital (equipment and premises) and anticipated expenses.

Table 1. Methodology for the calculation of the transformation cost.

Factors Employed	Calculation Criteria	Cost Includes
Land and building capital	% of the value of the land and buildings capital	Land rent Land and building depreciation quota
Agricultural capital stock	% of the value of the agricultural capital stock (equipment and machinery)	Agricultural depreciation quota Interests payable
Services and technical means	Analytic calculation	Miscellaneous expenses
Labor	Analytic calculation	Wages and social obligations
Other	Flat rate or analytic calculation	Taxes, salaries, interest on anticipated capital

The added value from transforming sheep milk into cheese (Vt) was appraised by detracting the costs sustained to process the obtained cheese products (liabilities) from the value of the same (assets) [83–86]:

$$Vt = Vm - K$$

where:

Vt = transformation value of sheep milk;
Vm = market value of the obtained products (cheese and ricotta);
K = cost of the transformation.

By relating Vt to the quantity of transformed milk, the transformation value per unit is obtained, called the transformation price.

If the transformation price of the milk is more than the market price of untransformed milk, then it can be concluded that the transformation activity to obtain cheese and its correlated joint product is economically convenient.

The value of the pecorino cheese and the ricotta produced was determined by summing all of the revenue coming from the sale of the products obtained by processing the sheep milk produced in-house during the year 2018 (the two companies used their own milk and did not resort to purchasing any from outside their farms). The total production of pecorino cheese in the two companies was derived from an average declared yield of 17% of the average annual milk production, from which a quota of 12% was first subtracted to account for the quantity of milk added to the whey to produce the ricotta cheese; the yield in ricotta was about 14% of the total processed milk. Based on the declarations of those interviewed, it is possible to derive the quantity of the different pecorino productions–Pecorino Siciliano DOP, semi-mature pecorino and fresh pecorino–as well as the jointly produced ricotta and the relative sale prices regarding different sale channels.

The items that make up the transformation cost are costs of miscellaneous expenditures, wages and social contributions; salaries; duties and taxes; depreciation costs (reintegration, maintenance and insurance quota); capitalized interest. One of the two surveyed companies also produces and processes cow milk: in this case, the joint costs are estimated by considering the percentage of processed sheep milk (40%) in respect to the total volume and the different cheese maturation periods for the products.

As for the miscellaneous costs (materials and third-party services), those relative to electricity, water, fuel, rennet and other material (salt, various products used daily in dairies for processing and sanitization, and packaging and labeling material) and for third-party services were determined based on the data provided by the company owners regarding their processing activity. The cost for the PDO certification was determined by considering both the fixed costs owed to the certifying agency and the variable costs relative to the quantity of certified cheese produced.

The wages and the contributions were calculated based on the number of daily hours declared by the interviewees regarding the operations carried out during the cheesemaking and aging phases, during a working period of about 260 days per year and of an hourly

wage rate obtained from the paychecks of the hired workers, equal to €10.40 gross of social obligation provisions.

Compensation for intellectual work was determined on a flat-rate basis by applying 3% to the processed product, while duties and taxes were based on the declarations of the company owners.

The depreciation quota regard premises and equipment. For the first, the replacement value of the buildings was preliminarily calculated (dairy and ripening room) considering a value of €300.00/m^2, while the value of new equipment was used for the latter.

A reintegration quota was calculated on the replacement value of the premises with a rate of 3%. Maintenance and insurance quotas were estimated with an overall percentage of 1.5%. The determination of the quotas for the equipment was carried out by adopting a 4% rate on their new value, respectively, for the reintegration quota and for the maintenance and insurance quotas. Since cow milk is also transformed in one of the two interviewed dairy farms (for the production of Caciocavallo Palermitano cheese), 60% and 40% of the quotas have been applied, respectively, to the value of the premises and equipment of this company based on the use made for the processing of sheep milk.

Capitalized interest was calculated on the equipment, on the premises and on the anticipated capital. The interest on the equipment was estimated to be equal to 3% of half of the new value, while a rate of 2% was applied to the premises on the cost of rebuilding the same. In the case of the cow and sheep cheese producing dairy farm, percentages of 60% and 40% were also applied to the amount of interest regarding the premises and equipment to account for the portion of this cost item related to processing sheep milk. The interest on the anticipated capital, which includes the costs actually incurred (miscellaneous expenses, maintenance and insurance fees, taxes, wages and contributions), were valued for an advance period of 2/12 (considering the flow of costs and of revenues) using an interest rate of 4%.

The transformation value of sheep milk obtained from the difference between assets and liabilities was also calculated for both companies; this value was then divided by the total quantity of processed milk, thus obtaining the transformation price per liter of milk.

Finally, the economic results of the two companies were assessed in a hypothetical scenario of the total transformation of the in-house produced sheep milk into Pecorino Siciliano DOP and ricotta. In this scenario, the data relating to the assets (production and sales prices and volumes) and the liabilities (various expenses, wages and social contributions, salaries, duties and taxes, depreciation quotas and capitalized interest) were appraised on the basis of the primary data of the production of the two products in the two companies.

5. Results

5.1. Company 1

This dairy farm is located in Santo Stefano Quisquina (AG), at an elevation of 900 m above sea level, in a typical area of the Sicilian hinterland and covering an area of about 300 ha along the shores of lake Fanaco. The farm is family-run, and the legal status of the company is that of a general partnership.

