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# Public perception of ecosystem and social services produced by Sardinia extensive dairy sheep farming systems

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## Abstract

Dairy sheep farming systems provide a great range of ecosystem services (ESs) and social services (SSs). These are Agro-pastoral Secondary Outputs (ASOs), the promotion of which can help the survival of the systems and the rural regions in which they exist. However, little attention has been paid to understanding which ASOs are recognized by the public, which is the first step to adequately promote them. This study first aims to review previous literature on ASOs relating to livestock in general and dairy sheep farming systems in particular. The literature review, conducted according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) framework, revealed significant gaps. Second, the research provides evidence of public perception of ASOs of a given dairy sheep sector—i.e. that developed on the region of Sardinia (Italy)—via a questionnaire distributed to a composite sample of 525 stakeholders. We found that cultural and landscape services are the most appreciated services. Multiple correspondence analysis suggests that appreciation of a specific secondary output would imply the appreciation of all the other outputs. Furthermore, we ran a set of logit regressions where each ASO was related to several socio-economic variables. Findings showed, among others, that the ‘subjective knowledge’ of the Sardinian agro-pastoral reality positively and significantly affects appreciation of all the ASOs. Several implications for practitioners, academics and policymakers are derived from these findings.

**Keywords:** Systematic qualitative literature review, Agro-pastoral secondary outputs (ASOs), Multiple correspondence analysis, Logit regression, Sardinia

## Introduction

Ecosystems provide a range of services that significantly impact human well-being, health, livelihoods and survival (MEA 2005; TEEB 2010; Costanza et al. 2014). Several ways of defining ecosystem services (ESs) have been developed, such as ‘the benefits people obtain from ecosystems’ (MEA 2005, p. 26) or as contributions of ecosystem structure and function (in conjunction with other inputs) to human well-being (economic, social and personal well-being) (Burkhard et al. 2012; Burkhard and Maes 2017). In this context, it is important to emphasize that ecosystems provide benefits to people only because of the presence of individuals (human capital), their communities (social

capital) and their built environment (built capital). Therefore, the benefits of ESs flow from natural capital to human well-being only through interaction with the other three forms of capital (Costanza et al. 2014).

The Millennium Ecosystem Assessment (MEA) (2005) classified ESs into four categories: provisioning (material or energy outputs), regulating (biophysical processes providing benefits such as climate regulation or water purification), supporting (processes that allow the functioning of other ecosystems that, in turn, provide other services, such as nutrient cycles, soil formation, photosynthesis or pollination) and cultural (recreational, aesthetic and spiritual benefits). Scientists and policymakers use ESs extensively to highlight the importance of the environment in supporting human livelihoods. Therefore, the term is broadly used and ES research has made advances in many areas, from theoretical conceptualization to practical applications (Potschin et al. 2016; La Notte et al. 2017). Numerous studies have investigated how the concept can be used in an agricultural context. In doing so, however, the few ES assessments aimed at decision support appear to be mainly limited to theoretical reflections. Few studies have focused on specific agricultural practices and the gap between ES research and information required to support decisions persists (Holt et al. 2016; Olander et al. 2017; Dendoncker et al. 2018).

However, one cannot ignore the existence of a variety of disservices to and from agriculture (Zhang et al. 2007; Herd-Hoare and Shackleton 2020). Ecosystem disservices (EDs) highlight the negative economic and non-economic effects of nature on human well-being within social–ecological systems (Blanco et al. 2019). The EDs generated by agroecosystems, i.e. “the ecosystem generated functions, processes and attributes that result in perceived or actual negative impacts on human well-being” (Shackleton et al. 2016), in many cases, can lead to impact production and economic losses, compromising food security, income, and thus well-being (Herd-Hoare and Shackleton 2020). The breadth and depth of EDs depend on management practices because, if they are appropriate, can improve and mitigate many agriculture negative impacts (Power 2010). Considering the livestock farming systems, utilization of resources and intensity of the production system can determine disservices; landscaping, hydrology and environmental damage are some examples (FAO 2006; Montrasio et al. 2020).

The present work is focused on the ESs commonly provided by dairy sheep farming systems. Sheep farming represents a traditional activity in many world regions, although the main product (milk, meat, wool, or a combination of the three) may vary depending on the geographical context or the breed raised. The breeding for milk production assumes considerable economic importance in many areas (Pulina et al. 2018). Sheep milk production accounts for about 10.6 Mt, of which 29.5% is from Europe (FAOSTAT 2022), with growth forecasts of around 3 Mt by 2030 (Pulina et al. 2018).

Sheep farming is especially practised in temperate and subtropical areas, concentrated in the Mediterranean and the Black Sea regions and accounting for approximately 211 million sheep (FAOSTAT 2022). In the Mediterranean areas, sheep breeding systems for milk production have been traditionally developed in economically and physically disadvantaged areas (Ripoll-Bosch et al. 2012) and strongly affect the agricultural economy of several regions, where it is often practised using a low-input system. It is important to note that, in general, low-input farming systems are associated with many agricultural practices that provide a greater range of ESs than intensive farming systems (Cooper

et al. 2009). Dairy sheep farming is no exception to such rule. Furthermore, the sheep farming systems also produce other externalities of public relevance in terms of social benefits. In other words, production of social services (SSs) in connection with ESs can be recognized from these practices; one example is the role of pastoralism in safeguarding the livelihoods of populations located in disadvantaged and/or rural areas, by ensuring jobs or preventing depopulation. These are public functions that can counteract elements that strongly affect the economic marginalization of rural areas and from which many adverse social, economic and environmental effects derive (O'Rourke et al. 2016; Nori et al. 2017; Quaranta et al. 2020). Pastoralism is commonly recognized as having a multifunctional dimension as it produces a wide range of environmental and social goods and services alongside food (Ripoll-Bosch et al. 2012; Nori et al. 2017; Bernués et al. 2019), thereby providing a valuable opportunity for sustainable development (Meloni et al. 2015). Overall, these externalities can be considered as Agro-pastoral Secondary Outputs (ASOs).

A significant research challenge concerns the evaluation of ASOs produced by dairy sheep farming systems, since 'the true contribution of agro-pastoralism to societal objectives is not fully accounted for, which provides an explanation for its decreasing role on Mediterranean islands over time' (Nori et al. 2017, p. 138). The ASOs are not properly valued and priced through market mechanisms, which means that these externalities are 'lost' across the value chain and often unrecognized by the final user (Nori et al. 2017). To that end, it is necessary to understand how the public perceives the relationships between such agriculture practices and ASOs and identify those that are the most requested (Bernués et al. 2016, 2019). However, a necessary condition is that the population are aware of such agro-pastoral outputs and appreciate them (Montrasio et al. 2020). The assessment of the values and perceptions of ASOs is of great importance because it is the first step towards developing a shared understanding of the agro-landscape, support change paths in terms of sustainability and understand how agricultural practices affect ASOs that, in its turn, influence agricultural productivity and society (Dendoncker et al. 2018).

In the context described above, this paper evaluates the perception of ASOs generated by the dairy sheep farming system in Sardinia, the second-largest Mediterranean island. Sardinia is one of the main European producers of sheep's milk and contributes to about 67% of Italian dairy sheep production (Autonomous Region of Sardinia 2020) (Italy accounts for 19% of total European milk production—FAOSTAT 2022). Sardinian dairy sheep breeding is usually pasture-based and quite extensive (Vagnoni et al. 2015; Vagnoni and Franca 2018). It uses traditional and low-input practices and maintains the semi-natural habitats they helped create (Ripoll-Bosch et al. 2013; Pulina et al. 2018; Faccioni et al. 2019). Moreover, the Sardinian shepherding model has been at the basis of local cultural identity, provides landscape maintenance and care, contributes to the protection of territory and animal and vegetable biodiversity, and ensures jobs for thousands of people (Furesi et al. 2013; Mattalia et al. 2020).

Despite the growing appreciation of primary and processed sheep dairy products (Nori et al. 2017, p. 136), and its role in the regional economy, the dairy sheep sector operates with low profit margins (Idda et al. 2010). Currently, its profitability often depends on the amount of financial aid made available by the Common Agricultural Policy (CAP) (Idda

et al. 2010; Vagnoni et al. 2015; O'Rourke et al. 2016; Quaranta et al. 2020). Sardinian dairy sheep sector is facing a serious threat to its medium- to long-term survival since if the business is scarcely profitable, current and future generations of stock farmers would not be encouraged to continue operating. The resulting impacts could be severe on most social, economic and environmental benefits people obtain from the agro-pastoralism contribution to societal objectives. The scenario presented here could worsen a critical situation already in place because Sardinia is one of the European Union's (EU) most underdeveloped areas and suffers from a lower Gross Domestic Product (GDP) and industrialization rate than the peninsula (ISMEA 2019). Consequently, it appears to be pivotal to foster sector durability, here understood as the ability to cope with chronic endogenous stress (Dawson et al. 2010), through the sustainability defined by Hodge as 'the persistence over an apparently indefinite future of certain necessary and desired characteristics of both the ecosystem and the human subsystem within' (Hodge 1997, p. 9).

