

Article

Perception of Ecosystem Services from Podolian Farming System in Marginal Areas of Southern Italy

Emilio Sabia , Ada Braghieri * , Corrado Pacelli, Adriana Di Trana  and Adele Coppola 

School of Agricultural, Forest, Food, and Environmental Sciences, University of Basilicata, 85100 Potenza, Italy; emilio.sabia@unibas.it (E.S.); corrado.pacelli@unibas.it (C.P.); adriana.ditrana@unibas.it (A.D.T.); adele.coppola@unibas.it (A.C.)

* Correspondence: ada.braghieri@unibas.it

Abstract: Ecosystem services (ESs) are gaining increasing interest among researchers, local communities, and policymakers. The farming of Podolian cattle in the remote and marginal areas of southern Italy plays an important socio-economic role. This study aimed to assess the perception of ESs provided by Podolian cattle farming in the Basilicata region among the local actors and stakeholders. Using a questionnaire administered to 198 respondents, the level of agreement and disagreement was assessed on a 1–5 scale for the four main ESs: cultural, regulating, supporting, and provisioning. On average, the perception of ESs related to Podolian cattle farming was positive. However, the role of promoting tourism in the region was somewhat controversial, and the results in terms of regulation were divisive. The perception of provisioning services had a highly positive result. Further research is needed to better understand the role of Podolian cattle farming in the Basilicata region, providing more explicit guidance for local communities and policymakers.

Keywords: extensive rearing systems; cultural services; provisioning services; regulating services; supporting services; livestock; grazing; policymakers



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1. Introduction

Land abandonment, ageing, and depopulation characterize many of southern Italy's inner areas, marked by low resources' productivity, scarce job opportunities, and a lack of social and economic infrastructures. Agriculture and livestock farming play a crucial role in maintaining these areas' populations and landscapes. Therefore, European Union (EU) intervention in marginal areas mainly focused on ensuring a fair income level to guarantee the persistence of agriculture. This objective may imply considering all the goods and services agriculture can provide and valuing its social, cultural, and environmental contribution. Recognizing the capacity of agriculture to supply different ecosystem services (ESs) and the value people assign to them is the basis for policymakers to define interventions to compensate farmers for the positive externalities and multiple functions they carry out.

Currently, research on ESs is growing, and this subject is gaining greater recognition and dissemination, extending its reach beyond scientific experts to a broader audience [1–4]. The view of ESs, popularized through the Millennium Ecosystem Assessment in 2005 [5], points to the connections between various ecosystems, including agroecosystems, and their impact on human well-being. Ecosystems can provide diverse services that hold significant importance for human welfare, health, livelihoods, and even our existence. Human well-being is a multifaceted concept often used interchangeably with personal happiness, quality of life, and health. It also encompasses broader aspects such as human welfare, robust social connections, and the protection of human rights [6]. In a formal classification, ESs can be categorized into four distinct groups [5]. *Provisioning* ESs include tangible or energy-related outputs, such as food, water, fuel, timber, and fiber. *Regulating* services refer to the biophysical processes that provide benefits like climate regulation,

flood prevention, waste treatment, and water purification. Ecosystems can also provide *supporting* services, processes like soil formation, photosynthesis, or nutrient cycling, which are essential for producing all the other ESs. The last group of ESs includes *cultural* services related to recreational, aesthetic, educational, and spiritual benefits the ecosystems can offer [7].

Agroecosystems are characterized as “cultural landscapes” [8] and play a vital role in delivering ESs. In marginal mountain areas, extensive livestock systems have played a significant role in establishing and sustaining semi-natural habitats. The key distinctions between these and other agricultural systems are evident in the utilization of traditional low-input practices and land management, particularly with meadows and pastures, especially in less favorable and less accessible areas. Additionally, they provide recreational and cultural experiences [9]. ESs can be perceived as an interface between people and nature, a concept often exemplified by the “cascade model” [6,10]. This model emphasizes the interconnectedness of ecosystems and human well-being, illustrating how natural processes provide services that ultimately benefit individuals and society. It underscores the idea that ecosystem changes can have cascading effects on human livelihoods, demonstrating the intricate relationship between people and the environment. Moreover, the outcomes in the cascade [11] model are goods and benefits that are relevant to people and, thus, reflect that in their value [11]. This value can lead to choices related to ecosystems management, and, therefore, its assessment is crucial to address policy intervention [11]. As a matter of fact, the value people assign to ecosystem services depends on people’s perception of benefits, which appears very heterogeneous, and also depends on their knowledge and awareness [12]. There is rising interest in applying the ESs framework to research on mountain regions and environments [13]. In a study conducted by Mengist et al. [14], more than a thousand articles were published between 1992 and 2019 on ESs in mountain areas, and, of these, about half in recent years. This study analyzed the ESs associated with extensive livestock farming in marginal mountain areas. Nevertheless, there is an increasing need for information concerning the consequences of decisions on ecosystem services and human well-being [15]. Unfortunately, a significant disparity exists between the research findings and the information requirements of decisionmakers and practitioners [16].

The increasing worldwide demand for food has spotlighted livestock production as never before. This sector, encompassing both meat and dairy production, stands out as a significant contributor to the emissions of greenhouse gases driven by human activities. It is crucial to recognize that livestock farming plays a pivotal role in the ongoing issue of climate change and environmental sustainability. Furthermore, it is essential to appreciate that different livestock production methods can yield diverse outcomes concerning ESs. These outcomes are not limited solely to environmental impacts but also extend to agriculture’s social and economic aspects and policymakers’ decisions. Understanding these synergies and tradeoffs across various agrozootechnical sectors becomes paramount as we navigate the complex landscape of global food production. Several studies underlined the contribution of livestock farming to ESs provision. Some of them analyzed how the animal density and intensity of grassland management relate to biodiversity [17–20], soil erosion [21,22], and *regulating* ESs [23,24]. Other studies focused on ranking and evaluating the environmental functions of livestock, such as pasture management, land use, and carbon sequestration [25–27]. Several studies have approached ESs in cultural terms [28–32], with relevance to the practice of transhumance [33], which plays multiple roles in ESs provision, such as soil fertility maintenance, wildfire prevention, and cultural engagement with local populations. Other studies have observed how natural afforestation due to the abandonment of inland areas can have multiple effects on cultural ESs in social terms [34]. Extensive rearing systems of native breeds may represent a valid opportunity to preserve natural ecosystems, supporting, at the same time, the socio-economic development of marginal areas, such as those of southern Italy. These marginal areas, in fact, are unsuitable for economically viable crop cultivation [10]. An example of this farming is provided by the Podolian system (Figure 1).

				
Podolian breed	Rearing system	Transhumance	Meat production	Cheese production
Calve with its dam: natural weaning at around 7–10 months	Extensive or semi-extensive rearing system during the different seasons	Practice applied on most farms to ensure a constant amount of pasture feed biomass for animals	Fattening phase of young bulls in the stable or on pasture	Cheese-making process of Caciocavallo Podolico Lucano cheese, a Traditional Agri-food Product

Figure 1. The main characteristics of the Podolian system.