The farming system is prevalently cereal and livestock. The animals are grazed on the farm's pastures with the integration of dry product (i.e., field beans and barley) for a few months out of the year. The local species of pasture grasses transmit a pleasant aroma to the milk, which in turn gives the dairy's products particular flavors. The owners' professional experience—skills that have been handed down for four generations—has efficiently led the company up to its current production results; the company, in fact, produces high-quality cheeses, with authentic full-bodied flavors, using only its own milk with rennet and salt, and without the addition of enzymes or other additives.

This dairy farm raises cattle as well as sheep, with each contributing to the total in-house milk yield by 60% and 40%, respectively. The cow milk is used to produce Caciocavallo Palermitano, plain and smoked caciotta, and salted ricotta, while the sheep

milk is used to produce fresh ricotta, fresh pecorino and, most importantly, Pecorino Siciliano PDO, for which the company has received several awards. The company joined the Pecorino Siciliano PDO Consortium in 2009.

The company owns about 1100 Valle del Belice sheep that produce an average of 920 L of milk per day. There are about 800 heads of cattle with an average daily production of milk per head of 1.15 L during a lactation period of 200 days, producing an average annual yield of 184,000 L of milk. The processing plant has a maximum working capacity of 3000 L of milk per day.

The dairy is 400 m^2 large with an adjoining ripening room of about 200 m^2, where the Pecorino Siciliano PDO and the Caciocavallo Palermitano are matured before being sold. The dairy has the various equipment necessary to process milk into cheese, including traditional equipment such as wooden vats and rush baskets where the cheese curd is placed after cooking, according to the Pecorino Siciliano PDO's PS.

The main, although not the only, sales channel is wholesale; only a small part of the product is sold directly through online retail on the company's website, while the ricotta is often sold directly to local pastry shops. About half of the produced cheese leaves national borders and primarily goes to Belgium and the United Kingdom.

For wholesale, the Pecorino Siciliano PDO is packaged in 12 kg wheels, in vacuum-sealed plastic pouches with the company logo and the Protection Consortium's certificate; smaller portions (up to 1 kg, with similar packaging) are available for online retail on the website. Fresh cheese is produced in portions that range from 1 kg to 5 kg, according to the wholesaler's request and is also packaged in vacuum-sealed plastic pouches with the company logo. Ricotta is sold in special containers called "fascedde" containing from 0.5 kg to 1 kg of product, according to the requests of the buyer.

During 2018, the sheep milk processed into cheese was all produced in-house. The value of the product made from sheep's milk processed by the company was €320,033.00 compared to a total estimated transformation cost of €100,078.01 (Table 2).

Given the difference between the two aforementioned values, the resulting transformation value is €219,954.99. The transformation price, equal to the relationship between the transformation value and the total quantity of processed milk (184,000 L), is €1.20/L. Comparing this price with the sale price of the sheep milk in the investigated area, which fluctuates between €0.70/L and €0.75/L, decidedly shows that processing the milk is economically convenient.

The value of the processed product is made up of 71.83% from the pecorino (49.27% of PDO certified pecorino and 22.56% of uncertified pecorino) and 28.17% from the ricotta.

However, analyzing the quantity produced shows how 51.66% of the total is composed of pecorino (27.02% PDO certified and 24.64% uncertified), and the remaining 48.34% is ricotta. The bearing of the ricotta and of the unlabeled pecorino on quantity is decidedly more than the bearing on value due to the lower unit sale prices: €5.50/kg for fresh pecorino and €3.50/kg for ricotta vs. €10.95/kg for PDO pecorino.

The total necessary transformation cost is made up of the miscellaneous expenses by 40.12%; among these, the cost item with the greatest impact is that regarding "other materials" (including materials for packaging and labeling, salt and various daily use products for production and sanitization of the premises). This is followed by wages and social contributions (29.72%), duties and taxes (12.79%), salaries (9.59%), depreciation quota (5.45%), and finally capitalized interest (2.32%).

Table 2. Comparison of the transformation value of the surveyed companies' milk.