The present paper focuses on this area of interest and has two aims. First, it aims to explore the state of knowledge of ESs and SSs related to both zootechnical activities on the whole and to dairy sheep farming systems specifically. A qualitative systematic review of world literature was performed using the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) framework. Second, it aims to evaluate the most recognized ASOs of the extensive Sardinian dairy sheep system. Building on qualitative systematic review findings, the ASOs were identified, and a qualitative survey of residents and non-residents was carried out to ascertain perceptions of the benefits of ASOs. Data were first analysed with a descriptive analysis, followed by a multiple correspondence analysis (MCA) to cluster perceptions of the relevance of ASOs. Finally, the relationship between preferences stated for each secondary output and sociodemographic variables was evaluated using a set multinomial logit regression (MLR).

The paper makes several contributions to the literature, for policymakers and stock farmers. First, as far as we know, this is the first economic study that considers both environmental and social secondary outputs provided by an extensive sheep farming system. Second, this paper helps to bridge the gap both between the growing scientific research on perceptions and values of ESs and the few studies on ES perception concerning specific agricultural practices, and between ES research and information required to support decisions (Bernués et al. 2016; Olander et al. 2017; Dendoncker et al. 2018). It does so by investigating the ESs provided by the Sardinian dairy sheep farming system and overcoming the limitations of previous research by including the assessment of perception of SSs. Third, it addresses recent calls for research on the complex relationship between pastoral activity and rural landscape in the Mediterranean region (Mattalia et al. 2020). As the paper highlights which socio-economic, cultural and environmental outputs of the Sardinian dairy sheep sector are most appreciated, it raises awareness of the agro-pastoral contribution to the pattern of sustainable development in the Sardinian region. Fourth, the paper highlights the appreciation of ASOs and recognizes the existence of supply and demand for a public good that is inadequately remunerated in the market. As a result, the financial aid provided by the CAP as a welfare contribution non-configurable and can make stock farmers aware of their role in maintaining territory and producing public goods.

The paper is structured as follows: Sect. 2 describes the research methodology and sample; Sect. 3 presents the results; Sect. 4 discusses the results and provides a conclusion, outlining the implications for practitioners, academics and policymakers, and recommendations for future research.

### Methodology

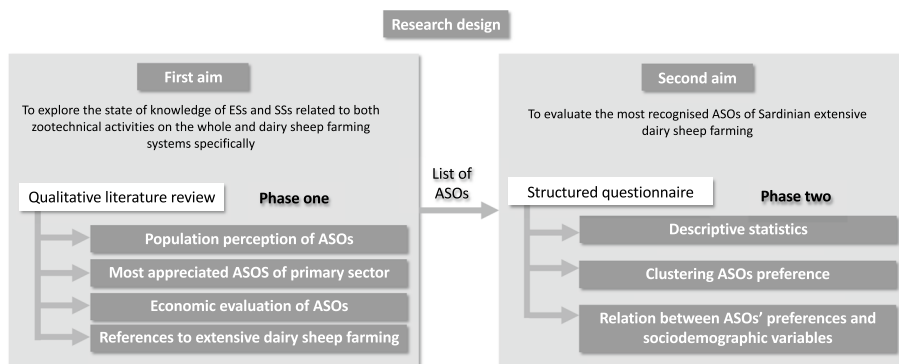
In order to achieve the aims of this paper, two-step research methodologies were used: a qualitative systematic review on the secondary outputs produced in breeding and an empirical analysis—by submitting a structured questionnaire—aimed to evaluate the perceptions of secondary outputs in extensive dairy system by part of society. Figure 1 provides a visual representation of the aims and methods used in the different stages of the research and the output of the first phase used in the second one.

#### Systematic review

To explore the first aim, we conducted a qualitative systematic review. Quantitative reviews usually produce meta-analyses and find applications in the case of selected studies that share a highly standardized procedure, centred on similar topics, analyses or research designs, allowing for a direct comparison of results that can be contextualized in terms of effect size (Borenstein et al. 2009). The available scientific literature on the ESs and SSs of zootechnical activities does not fulfil all these conditions. A qualitative literature review based on narrative surveys overcomes problems arising from the wide differences in the literature in terms of methods and results and the relatively limited number of relevant studies available (Baumeister and Leary 1997; Jahan et al. 2016).

We followed one of the approaches to qualitative survey proposed by Baumeister and Leary (1997) and drew up a survey aiming to explore the state of knowledge of the ASO-related aspects of livestock activities. While the literature on ESs in a broad sense has developed in recent years, the same does not apply to zootechnical activities. As our aim was to investigate if sheep farming systems can survive giving value to positive externalities, our review addressed the following research questions:

1. Has previous literature analysed the population’s perception towards ASOs in the context of agroecosystems?



**Fig. 1** Graphical representation of the research model

2. Is there evidence for which ASOs provided by the primary sector are most appreciated?
3. Has the previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?
4. Are there any references to extensive dairy sheep farming systems?

The review focused on scientific, English-language, peer-reviewed publications after 2010. We used the most common online database, Scopus (Moher et al. 2009), which has previously been used across a wide range of studies because of its uniqueness, its reputable publisher (Elsevier Co.) and because it indexes over 14,000 journals in numerous fields, including social, environmental and economic. The literature search considered all countries and was performed on 8th March 2021. The PRISMA framework procedure (Moher et al. 2009) was adapted for our purposes. The PRISMA statement highlights four steps: identification, screening, eligibility and inclusion criteria.

Concerning the keyword identification process to retrieve as many articles as possible in the target research fields, data were acquired by searching publications in agriculture, business and economy areas, whose title, abstract or keywords contain the following words: (“ecosystem service\*” OR “agroecosystem\*” OR “multifunctional\*” OR “agroecosystem service\*” OR “socio-economical system\*”) AND (“economic valuation” OR “socio-cultural valuation” OR “perception” OR “socio-economic valuation” OR “social preferences” OR “stakeholder involvement” OR “service value” OR “ecosystem services value” OR “agroecosystem\*” OR “agrienvironmental payment\*” OR “agri-environmental payment\*” OR “choice experiment” OR “survey” OR “agrienvironmental polic\*” OR “agri-environmental polic\*”) AND (“agriculture” OR “farm\*” OR “livestock” OR “landscape” OR “silvopasture” OR “pastoralism”). The truncation symbol “\*” covers the variations of the selected terms.

After the screening process to include or exclude based on the criteria previously defined, the eligibility step involved two researchers who examined titles, abstract, methods, results and discussion to verify the articles’ relevance to the study’s research questions and compliance with the inclusion criteria. A third researcher conducted an independent evaluation in case of doubts about inclusion criteria satisfaction. Articles that fulfilled all requirements were analysed.

#### **Clustering of Sardinian extensive dairy sheep system secondary outputs**

To investigate the societal awareness and appreciation of social and environmental benefits obtained by Sardinian agro-pastoralism externalities, we first specified a list of ASOs. Based on the findings of a previous systematic qualitative review, a list of ESs relating to other livestock realities suitable to the Sardinian sector was identified and classified as ‘regulating’, ‘supporting’ and ‘cultural’. The ‘provisioning’ services were excluded since they were outside the research scope. The list of externalities of SSs counts the outputs referring to the means of subsistence provided in inland areas (e.g. employment for indigenous people and immigrants), the avoidance of depopulation and the provision of social agriculture activities. Twenty secondary outputs were identified and used to answer our second research question (see Table 4 of Appendix).



A structured questionnaire was created in Google Forms in the Italian language and disseminated across social networks. Online surveys are increasingly used to collect data for research purposes, as they are cheap, fast and efficient in collecting valid data, removing geographic limitations and costs (Wright 2005; Vecchio et al. 2020). Recruitment was based on non-random criteria and influenced by the use of social networks, creating a potential selection/sampling bias, as respondents' beliefs, interests and strength of feelings about a topic can influence their willingness to participate in a survey (McAleese et al. 2016; Burruss and Johnson 2021). However, since no respondents received incentives for participating in this study, the voluntary response sample allowed us to investigate who has a strong opinion (positive, negative or neutral) about ASOs, therefore understanding genuine appreciation for ASOs.

The form was sent to a sample of Italian people, with a sub-category represented by Sardinian residents and was in the field for 1 month (18 March–18 April 2021). By the closing date for responses, 525 answers were recorded, all valid as the questionnaire could only be sent if all questions were answered. According to Kline (2015), there should be at least 10 valid responses per parameter. Therefore, given the numbers of the final sample (525) and the items (20), the research meets the above prior condition.

The questionnaire comprised three parts. After being welcomed into the study and reassured about the reliable and anonymous use of the data provided, respondents were first given a brief overview of the economic role of sheep farming in Sardinia, as well as how its environmental, social and cultural functions—if preserved and well-valued—can contribute to guaranteeing not only the sustainability of the sheep system but also generating well-being in the populations and the vitality of the territories concerned.

The second part collected the sociodemographic data of respondents. The third aimed to investigate two constructs that influence people's perception: past professional or family experience and subject knowledge. The latter reflects the self-confidence that an individual has in the adequacy of their knowledge (Brucks 1985; Carlson et al. 2009), and within the environmental behaviour context, is of substantial importance for the individual's formation of perceptions and behaviours (Kaiser and Fuhrer 2003; Frick et al. 2004).

In the last part, respondents were asked to express their appreciation for the ASOs of the Sardinian extensive sheep sector, indicating what level of benefit (none, moderate or high) they recognize from each of them. In other words, respondents valued ASOs based on their individual subjective (group-, time- and location-dependent) assessment (Spangenberg et al. 2014; Spangenberg and Settele 2016).