Podolian cattle represent a native breed, traditionally raised on pasture in southern Italy, with nocturnal shelter. This system is frequently established on low-fertility soils and permanent pastures characterized by low production, where herbage growth exhibits uneven distribution throughout the year. These cows graze on natural pasture year-round, with transhumance practiced by most farms to guarantee the animals a fairly constant quantity of grazing biomass. Podolian cows typically calve in the spring between February and April [35]. Calves usually remain with their dams until 7 or 10 months of age, either at pasture or in provisional sheds or in loose barns; during this period, they benefit from suckling and natural weaning (Figure 1). After weaning, calves may be finished in the same farm or sold and finished in a fattening farm, provided by a straw-bedded barn equipped with an outdoor paddock (Figure 1). The slaughtering age varies from 16 to 18 months [35].

Thus, rearing indigenous breeds like Podolian cattle is a way to use natural ecosystems while supporting economically active local communities sustainably [36]. Indeed, Podolian cattle are known for their rusticity and remarkable adaptation to semi-arid regions with sparse vegetation [37]. The Podolian system represents an interesting case study for providing ESs (Figure 2) because it relates to several ESs typologies [35]. As for *provisioning* ES, the Podolian breed provides products with high nutritional and organoleptic values. The production of Podolian beef is guaranteed by the “BOVINO PODOLICO AL PASCOLO” registered trademark, according to the National Zootechnic Quality System, recognized at the national and community level (Figure 2A). However, Podolian production is also famous for Caciocavallo Podolico cheese (Figure 2B), a renowned stretched curd cheese [35,38], included in traditional agrifood products of the Basilicata region [39]. As a typical product, this cheese is associated with a low environmental impact and the preservation of artisanal processing. The extensive pasture systems are traditional components of the regional landscape and largely contribute to maintaining biodiversity and landscape in rural areas (Figure 2C,D) [35,40,41].

For all these considerations, this study represents a first attempt to understand the perception by stakeholders (breeders and potential consumers) of the multifunctional role played by the Podolian breed and of the important role of the breeders themselves as “guardians” of the territory and cultural heritage of the marginal areas of southern Italy.

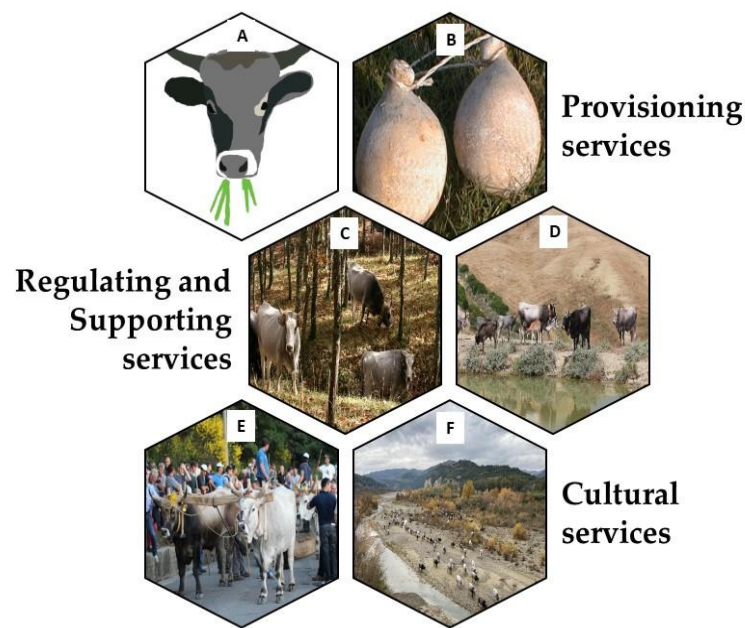


Figure 2. Examples of ecosystem services (ECs) provided by Podolian cattle farming: provisioning services such as the registered trademark of Podolian meat “*Bovino Podolico al pascolo*” <https://www.politicheagricole.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/10952>, accessed on 11 December 2023 (A) and *Caciocavallo Podolico* cheese (B); regulating and supporting services such as grazing in the forest (C) and grazing in marginal areas (D); cultural services such as Maggio di Accettura www.ilmaggiodiaccettura.it (E) and transhumance from mountain areas to marine areas <https://iyrp.info/unesco-intangible-cultural-heritage-un-ich>, accessed on 10 December 2023 (F).

2. Materials and Methods

2.1. Study Area

The geographical area involved in the study is the Basilicata region in southern Italy (Figure 3). The topography of the study area comprises 8 % plains, primarily concentrated in the Agri River valley region, 45.2% hills, and the remaining 46.8% mountainous terrain, where the Podolian system is predominantly focused. It has an area of 659,400 ha, with a population of 537,577 and a density of 54.5 inhabitants/km², and it includes 131 municipalities [42]. The level of urbanization in the Basilicata region appears to be very low, with the population primarily concentrated in the capital city [42]. The population is evenly distributed by gender (49.3% male and 50.7% female), while the average age is 45.7 years, and the population aged 65 and older accounts for approximately 25%. There are two national parks, the “Appennino Lucano-Val d’Agri-Lagonegrese” and the “Pollino” National Park, with a total of 261,561 hectares, and a regional park called “Gallipoli Cognato Piccole Dolomiti Lucane”, covering an area of 27,027 hectares, where the municipalities of Accettura and Pietrapertosa are located, areas with a higher presence of the Podolian cattle. The area in question is surrounded by forests of oak and holm oak trees, as well as Mediterranean scrubland. The park has permanent pastures and grazing meadows that characterize the local biodiversity. The parks are characterized by having large upland areas that are not all usable for grazing livestock, but many of them are usable exclusively for the extensive rearing of the Podolian cattle. In the Basilicata region, there are 356 Podolian cattle farms with 21,137 heads of cattle reared, representing 21.0% of the total bovine population in the region [43]. Not all farms are located in the park areas, and the other livestock farms in the Basilicata region are represented by intensive dairy and beef farms and by a decreasing number of extensive sheep and goat farms [43].



Figure 3. Location of study area <https://gisportal.istat.it/IstatViewer/?locale=en>, accessed on 12 December 2023.

2.2. Data Collection

The data were gathered by a survey conducted by a trained interviewer administering a questionnaire customized according to previously employed questionnaires in related research [33,44,45]. Respondents were chosen randomly, and all were knowledgeable about Podolian cattle farming as a livestock breed and production system that is well-known in the Basilicata region. The questionnaire was divided into three sections. The first section aimed to describe the research purpose and gather opinions on the extensive rearing of the Podolian cattle. The second section focused on the interviewees’ opinions regarding the four main ESs (i.e., cultural, provisioning, regulatory, and supporting). Each ES category was subdivided into specific items, as defined in Tables 1–4, according to the CICES class [6]. The third part of the questionnaire was dedicated to collecting personal information from the interviewees, including their gender, age, educational level, occupation, and the sector in which they were employed. The questionnaires were collected in June 2023, with 198 respondents. The perception of the impact was scored by using a five-point Likert scale, and, in accordance with [46], the categories were 1 (strongly disagree), 2 (disagree), 3 (neither agree nor disagree), 4 (agree), 5 (strongly agree).