Items	Company 1		Company 2	
1. Value of the processed product	€320,033.00	100.00%	€128,117.55	100.00%
• Pecorino Siciliano PDO	€157,680.00	49.27%	€34,128.00	26.64%
- Quantity (kg)	14,400		2880	
- Price (€/kg)	10.95		11.85	
• Fresh pecorino	€72,193.00	22.56%	€32,182.40	25.12%
- Quantity (kg)	13,126		5696	
- Price (€/kg)	5.50		5.65	
• Semi-mature pecorino	-	-	€22,362.15	17.45%
- Quantity (kg)			3467	
- Price (€/kg)			6.45	
• Ricotta	€90,160.00	28.17%	€39,445.00	30.79%
- Quantity (kg)	25,760		11,270	
- Price (€/kg)	3.50		3.50	
2. Processing cost	€100,078.01	100.00%	€43,751.38	100.00%
2.1 Miscellaneous expenses	€40,150.00	40.12%	€11,477.00	26.23%
- Electricity	€7200.00	7.19%	€1800.00	4.11%
- Water	€1200.00	1.20%	€450.00	1.03%
- Rennet	€3000.00	3.00%	€375.00	0.86%
- Fuel	€10,000.00	9.99%	€2352.00	5.38%
- Other materials	€11,000.00	10.99%	€4500.00	10.29%
- PDO certification	€1750.00	1.75%	€800.00	1.83%
- Third-party services	€6000.00	6.00%	€1200.00	2.74%
2.2 Wages and social obligations	€29,744.00	29.72%	€18,928.00	43.26%
2.3 Salaries	€9600.99	9.59%	€3843.53	8.78%
2.4 Duties and taxes	€12,801.32	12.79%	€5124.70	11.71%
2.5 Depreciation quota	€5458.40	5.45%	€3259.00	7.45%
- Maintenance and insurance quota	€2279.20	2.28%	€1427.00	3.26%
- Reintegration quota	€3179.20	3.18%	€1832.00	4.19%
2.6 Capitalized interest	€2323.30	2.32%	€1119.15	2.56%
- Interest on equipment	€556.80	0.56%	€383.25	0.88%
- Interest on anticipated capital	€566.50	0.57%	€195.90	0.45%
- Interest on premises	€1200.00	1.20%	€540.00	1.23%
3. Transformation value	€219,954.99		€84,366.17	
4. Transformation price	€1.20/L		€1.05/L	

5.2. Company 2

This dairy farm is located in Castronovo di Sicilia (PA), at an altitude of about 600 m above sea level and covering an area of about 40 ha with a primarily cereal and livestock farming system. The legal status of the company is a limited partnership, consisting of two partners who are brothers.

The livestock is almost exclusively sheep, with a few cattle and poultry; the animals feed on natural pasture, for the most part, an aspect that gives the dairy products their unique aromas and tastes that are characteristic of the area.

The company, which has been run by the family for over three generations, now enjoys an excellent local reputation thanks to the experience accumulated by the owners and the transmission from father to son of traditional techniques and the use of simple, genuine raw materials such as their own whole sheep milk coagulated with lamb rennet, without any kind of additive.

The company only produces Pecorino Siciliano PDO in the Spring, when the sheep are exclusively fed on natural pasture. Aside from Pecorino Siciliano PDO, fresh and semi-mature pecorino are also produced, as well as ricotta, of course. The company was one of the first to join the Pecorino Siciliano PDO in 2005.

The herd is made up of about 500 sheep of the Valle del Belice breed and produces an average of 402 L of milk per day; specifically, an average of 350 head produce milk with an

average daily production of 1.15 L per head and a lactation period lasting 200 days, for a total of about 80,500 L of milk produced yearly.

The dairy farm's processing plant has a maximum working capacity of 600 L per day. It is made up of a dairy with a connected ripening room for a total of about 90 m^2. Traditional equipment is used, such as wooden vats, as well as more modern equipment that meets current health codes.

The main sales channel is wholesale (70% of the company product) with distributors than selling the product at a prevalently national level (just a small percentage of the product is sold internationally); retail sale follows (30%) and regards fresh and semi-mature pecorino. The Pecorino Siciliano PDO destined for wholesale is packaged in 10 kg and 12 kg wheels in vacuum-sealed pouches with the company logo and the Protection Consortium's label; smaller portions are also available for the retail of up to 1 kg with the same packaging system. Fresh and semi-mature cheese is produced in portions between 2 kg and 5 kg, according to buyer request and is also vacuum sealed with the company label attached. The ricotta sold in the "fascedde", containing between 0.5 kg and 1 kg of product according to buyer request, is sold via both wholesale and retail channels.

In 2018, the value of the processed product made entirely from their own sheep milk was estimated to be €128,117.55 compared to a cost of €43,751.38. Therefore, the resulting transformation value is equal to €84,366.17 (Table 2).

A transformation price of €1.05/L is obtained by comparing this last value to the total volume of processed milk (equal to 80,500 L). It is clear that processing is also convenient in this case, considering the average selling price of milk in the region in question (between €0.70/L and €0.75/L).

The value of the processed product is made up of 69.21% from pecorino (26.64% from PDO labeled cheese and 42.57% by non-labeled cheese); the remaining part, 30.79%, is from ricotta.

An analysis of the produced quantities shows that 51.66% of the total is pecorino, with 12.36% of that being PDO labeled cheese and 39.30% being unlabeled; the remaining 48.34% is ricotta. Regarding the effects of the ricotta and the unlabeled pecorino on total quantities compared to total value, the same considerations made previously regarding the different sales prices apply, in this specific case equal to €11.85/kg for pecorino DOP, €6.45/kg for the semi-mature pecorino, €5.65/kg for fresh pecorino and €3.50/kg for ricotta.

The total cost necessary to process in-house milk into pecorino and ricotta is made up by 43.26% of wages and social obligations (this is decidedly more than in company 1, probably due to less efficient use of manpower), by 26.23% of miscellaneous expenses, where the largest expense item is also that of other materials, by 11.71% of duties and taxes, by 8.78% of salaries, by 7.45% of depreciation quota and 2.56% by capitalized interests.

5.3. A Comparison between the Two Companies

Table 3 shows a comparison between the two surveyed companies regarding the determination of the transformation value of the dairy farms' sheep milk into cheese.

Table 3. Comparison of the transformation value of the surveyed companies' milk.