Data were analysed with three methods. First, descriptive statistics were calculated to summarize the data and provide background information about the variables in the data set. Afterwards, based on the perception of the relevance to the community of the secondary outputs, we clustered preferences using MCA. In so doing will be possible to highlight the most recognized agro-pastoralism ESs and SSs and, especially, to estimate the connections among agro-pastoralism amenities. MCA is an exploratory, multivariate analysis technique considered particularly suitable for categorical data description (Greenacre 1984, 2017; Le Roux and Rouanet 2004; Greenacre and

Blasius 2006). It is a technique of interdependence used for dimension reduction in qualitative variables (Benzécri 1992), considered as a multivariate extension of simple correspondence analysis and principal component analysis between quantitative variables, enabling the visualization of perceptual maps.

We used an MCA biplot (Greenacre 2010) to visualize the pattern of relationships of several categorical dependent variables in a two-dimensional plot. An orthogonal rotation of the principal axes was performed to improve the interpretation. MCA is obtained using a standard correspondence analysis on an indicator matrix ( $X$ ). It is a  $J \times M$  matrix where  $J_k$  is the vector of the levels (three levels: null, moderate, elevate attributed importance) for each  $K$  nominal variable (with  $\sum J_k = J$  and where  $k=20$  nominal variables represented by the considered secondary outputs), and  $M$  is the number of observations (525 respondents).

Performing MCA on  $X$  will provide two sets of factor scores, one for the rows and one for the columns. These factor scores are, in general, scaled such that their variance is equal to their corresponding eigenvalue.

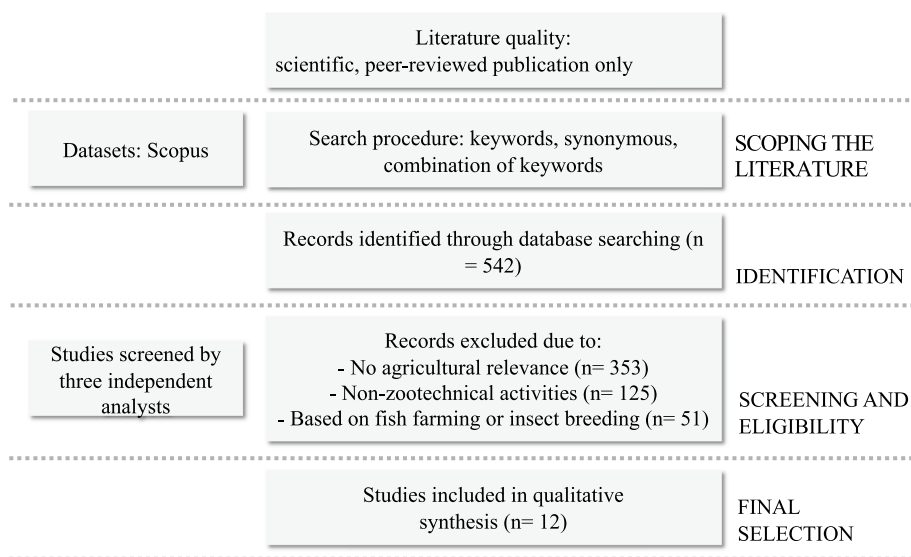
The analysis should allow us to provide evidence for the relationship between the 20 individuated ASOs by a representation in a low-dimensional space—designed based on few principal components—in order to define some clusters (profiles).

Finally, we evaluated the relationship between preferences stated for each ASO and the sociodemographic variables using an MLR model set. MLR is a highly efficient probability estimation method that can be used to address binary, ordinary or multinomial problems. It is an extension of binary logistic regression that can be used to forecast the probabilities of the different possible outcomes of a multi-way categorical dependent variable (in our case, the variable can assume three levels) given a set of independent variables that can be either dichotomous (i.e. binary) or continuous (i.e. interval or ratio in scale). Using MLR, we can see the influence of sociodemographic variables in determining trends in appreciation of ASOs arising from the Sardinian extensive dairy sheep system. Specifically, each ASO was regressed on the set of variables reported in Table 1.

**Table 1** List of the independent socio-economic variables involved in the regressions

Independent variable	Description	Scores
Residence	Region of residence	1 = Sardinia; 0 = Other regions
Gender	Gender of the respondent	1 = Male; 0 = Female
Past-prof-experience	Past employment in agriculture	1 = Yes; 0 = NO
Education	Level of education	1 = Secondary school; 2 = High school; 3 = Graduation; 4 = Postgraduate
Sheep breeder	Working as sheep breeder	1 = Yes; 0 = NO
Farmer	Working as farmer	1 = Yes; 0 = NO
Past-fam-experience	Coming from a peasant family	1 = Yes; 0 = NO
Age	Age of the respondent	1 = $\leq 17$ ; 2 = 18–29; 3 = 30–39; 4 = 40–49; 5 = 50–59; 6 = $\geq 60$
Subject knowledge	Knowledge of the Sardinian agro-pastoral reality	From 1 to 7
Frequency	Frequency in consuming Sardinian sheep dairy products	0 = never; 1 = about one a year; 2 = about one a month; 3 = about once a week; 4 = about every day





**Fig. 2** Systematic review of ecosystem services using PRISMA in Scopus database

## Results

### Qualitative literature review

Using the PRISMA framework procedure (Moher et al. 2009), 12 papers were considered relevant to our research questions. Figure 2 shows the flow diagram of the selection of relevant records.

Table 5 of the Appendix reports a summary of the results for the selected studies according to the research questions. Findings show that only five studies have previously examined the population's perception towards some ESs in the context of agro-ecosystems (RQ1), only three provided early indications on preferences among some ESs provided by the primary sector (RQ2), and only four studies provided an economic evaluation of primary sector ecosystem output (RQ3). Four out of 12 articles are attributable to Bernués A. and Ripoll-Bosch R. Four papers have been published in the *Land Use Policy* journal and three in *Ecosystem Services*. The main results are in the literature gaps detected. First, none of these studies investigated the social benefit generated from breeding in general. Second, no previous research focused on the secondary output of extensive dairy sheep farming systems on the whole. Third, there is a lack of studies on the economic benefits generated by extensive dairy sheep farming systems. These literature gaps validated the opportunity and importance of the second part of our research.

### Sample profile

The 525 Italian respondents, mainly residents, were 48.8% males and 51.2% females; 32.4% were aged between 50 and 59 years old, 24% were under 40 years old, about 23% were aged between 40 and 49 years old, and 7.1% were over 60 years old. Only 5.5% had a lower secondary school education, whereas 23.1% had an intermediate education level, 44.8% had a university degree and 26.7% had a postgraduate degree.

These percentages may result from the voluntary response sample. Regarding occupations, most respondents had a desk job (24%), 15.4% were students, 12.8% were shepherds

**Table 2** Profile of the sample

	Total n = 525	%
<i>Gender</i>		
Male	256	48.8
Female	269	51.2
<i>Age</i>		
≤ 17	1	0.2
18–29	125	23.8
30–39	108	20.6
40–49	170	32.4
50–59	84	16.0
≥ 60	37	7.1
<i>Resident</i>		
In Sardinia	450	85.7
In other regions	75	14.3
<i>Education</i>		
Secondary school	29	5.5
High school	121	23.1
University	235	44.8
Post University	140	26.7
<i>Occupation</i>		
Farmer	9	1.7
Househusband/housewife	9	1.7
Pensioner	11	2.1
Unemployed	22	4.2
Director	31	5.9
Teacher	48	9.1
Others	53	10.1
Breeder	67	12.8
Freelance	68	12.9
Student	81	15.4
Desk job	126	24.0
<i>Prior employed in the agricultural or livestock sector</i>		
Yes	241	45.9
No	284	54.1
<i>Coming from a family with a peasant tradition</i>		
Yes	285	54.3
No	240	45.7
<i>Subject knowledge about pastoral reality in Sardinia</i>		
1	6	1.1
2	24	4.6
3	62	11.8
4	91	17.3
5	126	24.0
6	122	23.2
7	94	17.9
<i>Frequency of Sardinian sheep products consumption</i>		
Never	7	1.3
Everyday	200	38.1
Once a week	208	39.6
Once a month	74	14.1
Once a year	36	6.9