Table 1. Cultural service from extensive rearing of Podolian cattle: details and explanation of services’ effects suggested during the interviews.

Service	Description
Preserves natural landscapes	Preservation of a typical landscape (e.g., maintenance of pastures, paths, and villages used by farmers)
Transmits the cultural heritage	Cultural identity and sense of belonging area
Promotes tourism activity	Recreational options available to tourists, such as rural accommodations, activities involving animals, pet-assisted therapy

Table 2. Regulating service from extensive rearing of Podolian cattle: details and explanation of services’ effects suggested during the interviews.

Service	Description
Controls the encroachment of shrubs and forests on pastures	Preserving grazing areas for livestock and promoting agricultural sustainability in these regions
Soil fertility	Direct soil fertilization (i.e., animals supply nutrients to the surrounding vegetation)
Soil erosion	Mitigation of land degradation and soil erosion, where the root systems of trees and grass contribute to stabilizing the soil and reducing the likelihood of erosive events
Fire control	Fire prevention through the management of shrub encroachment
Animal welfare	Preserves the welfare of animals
Water pollution	Pollution and excessive consumption of water
Greenhouse gas emissions	Increased emission of greenhouse gases (e.g., methane, nitrous oxide)
Soil contaminations	Pollution inside the soil
Lower air quality	Air contamination (e.g., bad smells)

Table 3. Provisioning service from extensive rearing of Podolian cattle: details and explanation of services' effects suggested during the interviews.

Service	Description
Milk productions	Produces milk with valuable organoleptic and nutritional properties
Cheese productions	Produces cheese like "Caciocavallo Podolico" with valuable organoleptic and nutritional properties
Meat productions	Produces meat with valuable organoleptic and nutritional properties

Table 4. Supporting service from extensive rearing of Podolian cattle: details and explanation of services' effects suggested during the interviews.

Service	Description
Maintains a high level of biodiversity (both plant and animal)	Maintenance of biodiversity, e.g., number of plant species present in pasture
Maintenance of local breeds	Genetic conservation of local/autochthonous breeds
Preserves natural landscapes	Preservation of a typical landscape (e.g., maintenance of pastures, paths, and villages used by farmers)

2.3. Data Analysis

After a descriptive analysis of items included in each ES's typology, collected data have been analyzed in two steps. Firstly, to obtain a synthetic picture of how the interviewees perceive the cultural, environmental, regulatory, and productive role of livestock farming, a principal component analysis (PCA) was carried out on the set of all items. The PCA is a multidimensional data analysis technique that synthesizes many variables by identifying a small set of complex indicators that allow for better reading and interpreting the phenomena under observation [47,48]. The Kaiser–Meyer–Olkin test (KMO) and Bartlett's sphericity test confirm the suitability of PCA for processing the collected data (Table 5). Three components with an eigenvalue greater than 1 were extracted, which explains 64.7% of the initial variance.

Table 5. Factor loadings matrix.

	Component		
	1	2	3
It prevents soil erosion	0.763	−0.121	0.108
It prevents the risk of fires	0.748	−0.125	0.027
It maintains a habitat suitable for the conservation of wild animals	0.716	−0.040	0.118
It maintains the soil fertility	0.664	−0.131	0.272
It maintains high plant and animal biodiversity	0.633	−0.068	0.339
It maintains a natural landscape of great beauty	0.621	−0.080	0.389
It controls the growth of shrubs and forest on pastures	0.597	−0.091	0.297
It preserves traditional agricultural landscapes	0.570	0.008	0.416
It produces water pollution	−0.076	0.903	−0.048
It produces soil pollution	−0.092	0.889	−0.094
It produces greenhouse gas emissions	−0.137	0.807	0.095
It contaminates the air with unpleasant odors	−0.088	0.778	−0.145
It produces milk with valuable sensory and nutritional properties	0.246	−0.098	0.910
It produces meat with valuable sensory and nutritional properties	0.287	−0.040	0.859
It produces cheeses with valuable sensory and nutritional properties	0.287	−0.043	0.832

KMO = 0.834; Bartlett's sphericity = 1626.928; sign. < 0.001.

In the second step, based on the extracted components, we carried out a non-hierarchical cluster analysis on the factor scores, representing the coordinates of observations (the interviewees, in this case) in the components' space. With the cluster analysis, we identified five different interviewee groups, each including individuals who are similar as overall ESs perception is concerned [48]. The choice in the number of clusters has been

based on the variance ratio criterion (VRC) introduced by Calinski and Harabasz [49], by minimizing the value of ω (the difference of VRCs across subsequent clustering steps (VCR = 280.542; ω = 46.797). The values of the centroids (the mean values of components within each group) and the analysis of socio-demographic variables of interviewees by group helped to highlight different sensibility towards ESs associated with the Podolian system and provide some insights on how the perception of ESs can differ according to some socio-demographic characteristics.

3. Results

3.1. Characteristics of the Sample

The characteristics of the sample are shown in Table 6. A total of 198 questionnaires were collected. The sample includes 53.5% males and 46.5% females, and these percentages are primarily in line with the gender distribution of the Italian and Basilicata region populations [42]. More than 75.8% of the sample turns out to be between 18 and 45 years old, while 24.2% are over 45 years old. Regarding education, graduates are overrepresented, with 53.0% of the sample possessing a degree level of education. Only 5.1% of the sample have a primary educational level, and 41.9% have an upper secondary educational level. Regarding employment, 60.1% declared themselves employed; 32.3% of the sample were students, and 5.6% were unemployed. About one-third of the employed people stated that they belong to the agricultural or livestock sector category.

Table 6. Socio-demographic characteristics of respondents recruited for the survey.

Variable	Freq.	%
Gender		
Male	106	53.5
Female	92	46.5
Age (years)		
18–25	54	27.3
26–31	44	22.2
32–45	52	26.3
>45	45	22.7
missing	3	1.5
Education level		
Lower secondary school	10	5.1
Upper secondary school	83	41.9
Degree	105	53.0
Occupation		
Employee	119	60.1
Student	64	32.3
Unemployed	11	5.6
Retiree	4	2.0

3.2. The Perception of Different Ecosystems Services

Figure 4 shows the level of agreement/disagreement of respondents about the role played by extensive rearing of Podolian cattle on the landscape and territory. The respondents believe that extensive farming systems play a role in maintaining the natural and rural landscape (over 90% agree or strongly agree on this aspect) and have a function in handing down the cultural heritage of an area. High, but lower than the previous aspect, is the percentage of those who believe that this farming type can promote tourism activity.

The positive effects on various environmental components are depicted in Figure 5. The respondents believe that extensive rearing of Podolian cattle plays a positive role in all the aspects investigated. In particular, 80–85% of them consider this type of rearing capable of controlling the encroachment of shrubs and forests onto pastures and contributing to maintaining biodiversity and soil fertility. The perception of the interviewees regarding biodiversity conservation is extremely interesting and positive; approximately 81% of the

respondents agree or strongly agree that it has positive effects. The responses regarding the ability of Podolian cattle farming to maintain a suitable habitat for wild animals (65% agree on this aspect) and to prevent soil erosion and fires (60% and 64% of the respondents agree, respectively) are more complex.