	Value of Processed Milk	Processing Cost	Transformation Value	Milk Processed	Transformation Price	Unprocessed Milk Price
Co. 1	€320,033.00	€100,078.01	€219,954.99	184,000 L	€1.20/L	€0.70–0.75/L
Co. 2	€128,117.55	€43,751.38	€84,366.17	80,500 L	€1.05/L	

The transformation prices calculated for the two surveyed companies testify to the economic convenience of processing their milk into pecorino cheese and ricotta since they are significantly higher than the average sale price of milk in the area.

The difference between the obtained values for each company (€1.20/L vs. €1.05/L) can be attributed to various factors; the most evident is the different bearing of the quantity

of PDO product on the total obtained from the transformation of in-house milk into cheese. The revenues obtained from the sale of the PDO product cause the processing price of company 1, whose production of Pecorino Siciliano PDO has a value equal to approximately half of the total value obtained (regarding pecorino and ricotta), to be significantly different from that of company 2, which on the contrary shows a value of Pecorino Siciliano PDO equal to about $\frac{1}{4}$ of the value of the overall product obtained.

Regarding costs, the income statement item with the strongest impact is labor. Another aspect that influences the different processing prices is the different economies of scale achieved by the two companies. Fixed costs for the companies, including the depreciation quota and the capitalized interests, diminish proportionally with the volume of processed products. This allows company 1 to amortize these costs to a greater extent. Some operational costs regarding the management of the processing plant also have an impact, albeit less so, and diminish proportionally as a greater volume of product is processed.

Regarding the considerations expressed by the owners about the current state and future possibilities for the sector, a common fear emerged regarding the possible entrance of medium-large industrial enterprises that would be very competitive, with greater production and commercialization techniques as well as more innovative and effective marketing and distribution.

Other aspects that emerged during the investigation regard the relationships between productive activities and the socioeconomic context of the inland area of Sicily in which the two examined companies are located. The disastrous infrastructural situation that characterizes the geographical area in which these companies operate was brought up various times by the company owners during their interviews and makes them skeptical regarding any short-term solutions. The lack of suitable infrastructure makes the transport of raw materials and the products made from them difficult: the two companies have remained isolated for long periods due to landslides and interruptions in the road systems, mainly due to heavy rains. Furthermore, this isolation has made it difficult for patrons, such as occasional tourists or hikers, to visit; this is a lost opportunity, which could represent an additional distribution channel for their product.

5.4. Hypothetic Scenario

A hypothetical scenario regarding the total processing of all of the dairy-farms' in-house sheep milk into Pecorino Siciliano PDO and ricotta is shown in Table 4.

Table 4. Determination of the transformation value of milk in the hypothetical scenario.

Items	Company 1		Company 2	
1. Value of the processed product	€391,569.70	100.00%	€182,154.55	100.00%
• Pecorino Siciliano PDO	€301,409.70	76.97%	€142,709.55	78.35%
- Quantity (kg)	27,526		12,043	
- Price (€/kg)	10.95		11.85	
• Ricotta	€90,160.00	23.03%	€39,445.00	21.65%
- Quantity (kg)	25,760		11,270	
- Price (€/kg)	3.50		3.50	
2. Processing cost	€118,408.28	100.00%	€56,955.14	100.00%
2.1 Miscellaneous expenses	€43,650.00	36.86%	€16,777.00	29.46%
- Electricity	€7200.00	6.08%	€2950.00	5.18%
- Water	€1200.00	1.01%	€450.00	0.79%
- Rennet	€3000.00	2.53%	€375.00	0.66%
- Fuel	€10,000.00	8.45%	€2352.00	4.13%
- Other materials	€12,500.00	10.56%	€6500.00	11.41%
- PDO Certification	€3250.00	2.74%	€1500.00	2.63%
- Third-party services	€6500.00	5.49%	€2650.00	4.65%
2.2 Wages and social obligations	€37,856.00	31.97%	€22,984.00	40.35%
2.3 Salaries	€11,747.09	9.92%	€5464.64	9.59%
2.4 Duties and taxes	€15,662.79	13.23%	€7286.18	12.79%

Table 4. *Cont.*

Items	Company 1		Company 2	
2.5 Depreciation quota	€6573.60	5.55%	€3259.00	5.72%
- Maintenance and insurance quota	€2656.80	2.24%	€1427.00	2.51%
- Reintegration quota	€3916.80	3.31%	€1832.00	3.22%
2.6 Capitalized interest	€2918.80	2.47%	€1185.12	2.08%
- Interest on equipment	€573.30	0.48%	€383.25	0.67%
- Interest on anticipated capital	€665.50	0.56%	€260.43	0.46%
- Interest on premises	€1680.00	1.42%	€540.00	0.95%
3. Transformation value	€273,161.42		€125,198.61	
4. Transformation price	€1.48/L		€1.56/L	

In this hypothetical scenario, a significant increase in the processing price can be observed in both estimated cases: from €1.20/L to €1.48/L for company 1 and from €1.05/L to €1.56/L for company 2 (Table 5).

Table 5. The economic convenience of processing milk.