**Table 3** Descriptive analysis of ASOS's perception level by residents and non-residents

Variable	Score		Frequency (%)								
			Residents n. 450			Non-residents n. 75			Total n. 525		
			Mean	S.D	Null	Mod	Elevate	Null	Mod	Elevate	Null
FERTILIZERS	2.09	0.59	14.7	62.7	22.7	5.3	73.3	21.3	13.3	64.2	22.5
BIODIVERSITY	2.44	0.57	4.4	49.6	46.0	1.3	38.7	60.0	4.00	48.0	48.0
HABITATS	2.10	0.71	21.1	51.3	27.6	16.0	34.7	49.3	20.8	49.0	30.7
FIRES	2.25	0.69	13.8	47.8	38.4	16.0	38.7	45.3	14.10	46.5	39.4
INSECTS	2.26	0.67	13.1	49.1	37.8	13.3	38.7	48.0	13–1	47.6	39.2
GHG	1.90	0.68	28.7	53.1	18.2	26.7	53.3	20.0	28.8	53.1	18.5
CARBON	1.99	0.65	22.2	57.6	20.2	18.7	60.0	21.3	21.7	57.9	20.4
EROSION	1.91	0.73	32.0	47.6	20.4	29.3	38.7	32.0	31.6	46.3	22.1
INVASIVE	2.20	0.67	15.6	51.6	32.9	8.0	45.3	46.7	14.5	50.7	34.9
WATER	1.89	0.65	26.2	56.7	17.1	33.3	57.3	9.3	27.2	56.8	16.0
CULTURE	2.54	0.65	8.9	30.4	60.7	6.7	17.3	76.0	8.6	28.6	62.9
ENV_EDUCATION	2.16	0.71	20.2	46.4	33.3	9.3	49.3	41.3	18.7	46.9	34.5
ARTS	2.14	0.72	20.9	46.9	32.2	16.0	37.3	46.7	20.2	45.5	34.3
RECREATION	1.93	0.70	29.6	51.1	19.3	22.7	44.0	33.3	28.6	50.1	21.3
LANDSCAPE	2.41	0.68	12.0	38.4	49.6	4.0	30.7	65.3	10.96	37.3	51.8
HERITAGE	2.08	0.68	19.8	55.3	24.9	14.7	45.3	40.0	19.1	53.9	27.1
TERRITORY	2.12	0.79	26.2	38.9	34.9	21.3	22.7	56.0	25.5	36.6	37.9
LOC_EMPLOYMENT	2.10	0.72	22.9	47.8	29.3	12.0	41.3	46.7	21.3	46.9	31.8
IMM_EMPLOYMENT	1.95	0.73	29.6	48.9	21.6	26.7	34.7	38.7	29.1	46.9	24.0
SOCIAL	1.90	0.69	29.8	53.6	16.7	25.3	42.7	32.0	29.1	52.0	18.9
Mean	2.12	0.71									

and 1.7% were farmers. Almost half of the sample stated that they had previously been employed in the agricultural or livestock sector (45.9%) and come from a family with a peasant tradition (54.3%). The subject knowledge was high, since on a scale of one to seven, 65.1% rated themselves at five and above. The purchase frequency of Sardinian products was also very high, as 38.1% and 39.6% declared that they consume Sardinian products at least once a day or once a week, respectively. The data are reported in Table 2.

### Descriptive analysis

The average of the responses for each ASO showed a moderate recognition of the externalities generated by the Sardinian extensive dairy sheep farming system (Table 3). The fact that the standard deviation was slight compared to the mean value demonstrated that the data were concentrated around the mean.

The tendency to recognize a moderate level of benefit generation from ASOs arose also when analysing the frequency, with two exceptions: the culture and landscape (enhancing cultural identity of Sardinia and safeguard of typical landscape). Most

respondents recognized that extensive dairy sheep farming generates high benefits in terms of these two secondary outputs.

Previous studies found differences between residents and non-residents concerning the perception of ESs (López-Santiago et al. 2014; Bidegain et al. 2019; Montrasio et al. 2020). As our sample mainly included residents, we wanted to investigate the possible differences between the respondents. The results showed that non-residents had a higher perception of ASOs than residents. In fact, in addition to the 'cultural' and 'landscape' ESs, non-residents demonstrated a high perception of the other six ESs ('biodiversity', 'habitats', 'fires', 'insects', 'invasive', 'arts') and also of three SSs ('territory', 'employment of local inhabitants', 'employment of immigrants'). It is striking that residents demonstrated a moderate perception of opportunities for social activities (i.e. social farming), which represents a form of resilience and innovation within rural systems and a tool to support the competitiveness of the production system (Nicolosi et al. 2021), and of employment of the foreign workforce, which has a growing relevance, especially in rural and marginal areas (Marongiu 2021).

#### **Multiple correspondence analysis**

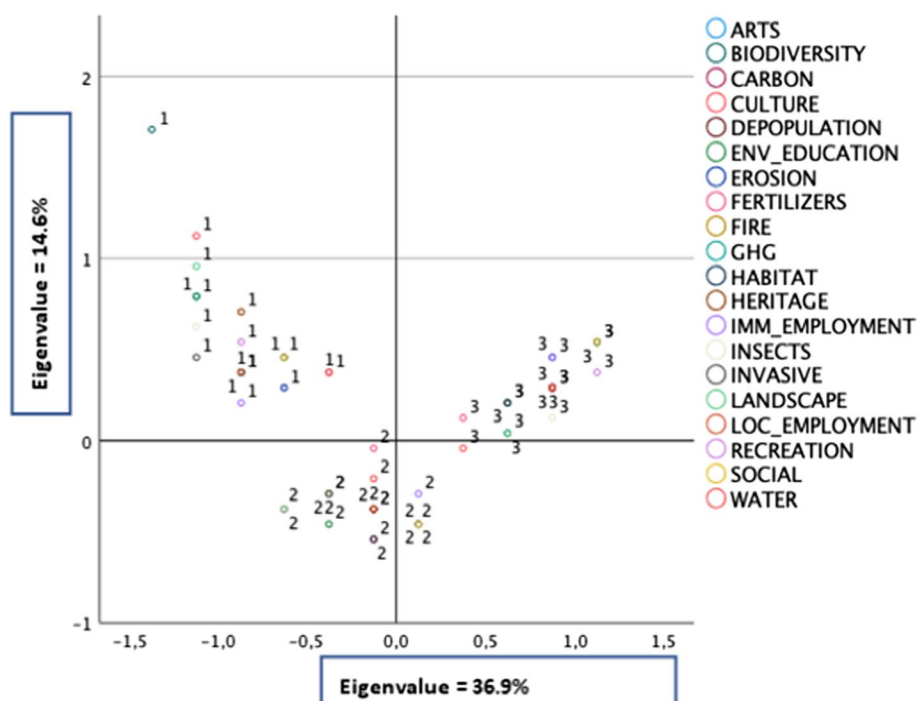
Two main dimensions were detected to represent the results within the Cartesian plane. Figure 3 shows the plot of component loadings for the survey data. Dimension one showed a Cronbach's alpha of 0.910 and explained 37% of the total variance, while dimension two showed a Cronbach's alpha of 0.69 and explained 15.5% of the total variance. Overall, about 50% of the variability was explained by the first two-component model.

The biplot allows us to investigate how well variables separate groups of objects. Findings indicated that observations were clustered based on the degree of relevance attributed by respondents. By examining the graph, it emerged that the first dimension (the horizontal axis) separated respondents who gave a moderate judgement of ASOs from those who gave more polarized opinions, i.e. null or elevated. Furthermore, 'biodiversity' was located much further from its origin than other variables, suggesting that taken as a whole, the others did not share many characteristics of it.

The second dimension (the vertical axis) separates the respondents who did not perceive a contribution from the Sardinian extensive dairy sheep farming system to the ASOs from those who detected a high contribution. The graph shows that the first and second dimensions involved perfect discrimination between the variables. Therefore, the overall picture shows that recognizing the importance of one service involves recognizing the importance of all services provided by the Sardinian system. It was therefore concluded that multifunctionality as a whole was recognized.

#### **Set of logit analysis**

Before running a set of MLRs, the multicollinearity test among sociodemographic variables was performed. All 10 sociodemographic variables reported a variance inflation factor (VIF) of less than 2 and a tolerance greater than 0.5. Therefore, there is no risk



**Fig. 3** Multiple correspondence analysis biplots

of multicollinearity or independent variables that are highly correlated and provide the same information in the present study (Hair et al. 2010; Tabachnick et al. 2013).

Each ASO (a trichotomic variable taken as dependent variables) was regressed to the bundle of sociodemographic variables (taken as independent variables) (see Table 6 of the Appendix). Findings showed that all 20 regression models led to significant results, although not all variables were significant in all regressions. In no case did coming from a family with a peasant tradition affect the perception of the Sardinian system over ASOs. Age and gender were rarely estimated among significant findings. In contrast, others variable, such as education level and regional residence, were often significant, although magnitude and sign can vary among the secondary output considered. Only three sociodemographic variables appeared noteworthy, past professional experience, residence and subject knowledge, which were found to be highly significant and positively correlated with all ASOs.

**Discussion**

The concept of ESs, as well as the research field, is ingrained in strong sustainability thinking (Jacobs et al. 2013) and provides a framework that unravels the complex feedback loops of how pasture affects ESs flows and how, in turn, these ESs are perceived (Lamarque et al. 2014). The multifunctional character of pasture-based sheep farming systems and thus their economic, environmental and social roles are recognized by policymakers and society (Ripoll-Bosch et al. 2012). Nevertheless, the literature analysis

through the PRISMA framework confirmed the need to broaden the research on ESs to meet decision-makers' and practitioners' information needs (Olander et al. 2017). Despite recognizing the pivotal role of sheep farming systems and their basis of the rural economy of Sardinia (Agris Sardegna 2017), there is a lack of studies on the secondary production of extensive dairy farming systems as a whole. Likewise, research on the economic benefits generated by extensive dairy sheep farming systems is missing. The lack of scientific relevance can only have repercussions on the ability of local, national and community policymakers to make informed decisions based on reliable information.

Moreover, the lack of studies focused on social benefits generated from breeding as a whole is surprising. Indeed, extensive dairy sheep farming systems are essential for the social fabric in rural areas. Due to the need to directly breed the sheep, people must live and work in these areas, avoiding depopulation and guaranteeing the defence of the territory. In addition, the rural decline is a global issue; extensive dairy sheep farming systems can tackle such problems by offering job opportunities to foreign workers, who in turn contribute actively to the process preservation of the above traditional practice (Nori et al. 2017).