The perception related to disservice in terms of ecosystem regulatory services is controversial. Approximately 27% of the respondents still believe that extensive grazing of Podolian cows results in greenhouse gas emissions that contribute to air pollution, while about 15% agree that it leads to water pollution. Indeed, regarding the effects of Podolian farming in terms of water pollution, approximately 54% of the respondents either strongly disagree or disagree, while 30% remain neutral (Figure 6).

On the other hand, regarding soil pollution and air contamination with unpleasant odors, the sample involved in this study generally strongly disagrees with these claims. This controversial perception is most likely because cattle farming is currently widely perceived as a driver of anthropogenic pollution despite the livestock production system. Therefore, although Podolian cattle are raised in an extensive context, they are partially perceived as similar to intensive rearing systems.

For most respondents, the Podolian system respects animal welfare (Figure 7).

Figure 8 shows the perception of the quality of food products, such as cheese, milk, and beef, provided by the Podolian system. Approximately 90% of the respondents either agree or strongly agree that the Podolian system provides dairy and meat products with high nutritional and sensory properties.

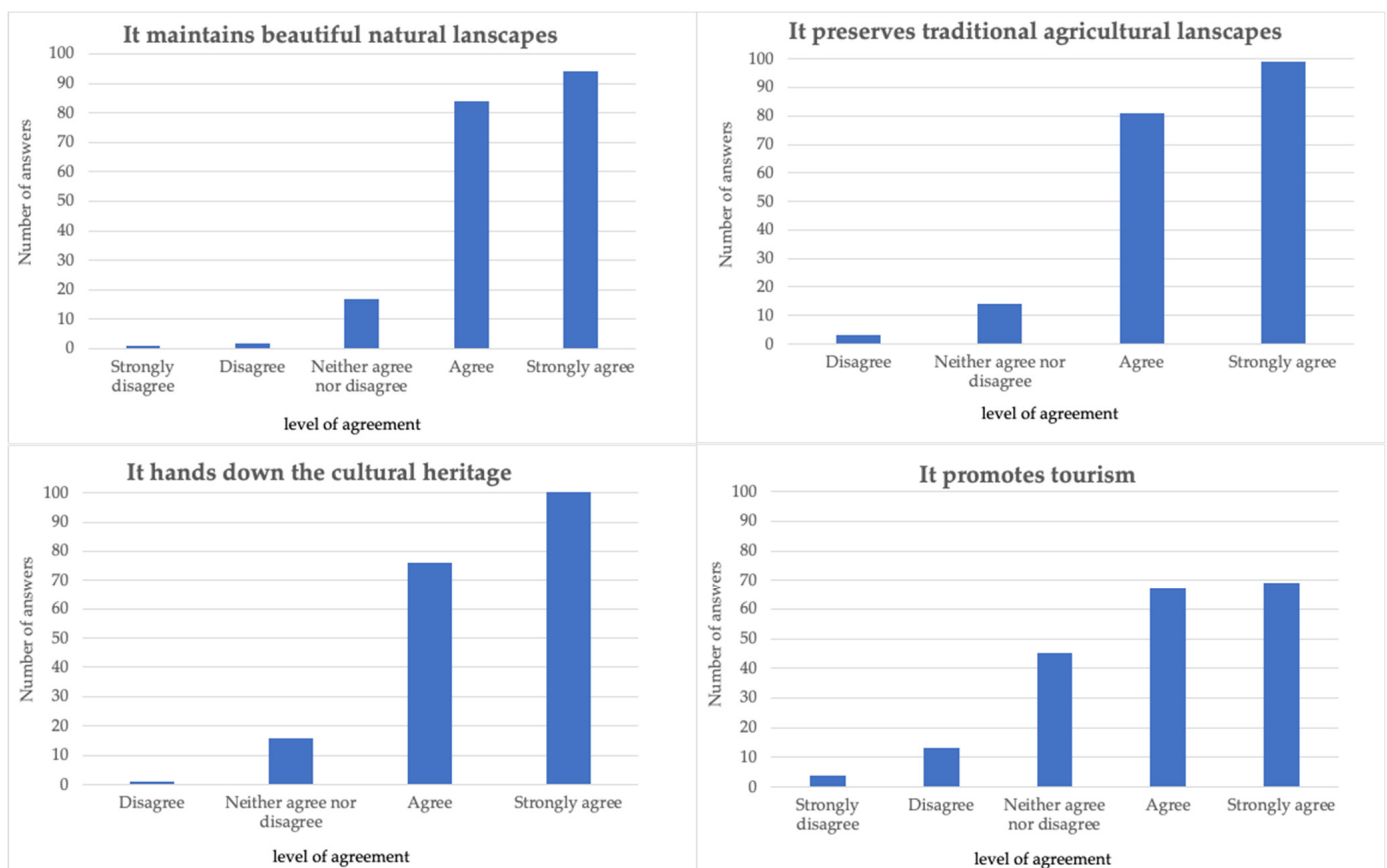


Figure 4. Perception of cultural service from extensive rearing of Podolian cattle.