Destination of Dairy Farm Milk	Price of Milk (€/L)	
	Company 1	Company 2
Only production and sale of milk	0.70–0.75	
Processing into pecorino, Pecorino Siciliano PDO and ricotta	1.20	1.05
Processing into Pecorino Siciliano PDO and ricotta	1.48	1.56

The resulting economic convenience of processing all of the milk into Pecorino Siciliano PDO and ricotta demonstrates the development potential of this PDO cheese, which, at the time of this study, had to be matured for at least four months. Factors that could have diminished these results, e.g., the production and commercial risks associated with producing a single type of cheese matured for four months, seem to disappear in the light of the recent amendments to the Pecorino Siciliano PDO PS, making the hypothetical scenario illustrated above less hypothetical and even more advantageous.

6. Discussion

The results of the research show that it is economically convenient to process the dairy farm's sheep milk into pecorino cheese (with and without the PDO certification) and the related joint products (ricotta), and that this convenience is even higher in the case of a complete transformation into Pecorino Romano PDO and ricotta, essentially due to the fact that the market price for the PDO cheese is much higher compared to uncertified cheese. These results agree with findings from other studies exploring how labels and quality certifications can improve the revenue of farmers and generate development for the entire production systems of local areas [10,17,24,26,28–32,87]. However, as in other studies where authors have identified the implementation of the protected GIs by producers that are less than their productive potential [30,44,88], the investigated dairy farms also do not fully take advantage of all of the potential offered by the Pecorino Siciliano PDO, notwithstanding the greater economic convenience of processing the milk into a certified product. It bears noting that not all of the companies that produce pecorino in Sicily are able to make use of the protected GI. In both cases, there is a limitation of the direct and indirect benefits for the entire productive system. Different factors influence the level of GI use by farms, including the long maturation periods requested by the old PS (active until 2020) and the simultaneous need to face operating costs with immediate returns, as well as other factors already identified in the literature, such as the direct and indirect cost-benefit relationship [44,89] as well as the characteristics of the PS itself [90]. The recent modifications to the Pecorino Siciliano PDO PS will make applying the GI certification to the

entire production much more advantageously feasible for all members of the Consortium in the immediate future, thereby also favoring the entrance of new members into the Consortium. Fresh and semi-mature cheeses are now recognized as categories that can be marketed with the PDO label [21]. This new version of the PS is in line with what has been shown by other studies [26,40] regarding opportunities to adapt the content of specifications to changes in the market with the aim of improving the efficiency of GIs. In fact, by eliminating the previously existing constraint restricting the production period to October through June, the new PS also allows the production of fresh and semi-mature Pecorino Siciliano PDO in the summer. These less-mature categories are the most requested by consumers (especially tourists), as specified in the application for approval to amend the PS itself [21]. The new option of producing certified cheese with the addition of black peppercorns, appreciated by some consumers, is also significant. In addition, the inclusion of specific labeling rules (hitherto self-regulated by the producers) that allow consumers to quickly identify the product will increase the effectiveness of promotion campaigns [24,28,87]. These elements will allow a reduction in the unit costs of using the label as well as an increase in the benefits obtained, making the use of the PDO label less burdensome, especially for small producers [89]. Consequently, it is foreseeable that the GI's use will increase. This forecast is supported by the affirmations of [44,89,91,92], according to whom more flexible PSs simplify the certification process and increase the possibility that farms will use GIs, determining an increase in both the number of enterprises that use PDO/PGIs as well as the total quantity of certified products, thereby further increasing the opportunity for these products to reach supermarket shelves and international distribution channels. At the same time, the same research [44,89,91] emphasizes that more flexible PSs attract large enterprises that are able to capture the benefits of an economy of scale, in line with the fears expressed by the interviewed entrepreneurs in this study. This could create more difficulties for smaller producers and even lead to their disappearance by making the processing of their product economically inconvenient [89,90]. Evidently, these fears can also be traced back to a low propensity for coming together in associations, a deep-rooted historic problem in the Sicilian agri-food sector [20].

7. Conclusions

The decision by enterprises to use a quality certification system is the result of a complex assessment of the costs and economic benefits that they derive from it. The factors that come into play in the cost-benefit analysis are numerous and often involve articulated evaluations and quantifications, and are closely linked to the characteristics of both individual companies and the entire regional production system. In general, the choice of whether or not to use a denomination falls within the logic of the strategies of individual companies, and in particular, the type of markets served and the requests of intermediate and final customers, and depends on the financial, technical and human resources of the enterprise.

This study attempts to evaluate the capacity of the EU's geographic certification system to generate a positive impact on the price of certified products and on the returns made by producers through an appraisal of the economic results of processing sheep milk into pecorino cheese, with and without the PDO certification, as well as a hypothetical scenario in which all milk is processed into the PDO labeled product. The results suggest that producing and commercializing Pecorino Siciliano PDO is a promising strategy to differentiate and increase the quality of dairy farm companies' products and to improve the financial performance of producers, with foreseeable positive consequences in the areas where they are located that are characterized by socioeconomic problems.