Previous research (Ripoll-Bosch et al. 2013; Furesi et al. 2013; Leroy et al. 2018; Mattalia et al. 2020) has shown that the dairy sheep breeding system performs various functions which have given rise to several services and, in turn, benefits, for humans, who give a value of those services (Hansen and Pauleit 2014). This work recognizes that the economic value analysis of ESs is a methodology that has been criticized because of a conceptual controversy surrounding the use of economic approaches applied to ecosystems (e.g. Pimm 1997; Pearce 1998; Toman 1998; Viglizzo et al. 2012). The economic approach is anthropogenic and evaluates ecosystems according to human utility. Accordingly, the concept of ESs outlines the various contributions of ecosystems to human well-being, which are the main target of the analysis (MEA 2005). It is acknowledged in this work that, under the ecological approach, every ecosystem has its own intrinsic value, independent of its benefits for humanity and of what people happen to like, want or need (Sagoff 1997). However, the anthropogenic definition of ESs proposed by the MEA (2005) originated from the aim of making natural capital relevant to society and decision-makers; moreover, making an economic evaluation allows for the comparison of the different benefits received by ESs by measuring them and expressing them in a common denominator, also including ESs not traded on the market and which do not directly produce monetary benefits (Ottaviani 2020).

This work recognizes both the need to give value to externalities of the Sardinian extensive dairy sheep farming system and the anthropocentric nature of the framework of ESs (D'Ottavio et al. 2018) and SSs, which requires the assessment of their perception by stakeholders (Leroy et al. 2018). The assessment of ES perceptions is the first step to develop a shared understanding of the agro-landscape and support change paths in terms of sustainability (Dendoncker et al. 2018). Thus, the interviewees' perceptions of the ASOs were estimated, shedding light on possible paths to foster the durability and sustainable development of the target areas. While respondents



generally showed a moderate perception of benefits generated by ASOs, significant findings emerged by analysing the differences among residents and non-residents. In effect, because the 'subjective values are attributed based on the (individual and social) perception of real-world objects' (Spangenberg and Settele 2016, p. 102), different groups with different worldviews and different relationships with an ecosystem may recognize diverse potential services (Spangenberg et al. 2014; Bidegain et al. 2019).

Our results showed that the residence of the interviewees influenced the perception of SSs and ESs, confirming previous studies (López-Santiago et al. 2014; Bidegain et al. 2019; Montrasio et al. 2020). Non-residents, compared to residents, gave great value to ASOs, especially to those related to supporting and social services. There may be many explanations for this finding. Overall, residents recognized—more than other ASOs—the importance of pasture for the regional economy and society to enhance Sardinia's cultural identity and safeguard its typical landscape. In effect, shepherding is Sardinia's traditional and stereotypical representation (Ferrari 2009). Pasture has been at the focus of Sardinia's cultural identity for millennia and the agro-pastoral landscape, with its product, is one of the major attractions for tourists (Mattalia et al. 2020). Perhaps, it is the reason why residents placed a high value on the landscape and cultural 'noticeable' variables. In contrast, they may take for granted all other positive externalities of pasture, unlike the non-residents who make a conscious and targeted territory-use choice (Montrasio et al. 2020). Moreover, residents could also acknowledge several pasture problems associated with economic and environmental implications, such as out-migration and changes in ecologies because of shifts in grazing patterns (Nori and Scoones 2019). Idda et al. (2006) found a sense of social hostility towards the professional category of shepherds and a negatively oriented mentality towards sheep farming entrepreneurs by a portion of residents who carry out other activities that can overshadow all the other benefits generated by the Sardinian dairy sheep system. It could be that some of the residents may not look beyond these problems, resulting in a lack of knowledge that limits their ability to evaluate ASOs (Gundersen et al. 2017). A lack of information on an ASO may involve its 'unperception' and, in turn, render its consideration as not important (Bingham et al. 1995).

Another fact worthy of reflection is the cultural ESs 'that are usually directly experienced and intuitively appreciated' (Hermes et al. 2018, p. 296). In addition to the 'culture' appreciated by all, and 'art' appreciated more by non-residents, it was surprising that there was a moderate value attributed to 'heritage' (safeguard of cultural heritage) and 'recreation'. In reference to the first, we need only think of the 'canto a tenore', which developed in the pastoral culture of Sardinia and 'the paths of transhumance', keepers of a rich social, cultural and environmental heritage, which the shepherds protect with their own activities. Both of these are forms of heritage inscribed in the United Nations Educational, Scientific and Cultural Organization (UNESCO) lists. The findings may mean that most people do not perceive that the Sardinian dairy sheep farming system is a vector for maintaining culture by carrying on traditions that have been going on for centuries.

These findings all highlight the need for a greater narrative effort to challenge the vision of pastoral activity, which too often is seen as old-fashioned and with negative connotations in terms of social environment and living conditions (Pastomed 2007, p. 8).

There is a need to favour an increase in knowledge of the role of dairy farming systems and in the handing down of the centuries-old traditions that mark the regional cultural identity.

The moderate perception of the ES 'recreation' suggests the need for greater attention both to the management and to the promotion of the areas dedicated to pastoral activity. The durability and sustainable development of the Sardinian extensive dairy sheep systems, and the areas in which they are present, can be achieved by leveraging sustainable tourism, especially that based on natural and cultural assets. In fact, it can favour the exploitation of the territorial capital—meaning as historic and artistic capital, agricultural, pastoral and forest systems, territorial protection, know-how and craftsmanship—which can be a lever to revitalize those territories (Garrod et al. 2006; UVAL 2014) and foster local development (Maretti and Salvatore 2012; Sechi et al. 2020). However, if 'only human activities and presence can maintain this huge capital' (Sechi et al. 2020, p. 2), the territorial capital exploitation may be challenging since most Sardinian tourism is concentrated along the coasts and only a small part is in the inner area (ISTAT 2020). The increase in coastal tourism matches a decrease in population of the inner areas of the island (Onni and Cannao 2017). The role of local policymakers in the implementation of policies to attract people towards these is essential.

Another noteworthy fact is the 'one for all' tendency, i.e. that the appreciation of one ASO involves the appreciation of all ASOs. These data can be very useful for policymakers looking to stimulate public recognition of ASOs provided by the Sardinian extensive dairy sheep farming system. The increase in information on ASOs deemed unimportant could lead to their perception and, in turn, appreciation of their importance.

Our results showed that personal provenance from a family with a peasant tradition does not affect perception of ASOs, but previous employment in the agricultural or livestock sector affects three ASOs ('insect', 'territory' and 'local employment'). Similarly, being a shepherd or a farmer affects only four ASOs positively ('biodiversity', 'habitats', 'carbon' and 'invasive') and affects provision of social agricultural activities negatively. These data align with previous studies that see Sardinian shepherds as 'unaware gardeners' who build, maintain and save the landscape unwittingly and play, albeit without knowing it, a social role related to cultural production and re-elaboration (Pitzalis and Zerilli 2013; Mattalia et al. 2020). Local organizations in conjunction with policymakers could adopt actions to raise the shepherds' awareness of the multifunctionality of their activity. On the demand side there is a recognition of the ASOs produced by the Sardinian extensive dairy sheep farming system, which could create value within the company and ultimately increase its involvement in the production of ASOs.

Given the descriptive analysis results regarding other sociodemographic variables, it is not surprising that residence significantly influences perceptions of almost all ASOs. The educational level of the interviewees affects the perception of seven benefits generated by the Sardinian extensive dairy sheep farming system. A strongly significant result concerns the variable 'subject knowledge', particularly given previous studies that have found a positive relationship between subject knowledge and objective knowledge, which refers to accurate stored information that an individual possesses (Radecki and Jaccard 1995; Carlson et al. 2009). These data confirm the need to increase public

awareness of the role of pastoralism in generating environmental, humans' health and social well-being.

## Conclusion

Shepherding is a primary source of livelihood for several communities in Sardinia and other Mediterranean areas. It has been at the heart of local cultural identity for millennia, provides landscape maintenance and care, and contributes to the protection of the territory and the safeguarding and enhancement of vegetal and animal biodiversity. A performing and sustainable agro-pastoral sector is seen as 'the best ticket to the future of most Mediterranean islands' (Nori et al. 2017, p. 145). Along the same lines, this study focused on the demand side, offering an overview of how the public perceives the relationships between the dairy sheep farming system and the territory's environmental and social aspects, demonstrating which ASOs are most appreciated by different beneficiaries and on which strategic policy choices should focus. This is the first step to value these positive externalities that are largely involuntary (UVAL 2014). The assessment of perception and valuation of ASOs could also allow for the setting of an effective communication strategy towards local and general communities about the positive externalities of dairy sheep farming systems.

Sardinian stock farmers provide maintenance and care of the territory almost unconsciously. Recognizing the value and contribution of their secondary products can turn them from unaware to aware territory keepers and voluntary public goods providers (Mattalia et al. 2020), and lay the foundation for 'bring together territorial protection, development and (living) labour, and ensure that territorial protection evolves from precondition to development process' (UVAL 2014, p. 42). This study, highlighting the appreciation of ecosystems and social public goods provided by stock farmers that are not adequately valued through the market mechanism, offers an answer to those who see the EU's agricultural policy support for livestock farming as excessive. The perception of ASOs makes it possible to give them a value and determine the magnitude of the benefits that the Sardinian dairy sheep farming system provides, thus supporting policymakers to make effective, informed decisions and to justify investments and actions. Our findings suggest the possibility to switch from the traditional concept of subsidies to payment for ES provision, which links payments to market demands (i.e. the values attributed to ASOs by society) and can target policy towards specific ASOs (Plieninger et al. 2012; Faccioni et al. 2019).