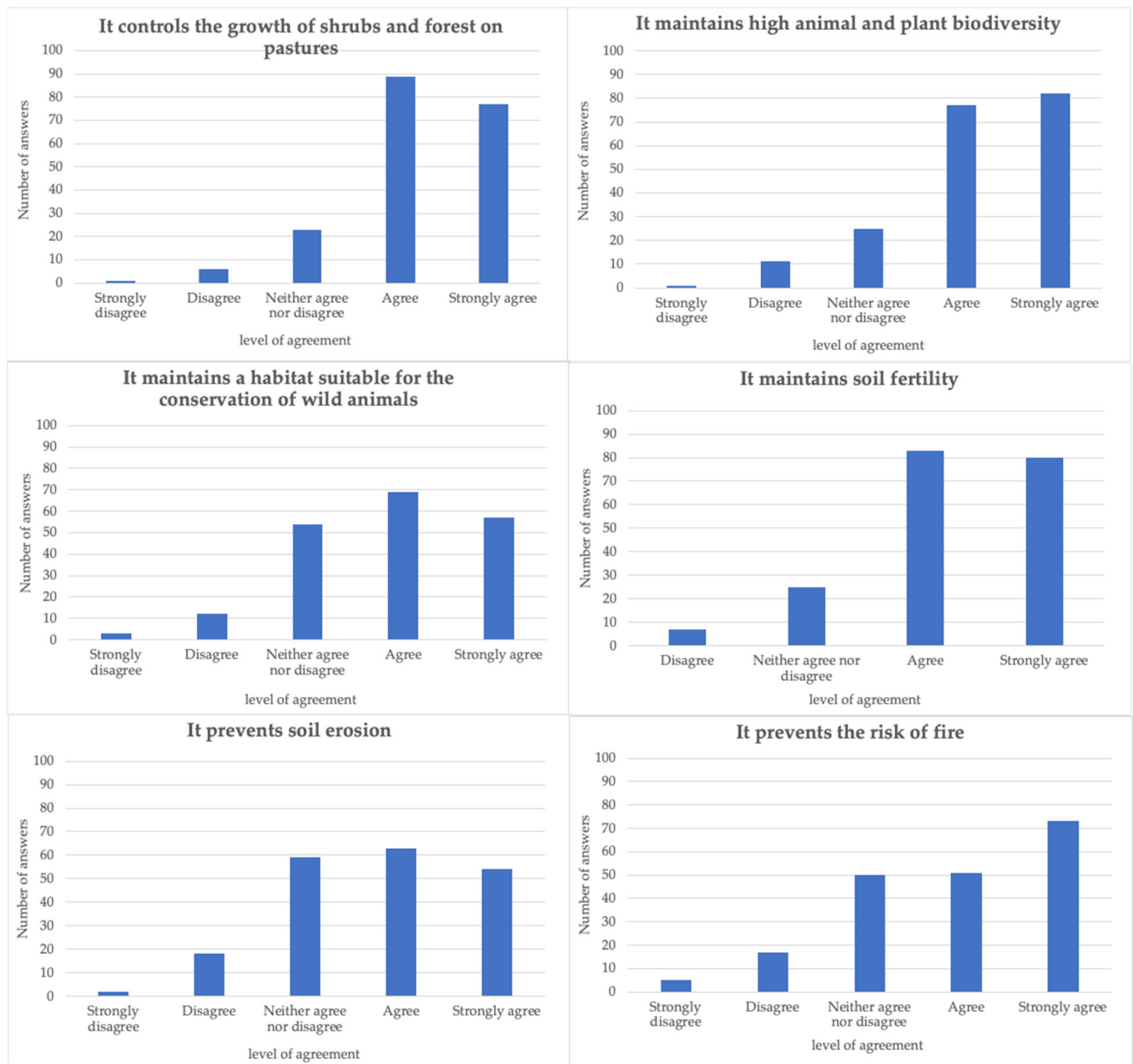


Figure 5. Perception of supporting service from extensive rearing of Podolian cattle.

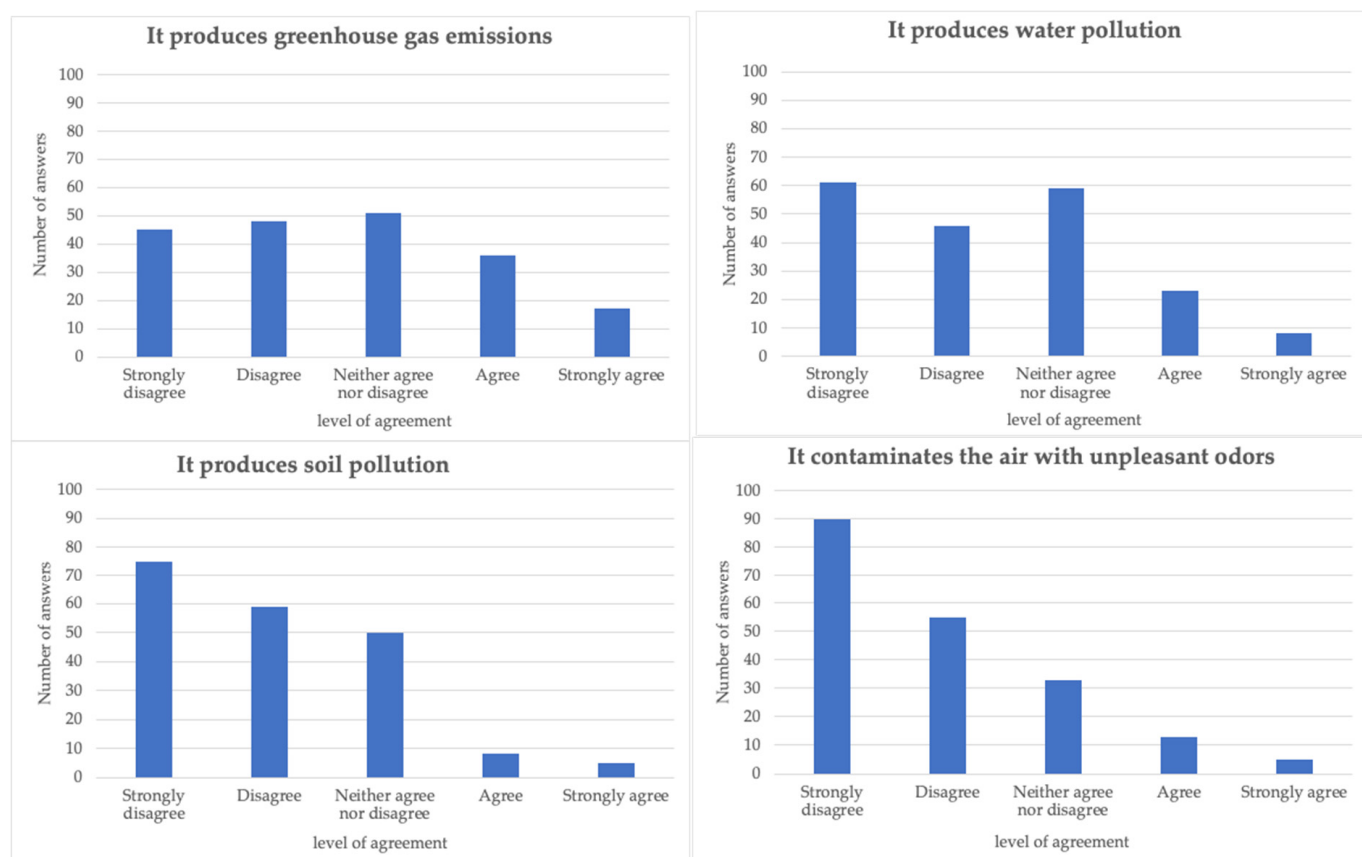


Figure 6. Perception of regulating service from extensive rearing of Podolian cattle.

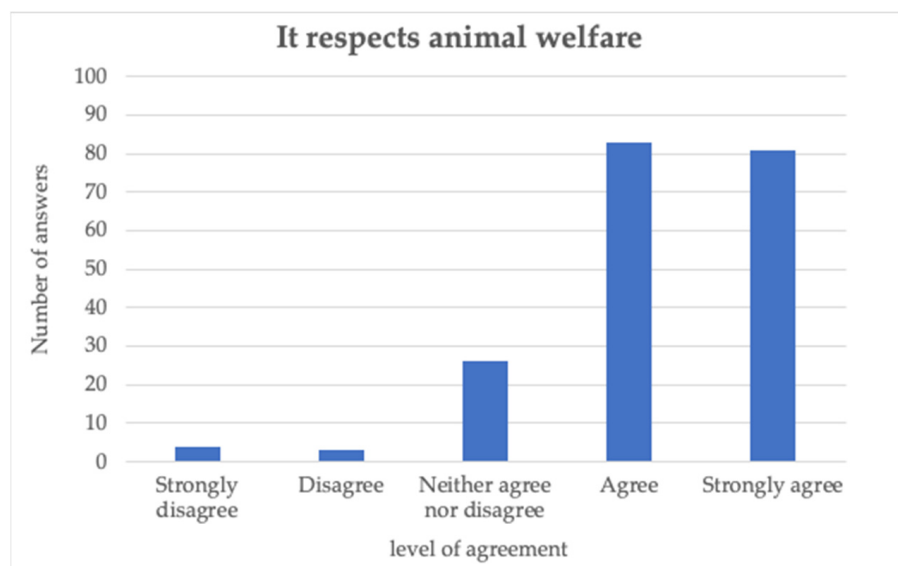


Figure 7. Perception of the role played by the extensive rearing of Podolian cattle on animal welfare.