This study has implications for local food producers; indeed, the results provide deeper insight into the cost-effectiveness of adding value to their dairy products with EU quality labels and could further stimulate their commitment to product certification, thus playing a significant role in activating and supporting the local development processes in the rural areas where they are located. However, these effects are not automatic and

can also entail a series of potential negative effects that must be carefully evaluated and managed. For example, the feared arrival of larger companies that can more efficiently process and commercialize the product in question can, on one hand, increase its visibility beyond regional and national borders (such as what has happened with more famous pecorino cheeses), but at the same time jeopardize the survival of the small dairy artisans that are the most connected to traditional methods and are the custodians of the history of these valuable products that have been handed down from generation to generation. The adoption of a certified label of origin makes PDO products more than local; despite being produced locally, they are codified by international rules that identify the product by elevating its typicality and at the same time homologating it for the international market. In fact, these are products that must be "changed" in order to be preserved and handed down; products that are precious because they are "different", but whose protection reduces diversity; products originating from evolving local "know-how", but that must be crystallized by "official" knowledge; products that are characterized as part of the community heritage, but which at the same time must obey market rules [62,93]. As a consequence, the contribution of the GIs to farm profitability and local development requires an adequate regulation of their production: strong local governance and teamwork between the Consortia, the producers and other local stakeholders are fundamental to coordinating the production sectors, from communication to price policies, and achieving an efficient promotion of the product and supply control, increasing the effects of the PDO reputation by more equitably distributing value added and stimulating other correlated beneficial local activities (for example the production of other goods and services, including tourism).

This study also has implications for researchers in the field: the methodology applied in this study can serve as an efficient model for future research regarding the direct producer-oriented appraisal of the economic benefits of the EU certification system on product prices, producer income and more generally on the local and regional economy. No other research study from the same point of view exists; indeed, little scientific interest has been shown for the determination of the transformation value and prices obtained from processing agri-food products. Although this is an Italian Valuation methodology, it may prove useful for investigating value added in sustainable supply chains. Because this methodology is based on the determination of elements such as transformation cost, sales returns and the simple price-cost margin, it provides a direct valuation of the impact of GIs on producers' results. Indeed, this study purposely chose to focus on the point of view of the producers, rather than of consumers, since the majority of research tends to concentrate on the latter. A balance between producer and consumer-oriented research would enrich the overall understanding of the subject of GI labels.

There are some limitations to this study that are hoped to be overcome with further investigations. One limit connected to the direct valuation method employed is exactly its reliance on prices and costs that are observed in a specific moment. Our evaluation of economic convenience is favorable in the cases observed, but should sale prices fall, or costs increase, then that could change.

Another limitation is the small number of cases; more would be auspicious. Unfortunately, these are mostly family-run enterprises where the owners are often not able to find the time to participate in research and provide data regarding costs and revenue because they must dedicate their entire work-day to the productive activity of their company. Another limit comes from the fact that the study was carried out while a previous PS was active. Now that a different PS is in force, the observed situation can no longer be reproduced. The research would benefit from continuing the investigation with a wider up-to-date sample, with the aim of also investigating the effects of changes introduced to the new PS, which presumably will result in an increase in producer revenue, more companies participating and an increase in the supply of PDO products. These effects of the new PS will become visible in a few years.

In addition, only Pecorino Siciliano PDO is investigated here. In the future, the study may be repeated by examining other PDO cheeses of both regional and national importance in order to verify the effects generated by the geographic certification system in terms of the economic convenience of processing the milk into cheese and comparing the results. Furthermore, it would be useful to continue this study by including other categories of certified products that are also from other regions. The contribution to the local (Monti Sicani area) and Regional (Sicily) economy should be further explored, both in scope and in-depth, in order to identify and make the best use of the potential offered by the certificate in the future and improve the sustainability of the local community.

Finally, the lack of similar investigations in the regional and national market limits the possibility of making comparisons between the results of this study and other analogous investigations.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study, including on the security, confidentiality, permissions, and appropriate use of the data provided.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

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Appendix A

Table A1. Italian whole sheep milk * cheese PDOs † ranked according to production volume.

Name	Registration Date	Types	Characteristics	Size and Impact ‡
Pecorino Romano	21/06/1996	Table cheese matured ≥5 months Grating cheese matured ≥8 months	Production area: entire regions of Sardinia, Lazio and Grosseto province (Tuscany) Production period: October–July Production material and methods: Made from milk from sheep bred in the production area that may be thermolyzed and lamb rennet Inoculation with probiotics allowed Dry or wet salting allowed Rind may have a black or neutral protective cover Product characteristics: Hard, cooked cheese Size and weight: 15–35 cm diameter; 20–35 kg Fat content of dry matter 36%	PV: 26,939 metric tons (2019) 35,632.42 metric tons (2016) SV: €251 M ESV: €148 M Workers: 11,424 Enterprises: 38 UAA: 271,922 ha Consortium: "Consorzio per la tutela del formaggio Pecorino Romano"
Pecorino Toscano	02/07/1996	"Tenero" matured ≥20 days "Stagionato" matured ≥4 months	Production area: region of Tuscany, municipalities of Allerona and Castiglione del Lago, (Umbria) and Acquapendente, Onano, San Lorenzo Nuovo, Grotte di Castro, Gradoli, Valentano, Farnese, Ischia di Castro, Montefiascone, Bolsena and Capodimonte (Lazio) Production period: September–June Production materials and methods: Made from raw or thermally treated milk from sheep bred in the production area Inoculation with lactic bacteria Veal or vegetable rennet allowed Dry or wet salting Anti-mold treatment of rind allowed Product characteristics: Soft or semi-hard cheese, distinctive for mild flavor Size and weight: 15–22 cm diameter; 7–11 cm heel height; 0.75–3.5 kg May be produced in other shapes if prepackaged Fat content of dry matter ≥45% for "tenero", ≥40% for "stagionato"	PV: 3205 metric tons (2019); 3651.64 metric tons (2016) SV: €31 M ESV: €6.9 M Workers: 852 Enterprises: 15 UAA: 19,889 ha Consortium: "Consorzio Tutela Pecorino Toscano DOP"