Finally, to our knowledge, this is the first economic study on secondary outputs provided by extensive sheep farming systems, and it considers a large number of secondary outputs. The voluntary response sample that has tilted the balance of sample in favour of resident limits the generalizability of findings, although it allowed an insight into the views of people who have a strong feeling about the topic. Further research based on stratified sampling could validate our findings. Comparative studies would also allow us to understand the change in perception and how this relates to characteristics of the agricultural landscape and its users. Given the importance of the issue to support the decisions of public and private actors to foster the survival of the dairy sheep sector in Sardinia and other Mediterranean regions, further research is needed

to deepen the relationship between pasture and the rural landscape in the Mediterranean region. Such evidence could support rural policies aimed at safeguarding primary sector activities in the European landscape.

This study focused on SSs and ESs provided by dairy sheep farming systems. According to Blanco et al. (2019) and Herd-Hoare and Shackleton (2020), an integrated assessment of ESs and EDs could offer further perspectives for proper management approach and the definition of innovative sustainability policies that consider and integrate the social, economic, and environmental dimensions of livelihoods and land use. Future research may expand our research by identifying EDs arising from dairy sheep farming systems, investigating people's reactions to them, and assessing whether the information obtained offers significant contributions to rethinking sustainability policies towards greater effectiveness and equity.

Finally, further research needs to be conducted in the field of economic evaluations of secondary production of the extensive dairy sheep farming system, such as the monetary valuation of key ASOs and preferences and willingness-to-pay of different groups of people.

## Appendix

See Tables 4, 5 and 6.

**Table 4** List of secondary outputs

Services	Variable	Description
Regulating	FERTILIZERS	Production of natural fertilizers
	HABITATS	Maintenance of natural habitats
	INSECTS	Presence of useful pollinating insects
	GHG	Greenhouse gas mitigation
	CARBON	Preservation of carbon in the soil
	EROSION	Reduction in soil erosion caused by rain
	INVASIVE	Control of invasive species of flora and fauna
	WATER	Ensuring good quality of water
Cultural	LANDSCAPE	Safeguard of the typical landscape
	CULTURE	Enhancing cultural identity of Sardinia
	ENV_EDUCATION	Promotion of environmental education
	ARTS	Inspiring arts and culture
Supporting	RECREATION	Supply of recreational and cultural activities
	HERITAGE	Safeguard of cultural heritage
	BIODIVERSITY	Safeguard of animal biodiversity (local breeds)
Social	FIRES	Fire prevention
	TERRITORY	Avoid depopulation and ensure the defence of the territory
	LOC_EMPLOYMENT	Job supply for the local population
	IMM_EMPLOYMENT	Job supply for immigrants
	SOCIAL	Providing social agricultural activities

**Table 5** Description of selected studies

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
1a Balázi Á, Dänhardt J., Collins S., Schweiger O., Settele J., Hartel T	Understanding cultural ecosystem services related to farmlands: Expert survey in Europe	2021	Land Use Policy	Agriculture	Europe	–	To assess the understanding and perceptions on the usefulness and acceptance of the cultural ecosystem services concept by experts working in the science-policy-implementation interface related to agricultural landscapes of Europe	<i>Cultural:</i> Recreation and ecotourism; aesthetic, spiritual, religious, educational, cultural heritage values, inspiration, sense of places, knowledge systems, social relationships, and cultural diversity
1b Bernués A., Rodríguez-Ortega T., Ripoll-Bosch R., Alfnes F	Socio-cultural and economic valuation of ecosystem services provided by Mediterranean mountain agroecosystems	2014	PLoS ONE	Farming	Guara Natural Park, northeast Espana	Meat sheep farming	Determine the economic, social, and cultural value of ecosystem services derived from mountain agroecosystems in the Euro-Mediterranean region	<i>Cultural:</i> Maintenance of the agricultural landscape <i>Supporting:</i> Conservation of biodiversity; fire prevention <i>Provisioning:</i> Production of quality food linked to the territory

**Table 5** (continued)

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
1c Leroy G., Hoffmann I., From T., Hiemstra S.J., Gandini G	Perception of livestock ecosystem services in grazing areas	2018	Animal	Farming	42 countries (53.7% European e 46.3% extra-European)	General	Investigate how ecosystem services (except provisioning) related to livestock grazing are perceived across countries	<p><i>Regulating:</i> Habitat; water quality; cycling regulation; climate and air; erosion and avalanche; bush encroachment; fire control; pest and disease; control of crop residues and eradication of weeds; seed dispersal</p> <p><i>Cultural:</i> Cultural–historical and natural heritage; knowledge systems; educational, landscape, recreational, spiritual, and religious values</p> <p><i>Supporting:</i> Nutrient cycling; support of primary production</p>



**Table 5** (continued)

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
1d York E.C., Brunson M.W., Hulvey KB	Influence of Ecosystem Services on Management Decisions by Public Land Ranchers in the Intermountain West, USA	2019	Rangeland Ecology and Management	Farming	Intermountain West—Western USA	Cattle (95%) and sheep (7%)	Identify which ES drive pasture management decisions	<p><i>Regulating:</i> Control of crop residues and eradication of weeds, bush encroachment and fire, erosion, and avalanche; regulation of climate and air quality, pest and disease, quality and cyclin water; seed dispersal</p> <p><i>Cultural:</i> Cultural, historical and natural heritage; knowledge systems; educational, landscape, recreational, spiritual and religious values</p> <p><i>Provisioning:</i> Habitat; nutrient cycling</p> <p><i>Supporting:</i> Support of primary production</p>

**Table 5** (continued)

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
1e Boeraeve F., Duf�ne M., Dendoncker N., Dupire A., Mahy G	How are landscapes under agricultural transition perceived and appreciated? A Belgian case study	2020	Sustainability (Switzerland)	Agriculture and farming	Hainaut—Belgium	Cattle	Assess the extent to which locals (local inhabitants and Farmers) appreciate and view landscapes undergoing agricultural transitions	<i>Regulating:</i> Water pollution, flood, and erosion protection; pest control; landscape aesthetics; soil fertility  <i>Cultural:</i> Recreation and education inspiration; heritage; social cohesion  <i>Supporting:</i> Biodiversity <i>Provisioning:</i> Food production

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results
1a Only this	81	Experts from the following areas of activity formed our target group: (a) sustainable agriculture, landscape ecology, grassland management; (b) nature conservation, cultural heritage conservation (i.e. conservationist profile); (c) ecosystem services research; (d) policy on environment and rural development	—	—	Social analysis through questionnaires by mail and post	The results show a wide knowledge and acceptance of the cultural ecosystem services concept within such expert communities. Especially the aesthetic, cultural heritage, educational and recreational values were considered the most relevant CES subcategories

**Table 5** (continued)

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

	<b>Preliminary phase</b>	<b>Users interviewed (preliminary phase)</b>	<b>Type of users interviewed (preliminary phase)</b>	<b>Users interviewed (secondary phase)</b>	<b>Type of users interviewed (secondary phase)</b>	<b>Methodology</b>	<b>Results</b>
1b	Yes	88	Five Focus Groups (FG); two with livestock farmers ( $n=11$ ) that used pastures within the park, and three with citizens ( $n=22$ ) residents in neighbouring cities	504	102 citizens of Guara Natural Park, 402 inhabitants of the Aragon region	Choice experiment	Cultural services (particularly the aesthetic and recreational values of the landscape), supporting services (biodiversity maintenance) and some regulating services (particularly fire risk prevention) were clearly recognised by both farmers and citizens. The prevention of forest fires ( $\approx 50\%$ of total willingness to pay) was valued by the general population as a key ecosystem service delivered by these agroecosystems, followed by the production of specific quality products linked to the territory ( $\approx 20\%$ ), biodiversity ( $\approx 20\%$ ) and cultural landscapes ( $\approx 10\%$ ). The value given by local residents to the last two ecosystem services differed considerably ( $\approx 10$ and 25% for biodiversity and cultural landscape, respectively). The Total Economic Value of mountain agroecosystems was $\approx 120$ € person $-1$ year $-1$ , three times the current level of support of agro-environmental policies

**Table 5** (continued)

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

	<b>Preliminary phase</b>	<b>Users interviewed (preliminary phase)</b>	<b>Type of users interviewed (preliminary phase)</b>	<b>Users interviewed (secondary phase)</b>	<b>Type of users interviewed (secondary phase)</b>	<b>Methodology</b>	<b>Results</b>
1c	Yes		Qualitative pilot survey by FAO in 2013	44 Europeans and 38 non-Europeans	Scientists and other experts working in grassland-related fields from 42 countries	Case study analysis	A large proportion of respondents reported either positive or very positive impacts for some cultural ES, namely cultural, historical and natural heritage (84%), knowledge systems and educational values (77%), landscape values (74%), and for some supporting and regulating ES, namely habitat provision (66%), nutrient cycling (65%), and bush encroachment/fire control (66%). Depending on the ES, between 0%, for spiritual and religious values, and 17%, for water quality and cycling regulation, respondents reported a negative or very negative impact. Respondents reported those impacts as more positive in Europe, in protected areas and where several species were present in the grazing area