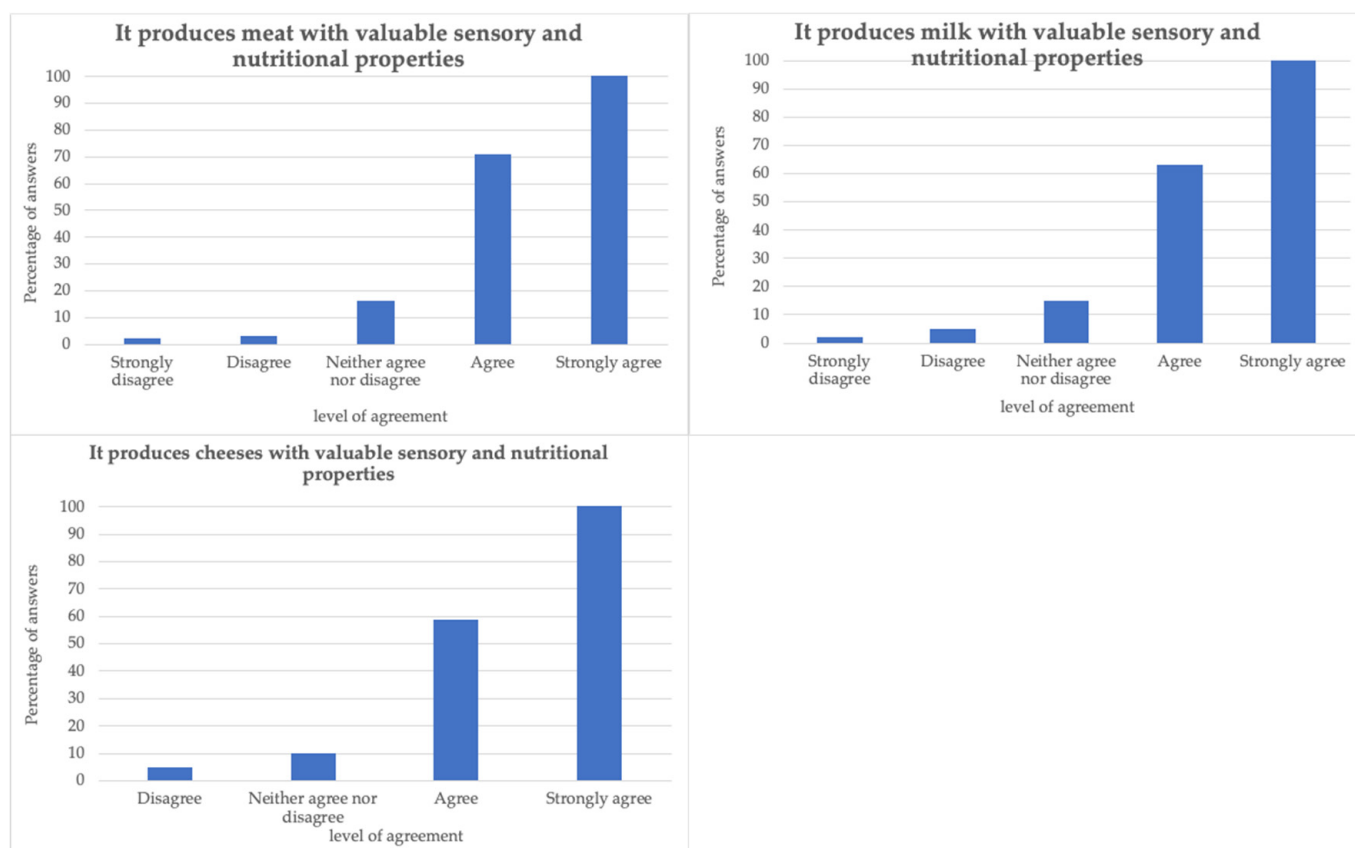


Figure 8. Perception of provisioning service from extensive rearing of Podolian cattle.

3.3. A Characterization of the Perception of ESs Related to Podolian Livestock Farming

The components obtained by applying the PCA to the ESs items identify the main factors differentiating the interviewees' ESs perception. The meaning of the components can be derived from the factor loadings matrix, which illustrates the correlation between the components and each initial variable (Table 6). Component 1 (25.5% of the variance) summarizes the "Perception of environmental and landscape effects". It is positively correlated with items concerning the regulatory services associated with livestock farms, including fire protection and the ability to prevent erosion; the ESs these farms can provide involve habitat and biodiversity and some cultural services related to landscape maintenance. The second component explains 19.6% of the overall variance. It is positively correlated with the issues related to water and soil pollution, air contamination, and greenhouse gas emissions. Thus, the second summarizes the "perceived effects in terms of pollution associated with cattle farming". The third principal component (19.5% of the explained variance) concerns the perception of "cattle farms' productive role" and their ability to provide products with valuable organoleptic and nutritional properties.

The values of the three components were used in the cluster analysis to identify homogeneous groups concerning ESs perception factors. Five groups were identified, whose characteristics can be deduced from the value of the centroids shown in Table 7 and by the box plots that illustrate the distribution of different perception components by group (Figures 9–11). The variance analysis confirms the differences among clusters in farmers' perceptions as a whole (Table 8). Tamhane post hoc tests highlight that cluster 2 shows similarities in component 1 with cluster 1 (mean difference = -0.96215 ; sig. = 0.142) and cluster 5 (mean difference = -0.411 ; sig. = 0.930) and in component 2 with cluster 3 (mean difference = -0.1532 ; sig. = 0.992). Moreover, clusters 3 and 4 do not statistically differ concerning component 1 (mean difference = -0.0329 ; sig. 1).

Factorial scores are standardized variables, so each group's characteristics can be read with reference to the sample's mean, represented by the zero in the graphs [48]. Therefore, the higher/lower the distribution of the factorial scores from zero, the more the group deviates (positively or negatively) from the sample's mean.

Group 1 comprises 27.4% of the respondents. This group includes people more attentive to the polluting effects of livestock farming, effects that, in their perception, do not find compensation either in the productive role or in the production of environmental and cultural ecosystem services (the group of *environmentally concerned*). More critical about the contribution that the Podolian system can provide in terms of regulatory and productive ecosystem services is group 2, which includes a small number of individuals (4.5% of the sample) for whom the first and third components assume the highest negative values on average. In this group, however, the Podolian rearing system is not perceived to affect water and soil contamination or the production of greenhouse gases (the group of *indifferent*). The production of ESs assumes greater importance in the case of groups 3 (29.5% of the sample) and 4 (10.5% of the respondents). These two groups differ from each other mainly in their perception of the effects in terms of pollution. Group 3 includes people who attribute only positive effects to the Podolian system (*supporters*). In contrast, within group 4, the perception of the environmental effects of this type of farming is more complex (*cautious*) as the respondents perceive both positive and negative effects of the Podolian system on the environment. Finally, group 5 (27.9% of the sample) is mainly interested in the productive function of livestock farming and does not associate it with a particular role in providing environmental ESs or polluting effects (*pragmatic*).