Table A1. *Cont.*

Name	Registration Date	Types	Characteristics	Size and Impact ‡
Pecorino Sardo	02/07/1996	"Dolce" matured for 20–60 days "Maturo" matured for ≥2 months "Maturo" cheese may be smoked Prepackaged grated cheese from "maturo"	Production area: entire Autonomous Region of Sardinia Production period: Unspecified Production materials and methods: Made from thermolyzed or pasteurized whole sheep milk and veal rennet Inoculation of milk with probiotics allowed Dry or wet salting Oil or anti-mold treatments of rind allowed Freezing prohibited Product characteristics: Semi-cooked cheese Size and weight of "dolce": 15–18 cm diameter; 8–10 cm heel height; 1–2.3 kg Size and weight of "maturo": 15–22 cm diameter; 10–13 cm heel height; 1.7–4 kg Fat content of dry matter: ≥40% for "dolce", ≥35% for "maturo"	PV: 2000 metric tons (2019); 1724.44 metric tons (2016) SV: €13 M (2016) ESV: €3.2 M Workers: 7181 UAA: 170,861 ha Consortium: "Consorzio Per La Tutela Del Formaggio Pecorino Sardo Dop"
Fiore Sardo	02/07/1996	Table cheese matured <6 months Grating cheese matured ≥6 months	Production area: Entire Autonomous Region of Sardinia Production period: Unspecified Production material and methods: Made from milk from sheep bred in the production area from Sardinian breeds and lamb or kid rennet May be inoculated with probiotics Wet salting Rind treated with olive oil Product characteristics: Hard, uncooked sheep cheese Size and weight: 1.5–4 kg Fat content of dry matter: ≥40% Smoked	PV: 981 metric tons (2019) 814.03 (2016) SV: €8.2 M ESV: - Workers: 269 Enterprises: - UAA: 6376 ha Consortium: "Consorzio Tutela Formaggio Fiore Sardo DOP"

Table A1. *Cont.*

Name	Registration Date	Types	Characteristics	Size and Impact ‡
Pecorino Siciliano	21/06/1996	"Fresco" matured 20–30 days "Semistagionato" matured 45–90 days "Stagionato" matured ≥120 days "Pepato" variant of "fresco" and "semistagionato" cheeses	Production area: Region of Sicily Production period: throughout the year (as of recent amendment [15]) Production materials and methods: Made from whole raw sheep milk and lamb rennet from animals bred in the production area; black peppercorns are also allowed in "fresco" and "semistagionato" cheeses Dry or wet salted Product characteristics: Semi-cooked hard cheese Size and weight: 10–20 cm diameter; 10–20 cm heel height, 3–5 kg weight for "fresco" and "semistagionato"; 15–30 cm diameter, 15–25 cm heel height, 6–14 kg weight for "stagionato" Fat content of dry matter: ≥40% Can only be sold whole or in pieces, not grated	PV: 87 metric tons (2019); 38.75 metric tons (2016) SV: €0.37 M (2016) ESV: €0.03 M Workers: 28 UAA: 500 ha Consortium: "Consorzio di tutela del Pecorino Siciliano DOP"
Piacentinu Ennese	15/02/2011		Production area: municipalities of Enna, Aidone, Barrafranca, Calascibetta, Piazza Armerina, Pietraperzia, Valguarnera, Villarosa in the province of Enna (Sicily) Production period: Unspecified Production methods and materials: Made from raw, naturally fermented lamb milk from "Comisana", Pinzirita", and "Valle del Belice" breeds and their hybrids and lamb or kid rennet, saffron produced in the production area and black pepper granules Matured for ≥ 60 days Size and weight: diameter 20–21 cm, heel height 14 cm-15 cm Fat content of dry matter ≥ 40% Protein of dry matter ≥ 35% Salt content ≤ 5% pH 4.8–5.7	PV: 36.19 metric tons (2016) SV: €0.46 M ESV: - Workers: 22 Enterprises: - UAA: 428 ha Consortia: "Consorzio di tutela formaggio Piacentinu Ennese DOP"