**Table 5** (continued)

**RQ 1: Has previous literature analysed the population's perception towards ASOs in the context of agroecosystems?**

	Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results
1d	Yes	11	Professionals in cooperative state agencies	287	Ranchers	Qualitative analysis through data-gathering through semi-structured "key informant interviews" before and large-scale survey after	The analysis identified services ranchers believe rangelands provide. The most frequently selected were provisioning or cultural services: forage for livestock (98.4%), demonstrating good stewardship to the public or other ranchers (95.9%), and maintaining a family legacy for future generations (93.8%). The least frequently selected were oil and gas production (11.4%), renewable energy production (21.9%) and income from tourism, recreation experiences and hunting leases (22.3%)
1e	Only this	37	9 local inhabitants, 2 local farmers, 2 agroecological experts	–	–	Qualitative analysis by questionnaire and mixed linear model	Both locals and experts see the agroecological scenario as delivering more ES and the conventional scenario as delivering the least ES. The agroecological scenario was seen as the most appreciated and the one delivering the most ES, while the conventional one was the least appreciated and seen as the one delivering the least ES

**Table 5** (continued)  
**RQ 2: Is there evidence for which ASOs provided by the primary sector are most appreciated?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
2a Bernués A., Tello-García E., Rodríguez-Ortega T., Ripoll-Bosch R., Casasús I	Agricultural practices, ecosystem services and sustainability in High Nature Value farmland: Unravelling the perceptions of farmers and nonfarmers	2016	Land Use Policy	Farming	Mountains of the Spanish Northeast (Central and pre-Pyrenees)	Meat cattle and sheep farming	Analyse the perceptions of farmers and nonfarmers regarding the relationships between agriculture and the environment in areas of naturalistic interest and the environment	<p><i>Regulating:</i> Air quality, water flows, and climate regulation; disturbance (forest fires) and soil fertility/erosion prevention; water purification/water purification/waste management; pollination; biological control (pests)</p> <p><i>Cultural:</i> Aesthetic; recreation/tourism; culture/art; spiritual experience; education/cognitive dev</p> <p><i>Supporting:</i> Lifecycle maintenance; gene pool protection</p> <p><i>Provisioning:</i> Food (meat and milk); water; raw materials (firewood, forage, mushrooms); genetic, medicinal, and ornamental resources</p>



**Table 5** (continued)

**RQ 2: Is there evidence for which ASOs provided by the primary sector are most appreciated?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
2b López-Santiago C.A., Oteros-Rozas E., Martín-López B., Plieninger T., Martín E.G., González J.A.	Using visual stimuli to explore the social perceptions of ecosystem services in cultural landscapes: The case of transhumance in Mediterranean Spain	2014	Ecology and Society	Agriculture and farming	Conquense Drove Road—España	Cattle and Sheep farming	Compare the perception of ES deriving from two different landscapes (pine forest and cultivated fields); investigate the perception of ES in landscapes with or without drove road dedicated to transhumance; analyse the links between the perception of ES and the socio-cultural and demographic characteristics of the sample	<p><i>Regulating:</i> Air purification; plant regeneration; fire prevention; soil erosion control; habitat for species; connectivity</p> <p><i>Cultural:</i> Aesthetic values; cultural identity; tourism; hunting; tranquility/relaxation</p> <p><i>Provisioning:</i> Feed for animals; gathering; food from agriculture; wood and timber; livestock</p>

**Table 5** (continued)

**RQ 2: Is there evidence for which ASOs provided by the primary sector are most appreciated?**

Authors	Title	Years	Journal	Sector considered	Reference Area	Type of farming considered	Aim of the analysis	Ecosystem services considered
2c Montrasio R., Mattiello S., Zucaro M., Genovese D, Battaglini L	The perception of ecosystem services of mountain farming and of a local cheese: An analysis for the touristic valorisation of an inner alpine area	2020	Sustainability (Switzerland)	Farming	Valli di Lanzo, Piedmont	Dairy cattle farming	Evaluate the community's perception towards livestock farming in the Lanzo Valleys and the typical product; investigate the consumers' habits and preferences to detect possible positive impacts on mountain tourism	<p><i>Regulating:</i> Control of fire, invasive species, and soil erosion; Improvement in water quality; pollination</p> <p><i>Cultural:</i> Cultural identity; environmental education; inspiration for arts and culture; maintenance of landscape; recreational opportunities; religious experiences</p> <p><i>Supporting:</i> Habitat maintenance; maintenance of local breeds</p> <p><i>Provisioning:</i> Food production; maintenance of biodiversity; production of fertilizers, wool, and leather</p>

**Table 5** (continued)

**RQ 2: Is there evidence for which ASOs provided by the primary sector are most appreciated?**

	<b>Preliminary phase</b>	<b>Users interviewed (preliminary phase)</b>	<b>Type of users interviewed (preliminary phase)</b>	<b>Users interviewed (secondary phase)</b>	<b>Type of users interviewed (secondary phase)</b>	<b>Methodology</b>	<b>Results</b>
2a	Only this	88	Five Focus Groups (FG): one with farmers of meat sheep, mixed agriculture sheep, one with farmers of cattle farmers with few or no agricultural crops, and three with nonfarmers	–	–	Focus groups	The farmers were very knowledgeable of ecosystem services (particularly regulation), the interactions among them, and their relationships with agricultural practices, particularly grazing management. Nonfarmers were less knowledgeable of ecosystem services, particularly regulation, and identified fewer relationships with agricultural practices. However, nonfarmers were highly concerned about the provision of quality food products and several cultural ecosystem services

**Table 5** (continued)

**RQ 2: Is there evidence for which ASOs provided by the primary sector are most appreciated?**

	Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results
2b	Yes		Information collected from a study by Oteros-Rozas et al. (2012)	314	191 residents and 123 non-residents	Qualitative analysis by a questionnaire that includes visual stimuli	Overall, respondents recognized the higher capacity of forests to deliver a wider range of ecosystem services to society compared with croplands. Provisioning services were mostly associated with cropland, whereas regulating services and cultural ecosystem services tended to be related to forests. All three types of ecosystem services were more perceived by respondents when a drove road was present in each landscape. However, differences in the visual perception of ecosystem services supply and preference for transhumance landscapes emerged in relation to certain socio-demographic and cultural respondent characteristics such as a previous relationship with transhumance and agriculture, rural/urban origin and identity, environmental awareness, and cultural attachment to a place

**Table 5** (continued)

**RQ 2: Is there evidence for which ASOs provided by the primary sector are most appreciated?**

	Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results
2c	Only this	233	Residents and non-residents	–	–	Qualitative analysis by a questionnaire	The respondents had a very positive awareness of the impact of mountain livestock farming in the Lanzo Valleys. The most important perceived ESs are cultural identity and maintenance of local breeds. Women, non-residents, and respondents with an intermediate education level generally had a more positive perception of ESs. There was a very low perception of disservices derived from mountain animal farming

**RQ 3: Has previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?**

Authors	Title	Years	Journal	Sector considered	Reference area	Type of farming considered	Aim of the analysis	Ecosystem services considered
3a Bernués A., Alfnes F., Clemetsen M., Eik L.O., Faccioni G., Ramanzin M., Ripoll-Bosch R., Rodríguez-Ortega T., Sturaro E	Exploring social preferences for ecosystem services of multifunctional agriculture across policy scenarios	2019	Ecosystem Services	Farming	Guara Natural Park (España), Aurland Municipality (Norway), Province of Trento (Italy)	Meat sheep farming (España), meat sheep farming and dairy goats farming (Norway), dairy cattle farming (Italy)	Analyse social preferences for ES and associated willingness to pay in three European multifunctional agroecosystems in Europe (Mediterranean, Atlantic, Alpine) under alternative agrivironmental policy scenarios	<p><i>Regulating:</i> Fire and water prevention; soil fertility in the Atlantic areas</p> <p><i>Cultural:</i> Agricultural landscape maintenance</p> <p><i>Supporting:</i> Biodiversity conservation</p> <p><i>Provisioning:</i> High-quality food</p>

**Table 5** (continued)

**RQ 3: Has previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?**

Authors	Title	Years	Journal	Sector considered	Reference area	Type of farming considered	Aim of the analysis	Ecosystem services considered
3b Bernués A., Rodríguez-Ortega T., Alfnes F., Clemetsen M., Eik L.O	Quantifying the multifunctionality of fjord and mountain agriculture by means of socio-cultural and economic valuation of ecosystem services	2015	Land Use Policy	Farming	Aurland, southeast Norway	Meat sheep farming and dairy goats farming	Define the value of the main functions performed by fjords and mountain agro-ecosystems in the Nordic countries by means of the ecosystem services framework	<p><i>Regulating:</i> Soil fertility</p> <p><i>Cultural:</i> Agricultural landscape</p> <p><i>Supporting:</i> Biodiversity</p> <p><i>Provisioning:</i> Quality products linked to the territory</p>
3d Bielski S., Marks-Bielska R., Novikova A., Vaznonis B	Assessing the value of agroecosystem services in warmia and mazury province using choice experiments	2021	Agriculture (Switzerland)	Agriculture	Warmia e Mazury region—Poland	–	Assess the non-market values of agroecosystem services in an exceptionally environmentally rich area of the Warmia and Mazury region (Poland); identifying consumers' preferences for them	<p><i>Regulating:</i> Water quality</p> <p><i>Cultural:</i> Agricultural landscape</p> <p><i>Supporting:</i> Biodiversity</p>