Further information on the distinctive elements of the groups was obtained by analyzing the extent to which they differ for the main socio-demographic variables. Significant differences were found for age distribution among clusters (Figure 12). Group 3 (*supporters*) includes individuals with the highest average age of the entire sample, while groups 1 (*environmentally concerned*) and 5 (*pragmatic*) had a higher percentage of very young people. There were no significant differences between the groups for gender and educational level. As for job positions, group 3 (*supporters*) had the highest presence of employed people (80%).

Table 7. Clusters' centroids.

	Cluster				
	1	2	3	4	5
Perception of environmental and landscape effects	−0.2898	−1.2519	0.9243	0.9573	−0.8409
Perception of polluting effects	0.5986	−1.0104	−0.8571	1.5800	−0.1063
Perception of production effects	−0.8308	−2.1626	0.1368	0.5300	0.8378
Number of cases	52	9	56	20	53
% of cases	27.4%	4.7%	29.5%	10.5%	27.9%

Table 8. Variance analysis on components' values among clusters.

	Sum of Squares	df	Mean Square	F	Sig.
Perception of environmental and landscape effects					
Between Groups	122.131	4	30.533	84.473	<0.001
Within Groups	66.869	185	0.361		
Total	189.000	189			
Perception of polluting effects					
Between Groups	119.502	4	29.875	79.527	<0.001
Within Groups	69.498	185	0.376		
Total	189.000	189			
Perception of production effects					
Between Groups	121.864	4	30.466	83.952	<0.001
Within Groups	67.136	185	0.363		
Total	189.000	189			

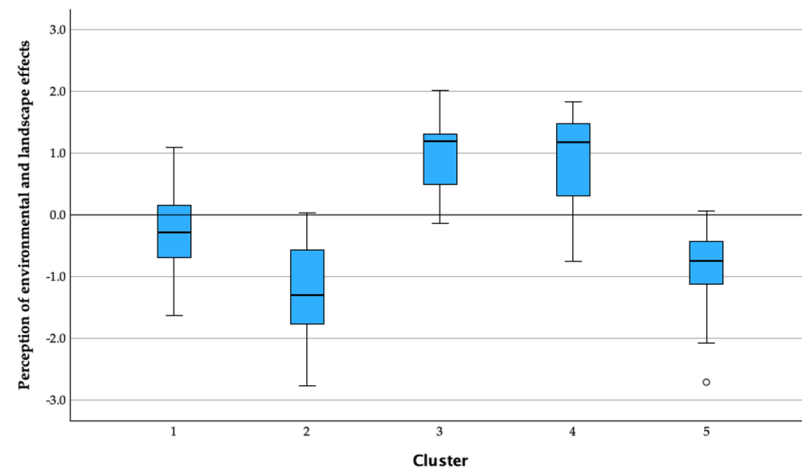


Figure 9. Distribution of component 1 by clusters (° identify extreme cases).

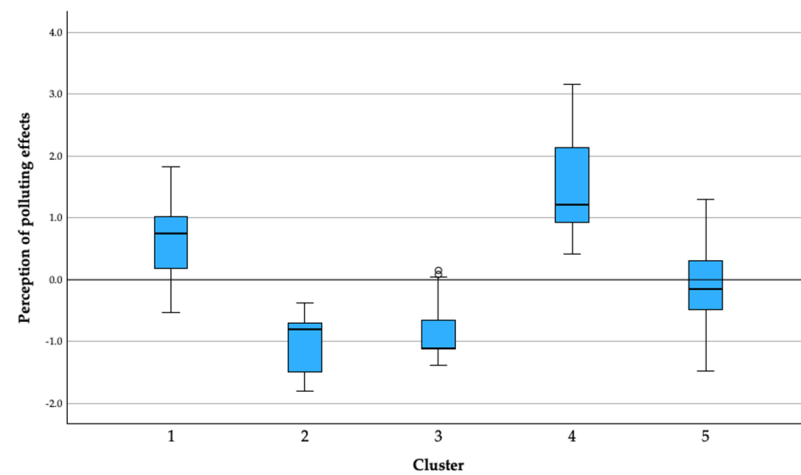


Figure 10. Distribution of component 2 by clusters (° identify extreme cases).

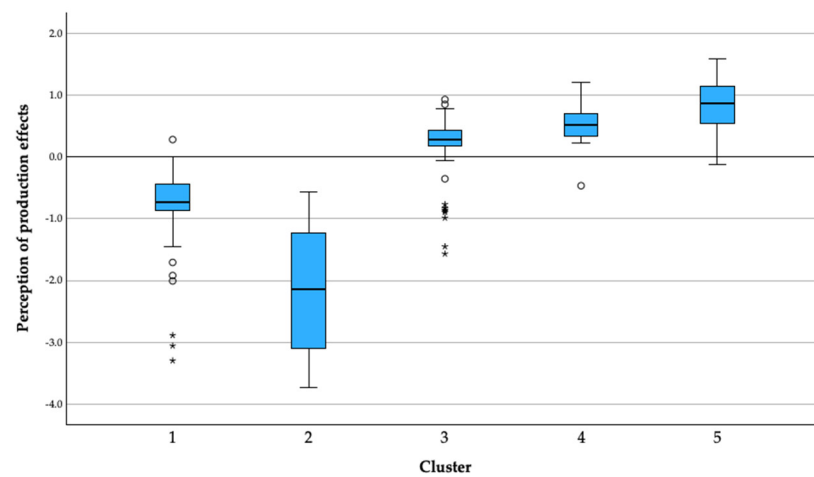


Figure 11. Distribution of component 3 by clusters (° identify extreme cases; * identify outliers).

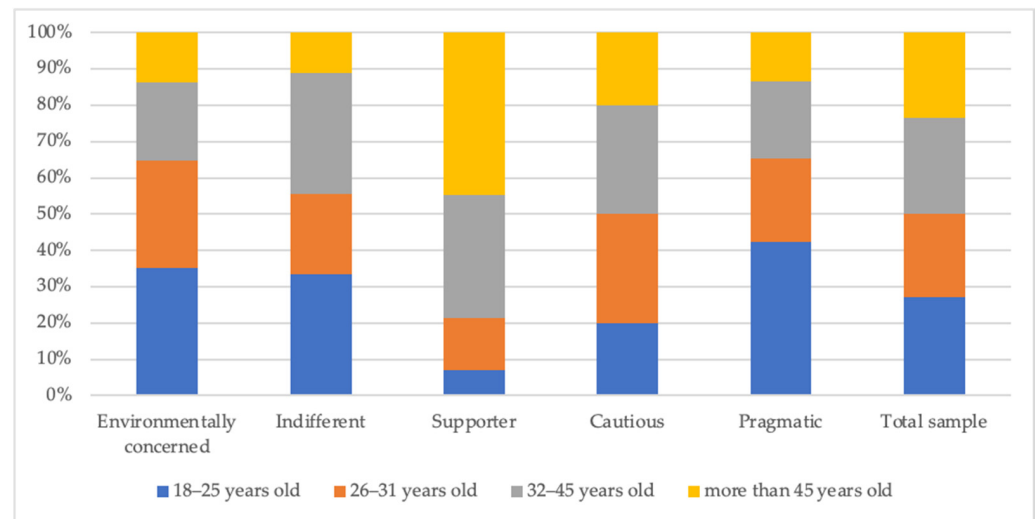


Figure 12. Distribution of interviewees' age by clusters. Pearson's chi-square = 35.771; sig < 0.001. Cramer's V = 0.252; sig. < 0.001.