Table A1. *Cont.*

Name	Registration Date	Types	Characteristics	Size and Impact ‡
Vastedda della Valle del Belice	29/10/2010	-	Production area: Caltabellotta, Menfi, Montevago, Sambuca di Sicilia, Santa Margherita di Belìce and Sciacca in the province of Agrigento (Sicily), Calatafimi, Campobello di Mazara, Castelvetrano, Gibellina, Partanna, Poggioreale, Salaparuta, Salemi, Santa Ninfa and Vita in the province of Trapani (Sicily), and Contessa Entellina and Bisacquino in the province of Palermo (Sicily) Production period: Unspecified Production method and materials: Made from raw, naturally fermented sheep milk from animals bred in the production area and lamb rennet Wet salted Traditional kneading method Product characteristics: Loaf shaped, rindless, kneaded-curd cheese Size and weight: 15–17 cm diameter, 3–4 cm thick; 500 g–700 g in weight Rindless Fat content of dry matter $\leq$35% Salt content of dry matter <5%	PV: 30.85 metric tons (2016) SV: €0.28 M ESV: - Workers: 14 Enterprises: 7 UAA: 309 ha Consortia: "Consorzia di tutela della Vastedda della Valle del Belice DOP"
Canestrato Pugliese	21/06/1996	Table cheese matured<6 months Grating cheese matured $\geq$6 months	Production area: Foggia Province (Puglia) and the municipalities of Altamura, Gravina di Puglia, Poggiorsini, Spinazzola, Minervino Murge, Andria, Corato, Ruvo di Puglia, Terlizzi, Bitonto, Toritto, Grumo Appula in Bari Province (Puglia) Production period: Year-round Production materials and methods: Made from sheep milk and animal rennet Dry or wet salted Matured 2–10 months Product characteristics: Uncooked hard cheese Fat content of dry matter $\geq$38% Brown crust treated with olive oil and vinegar Size and weight: 25–34 cm diameter, 10–14 cm heel height, 7–14 kg weight	PV: 21.98 metric tons (2016) SV: €0.21 M (2016) ESV: - Workers: 17 UAA: 381 ha Consortium: -

Table A1. *Cont.*

Name	Registration Date	Types	Characteristics	Size and Impact ‡
Pecorino delle Balze Volterrane	20/02/2015	"Fresco": 7–44 days "Semistagionato": 45 days–6 months "Stagionato": 6 Months#x2013;12 months "Da asserbo": ≥ 12 months	Production area: municipalities of Volterra, Pomarance, Montecatini Val di Cecina, Castenuovo Val di Cecina, and Monteverdi (Tuscany) Production period: Unspecified Production materials and methods: Made from raw sheep milk from Sardinian breeds bred in the production area and vegetable rennet extracted from *Cynara cardunculus* Thermophile or mesophile probiotics, or whey probiotics admitted Dry salted Rind of "da asserbo" cheese treated with olive oil and ashes Product characteristics: Size: 10–30 cm diameter; 5–15 cm high; 0.6–7 kg Fat in dry matter: >45% Protein <20%	PV: 13.62 metric tons (2016) SV: - ESV: - Workers: 12 Enterprises: - UAA: 262 ha Consortium: "Consorzio di Tutela del Pecorino delle Balze Volterrane DOP"
Pecorino di Filiano	15/12/2007	-	Production area: Potenza province (Basilicata Region) Production period: Year-round Production materials and methods: Made from raw sheep milk from the Gentile di Puglia, Lucania, Leccese, Comisana, and Sarde breeds and their hybrids and kid or lamb rennet Dry or wet salted Maturation in natural tufo caves or underground Matured for ≥180 days Rind treated with extra-virgin olive oil and wine vinegar Product characteristics: Hard cheese Percentage of fat in dry matter ≥30% Size and weight: 15–30 cm diameter, 8–18 cm heel height, 2.5–5 kg weight	PV: 1 ton SV: €0.01 EV: - Workers: 9 Enterprises: - UAA: 190 ha Consortium: "Consorzio per la tutela del Pecorino di Filiano"

Table A1. *Cont.*

Name	Registration Date	Types	Characteristics	Size and Impact ‡
Pecorino Crotonese	27/11/2014	"Fresco" "Semiduro" "Stagionato" ≥6 months	Production area: carious municipalities in the provinces of Crotone, Catanzaro and Cosenza (Calabria) Production period: Unspecified Production method and materials: Made from whole raw, thermolyzed or pasteurized sheep milk from animals bred in the production area and kid rennet May be naturally fermented with whey probiotic Dry or wet salting Product characteristics: Hard, semi-cooked cheese Smaller format: diameter 10–20 cm, heel height 6–15 cm, weight 0.5–5 kg; Larger format: diameter 20–30 cm heel height 15–20 cm, weight > 5 kg Fat of dry matter ≥ 40% Protein ≥ 25% Humidity ≥ 30%	PV: - SV: - ESV: - Workers: 34 Enterprises: - Consortium: "Consorzio di tutela Pecorino Crotonese"
Pecorino del Monte Poro	07/07/2020	"Fresco": 20–60 days "Semistagionato": 61 days-6 months "Stagionato": 6–24 months	Production area: Monte Poro district in the Vibo Valentia province (Calabria) Production period: Unspecified Production materials and methods: Made from raw whole sheep milk and lamb or kid rennet Rind may be treated with olive oil and, for cheeses matured >6 months, crushed chili pepper Product characteristics: Size: 6–40 cm diameter; 6–20 cm high; 0.6–10 kg Fat in dry matter: >45%	PV: - SV: - ESV: - Workers: - Enterprises: - UAA: - Consortium: "Consorzio del Pecorino del Monte Poro DOP"

* Only cheeses made exclusively with sheep milk were considered; cheeses such as Pecorino di Picinisco PDO were not included because they allow a certain percentage of goat or cow milk. † Data compiled from the QUALIGEO database [94], eAmbrosia database [6] and the PSs made available on the MiPAAF DOP IGP portal [67]. ‡ Production volume abbreviated as PV; sales volume abbreviated as SV; PV from 2019 from [52], PV from 2016 from [94].

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