4. Discussion

The participants of the survey showed a highly positive perception of the role played by extensive rearing of Podolian cattle on the landscape and territory for keeping local culture and traditions, thus promoting the development and preservation of marginal areas. In a study conducted in the French territory, nearly all the respondents stated that landscapes shaped by agricultural activities involving livestock could be considered "cultural" as they unquestionably play a significant role in shaping the unique identity of each region [50]. In a similar study conducted in an Alpine environment, the aspects related to the natural landscape and cultural services received equally high scores [45,51]; this underscores the universal recognition of the significance of maintaining the pristine beauty of the mountain environment and the promotion of its rich cultural heritage as integral components of sustainable practices and regional identity across different regions. It is interesting to note that, in a particular area of Sweden [52], the cheese consumers and producers do not have strong connections to the local terrain and its history. However, they still place considerable importance on cultural heritage, food traditions, the sense of place and its historical context, and the preservation of natural landscapes and grazing animals. This observation highlights that these values remain significant, even when considered in different contexts. The idea is that these elements hold a profound place in the minds of individuals [53], even in settings where the historical and geographical connections may not be as pronounced. It underlines the universal appreciation for cultural heritage, the intrinsic bond between people and their surroundings [53], and the enduring allure of unspoiled natural environments and traditional agricultural practices, transcending geographical and cultural boundaries.

Surprisingly, our results show that many interviewees do not perceive Podolian livestock as relevant to promoting tourism. That may be due to people's perception of tourist activity as solely focused on monuments and pictorial art. However, this perception contrasts with what emerges in many actual situations and underestimates the economic potential of livestock provisioning ESs. Several studies in European and non-European countries have highlighted the numerous benefits of cheese production and marketing in terms of tourism activity [54,55]. This phenomenon underscores the pivotal role that cheese can play as a catalyst for tourism development, stimulating economic growth, fostering cultural exchanges, and enhancing culinary tourism experiences. The connection between a region and its unique cultural identity and traditions is a significant factor that motivates customers to buy traditional products [56]. This is supported by the latest data from the XX ISMEA-Qualivita report [57], which indicates a growing preference for local

and traditional foods. These products are often perceived as being of higher quality [58], more sustainable [56], and possessing a solid cultural identity compared to industrial foods. Notably, an important work by Fusté-Forné (2020) [59] examined the intertwined relationship between cheese production and tourism, shedding light on the symbiotic dynamics that unfold when artisanal cheese-making traditions intersect with the demands of a burgeoning tourist industry.

As for provisioning ESs, in this study, most of the respondents perceived dairy and beef provided by the Podolian system to have high nutritional and sensory properties. Sensory properties, such as the appearance, odor, flavor, taste, and texture of foods detectable by human senses, are particularly important to characterize the peculiarities of typical products. Recent studies stated that the traditional Caciocavallo Podolico cheese-making protocol is the strategy to harmonize the microbial evolution and to almost constantly maintain the final characteristics of this cheese [60]. In addition, consumer perception of products deriving from traditional pasture-based farming, such as the Podolian system, tends to be more positive compared with products obtained from intensive farming practices [61].

Regarding environmental effects, the interviewees' perception is coherent with findings from studies conducted in Mediterranean natural parks, where livestock grazing was found to influence the dynamics of shrubs [62]. Recent studies conducted in China have observed that the advancement of shrubs in Alpine ecosystems and meadows leads to changes in soil properties, increases the risk of soil erosion, and results in a reduction in soil moisture and, consequently, in soil water content [63], although other authors have observed in Mediterranean environments how the invasion of shrubs and climate change increase the susceptibility of wooded pastures to drought [64]. Similar results in soil fertility, soil erosion, and wildfire risk assessment have been observed in a recent study conducted in an Alpine and Mediterranean environment [51,65]. These findings highlight the interconnectedness of ESs in high-altitude regions. The impact of changing vegetation patterns on soil fertility can have cascading effects on nutrient availability, which in turn can affect the provision of essential ESs like habitat support and water purification.

Furthermore, the increased risk of wildfires due to altered vegetation dynamics underlines the significance of these ecosystems in providing fire regulation services and carbon sequestration [66]. The findings on the perception of the polluting effects of Podolian livestock are more controversial. The perception of the role of this livestock system in the emission of greenhouse gases and water and soil pollution highlights how people often equate it with intensive farming. Similar findings have also been observed by [51] in an Alpine environment. Conversely, intensive beef production systems have been observed to result in significant water quality issues, mainly due to the transportation system and feed production [67]. The neutral score expressed by many respondents towards water pollution issues might be ascribed to limited knowledge of the husbandry techniques and practices employed in rearing Podolian cattle.

Most of the sample perceived the Podolian system as respectful of animal welfare. In extensive rearing systems, a diet based mainly on forage and fibrous foods prevents the onset of pathologies and abnormal behaviors, such as stereotypes [68]. Indeed, it is widely documented that extensive rearing conditions may positively affect animal welfare [37]. During grazing, animals can express their natural ethogram, with positive effects on cellular immune responsiveness and thus on their health [37].

In addition, consumers clearly express preferences for products obtained using animal-welfare-friendly techniques [69], and information on animal welfare can positively affect the quality perception of lamb meat and beef [70].

5. Conclusions

Our study shows, for the first time, the perception of ESs in the extensive Podolian cattle farming system in the Basilicata region, which tends to be generally positive and highly positive. The positive perception of Podolian cattle farming may also be due to

the broad familiarity of the Lucanians toward this breed, which is very appreciated for its distinctive characteristics and rusticity, making it well-suited for the rugged and wooded mountainous terrain of the Basilicata region.

However, this study offers valuable insights into the intricate relationship between agriculture, culture, and the environment. It emphasizes that traditional, sustainable farming practices, like the Podolian system, can be pivotal in a region's economic, cultural, and ecological recognition.

The perception of ESs is the basis for defining their value and identifying intervention strategies to preserve the Podolian rearing system in marginal areas. Different socio-economic groups can have different perceptions of the ESs extensive livestock farming can provide. Moreover, the perception can be related to the knowledge of livestock practices, and this suggests a need for increased awareness and education on the environmental impacts different agricultural practices have on environmental components.

That highlights the need for a deeper analysis of the link between the socio-economic characteristics of the population and the perception of (dis)service provided by extensive livestock systems, as well as between ESs perceptions and the value people assign to them.

Moreover, further research is needed to unlock the full potential of such farming systems and their role as drivers of tourism and high-quality product production in the Basilicata region.

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