**Table 5** (continued)

RQ 3: Has previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?								
Authors	Title	Years	Journal	Sector considered	Reference area	Type of farming considered	Aim of the analysis	Ecosystem services considered
Rewitzer S., Huber R., Grét-Regamey A., Barkmann J	Economic valuation of cultural ecosystem service changes to a landscape in the Swiss Alps	2017	Ecosystem Services	Agriculture and farming	Visp—Swiss	Cattle	Advance the notion that the economic valuation of cultural ecosystem services is, principally, not more problematic than the economic valuation of non-cultural ecosystem services	<p><i>Regulating:</i> Protection against natural hazards</p> <p><i>Cultural:</i> Agricultural heritage; aesthetic value of landscape</p> <p><i>Supporting:</i> Biodiversity</p>
RQ 3: Has previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?								
Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results		
3a Yes	–	Representative panellists	1044	Resident	Choice experiments and questionnaire	<p>Some lessons were delivered. (i) Value of ES: biodiversity and regulating ecosystem services always produce welfare gains; people, however, perceive trade-offs between delivery of agricultural landscapes and quality food products. Nevertheless, preferences are heterogeneous and vary across regions, scenarios, and ES. (ii) Policymaking: society's willingness to pay for ecosystem service delivery largely exceeds the current level of public support. Moreover, further abandonment and intensification of agriculture are clearly rejected by the public. (iii) Methodological: monetary valuation is context-dependent, and extrapolation of economic values can be misleading</p>		

**Table 5** (continued)

**RQ 3: Has previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?**

Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results
3b -			43; 312	Socio-cultural analysis: farmers (27), local businesses (9), representatives of governmental agencies (3) and non-profit organizations (4) involved in the conservation of environmental and cultural heritage Choice experiment: Resident of Aurland (72) and inhabitant near Bergen (240)	Socio-cultural analysis and Choice experiment	The socio-cultural perceptions of multifunctionality among local stakeholders were similar, but differences in the relative importance of the functions reflected particular interests (agriculture compared with tourism). Both the local and the general populations attached great importance to the production and availability of quality foods. The general population showed very homogenous preferences among ecosystem services, but local people rated them very differently. Local people ranked a more agricultural landscape very high. The total economic value of fjord and mountain agro-ecosystem was 850 € per person per year. The willingness to pay for the provision of ecosystem services under a policy scenario of further development of multifunctional agriculture clearly exceeded the current level of public support. The welfare loss that society would experience in a scenario of further abandonment of agriculture was even greater



**Table 5** (continued)  
**RQ 3: Has previous literature provided an economic evaluation of primary sector ASOs, especially concerning breeding systems?**

	Preliminary phase	Users interviewed (preliminary phase)	Type of users interviewed (preliminary phase)	Users interviewed (secondary phase)	Type of users interviewed (secondary phase)	Methodology	Results
3d	-	-	-	353	Residents	Choice experiment	Residents were concerned about environmental issues that may be caused by agriculture. There was a demand for the provision of agroecosystem services. Marginal willingness to pay values were the highest for water quality (EUR 1.94), followed by wildlife population (EUR 1.02) and agricultural landscape (EUR 0.85)
3e	Yes	117	Local inhabitants	252	Local inhabitants	Pre-studies (semi-structured interviews, stakeholder workshop); pilot study (n = 117); discrete choice experiment	Citizen support was expressed for agricultural heritage and biodiversity-rich dry grasslands. Aesthetic impacts of settlement extension and grassland intensification reduced the economic value of development options impacting the Visp landscape. Estimated marginal willingness-to-pay ranged from 410 CHF (1 CHF approx. 0.8 EUR in 2013)/person/year for 60 additional ha of dry grassland to 833 CHF for the visual impact of settlement expansion (by changes of the tax bill)

**Table 6** Set of logit regressions

	Independent variables														
	FERTILIZERS			BIODIVERSITY			HABITATS			FIRE			INSECTS		
	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value
Residence	-0.372	0.296	0.208	<b>-0.618</b>	<b>0.297</b>	<b>0.037**</b>	<b>-0.779</b>	<b>0.286</b>	<b>0.007***</b>	<b>-0.518</b>	<b>0.286</b>	<b>0.070*</b>	-0.077	0.285	0.786
Gender	-0.216	0.187	0.248	-0.136	0.184	0.459	<b>-0.344</b>	<b>0.173</b>	<b>0.047**</b>	-0.284	0.178	0.111	-0.234	0.177	0.186
Past_Prof_Experience	-0.042	0.213	0.844	0.227	0.210	0.279	-0.100	0.199	0.614	0.061	0.205	0.767	<b>0.488</b>	<b>0.203</b>	<b>0.016**</b>
Education	-0.172	0.117	0.143	<b>0.269</b>	<b>0.115</b>	<b>0.019**</b>	0.176	0.108	0.104	0.133	0.112	0.234	0.095	0.112	0.392
Sheepbreeder	-0.065	0.325	0.842	0.125	0.314	0.692	<b>0.566</b>	<b>0.299</b>	<b>0.058*</b>	0.447	0.307	0.145	0.404	0.305	0.185
Farmer	-0.376	0.728	0.605	<b>138,122</b>	<b>0.833</b>	<b>0.097*</b>	0.234	0.595	0.694	0.239	0.657	0.716	0.820	0.668	0.220
Past_Fam_Experience	-0.019	0.208	0.926	0.241	0.202	0.233	-0.091	0.192	0.636	0.159	0.197	0.420	-0.247	0.196	0.208
Age	-0.086	0.075	0.254	-0.012	0.074	0.868	0.017	0.069	0.805	0.079	0.071	0.265	0.053	0.071	0.450
Subject_Knowledge	<b>0.135</b>	<b>0.078</b>	<b>0.083*</b>	<b>0.198</b>	<b>0.077</b>	<b>0.010***</b>	<b>0.191</b>	<b>0.071</b>	<b>0.007***</b>	<b>0.346</b>	<b>0.075</b>	<b>&lt;0.0001***</b>	<b>0.340</b>	<b>0.076</b>	<b>&lt;0.0001***</b>
Frequency	-0.052	0.117	0.656	-0.080	0.113	0.482	-0.112	0.107	0.297	-0.088	0.107	0.409	<b>-0.238</b>	<b>0.110</b>	<b>0.030**</b>
cut1	-272,266	0.670	<0.0001***	-222,477	0.676	0.001***	-121,074	0.628	0.054*	-0.389	0.631	0.538	0.163	0.630	0.796
cut2	0.433	0.655	0.509	116,932	0.656	0.075*	106,312	0.628	0.091*	211,045	0.638	0.001***	277,621	0.645	<0.0001***
Log-Likelihood ratio test:	104,962			112,456			963,421			119,658			127,404		
Chi-square (10)															
	Independent variables														
	GHG			CARBON			EROSION			INVASIVE			WATER		
	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value
Residence	-0.387	0.292	0.185	<b>-0.764</b>	<b>0.285</b>	<b>0.007***</b>	<b>-0.680</b>	<b>0.283</b>	<b>0.016**</b>	-0.111	0.284	0.696	<b>-0.694</b>	<b>0.333</b>	<b>0.037**</b>
Gender	-0.125	0.181	0.487	-0.121	0.174	0.488	0.029	0.175	0.870	<b>-0.526</b>	<b>0.180</b>	<b>0.004***</b>	0.014	0.188	0.942
Past_Prof_Experience	0.289	0.209	0.168	<b>0.354</b>	<b>0.197</b>	<b>0.073*</b>	-0.061	0.200	0.762	-0.122	0.205	0.554	0.205	0.222	0.355
Education	<b>0.300</b>	<b>0.113</b>	<b>0.008***</b>	0.057	0.108	0.595	0.098	0.110	0.371	<b>-0.217</b>	<b>0.113</b>	<b>0.055*</b>	0.064	0.117	0.581
Sheepbreeder	0.245	0.304	0.421	0.452	0.287	0.115	-0.335	0.296	0.258	<b>116,924</b>	<b>0.309</b>	<b>0.000***</b>	-0.246	0.323	0.447
Farmer	114,495	0.699	0.101	<b>119,250</b>	<b>0.643</b>	<b>0.064*</b>	0.624	0.648	0.335	<b>154,040</b>	<b>0.731</b>	<b>0.035**</b>	0.487	0.839	0.562

**Table 6** (continued)

	Dependent variables														
	GHG			CARBON			EROSION			INVASIVE			WATER		
	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value
Past_Fam_Experience	-0.039	0.201	0.845	0.302	0.193	0.117	-0.057	0.196	0.772	0.214	0.200	0.284	-0.036	0.210	0.863
Age	0.049	0.072	0.500	-0.014	0.069	0.840	-0.068	0.070	0.329	-0.051	0.072	0.478	-0.008	0.076	0.912
Subject_Knowledge	<b>0.258</b>	<b>0.076</b>	<b>0.001***</b>	<b>0.190</b>	<b>0.073</b>	<b>0.009***</b>	<b>0.204</b>	<b>0.074</b>	<b>0.006***</b>	<b>0.160</b>	<b>0.075</b>	<b>0.033**</b>	<b>0.249</b>	<b>0.078</b>	<b>0.002***</b>
Frequency	0.081	0.111	0.469	0.044	0.106	0.681	-0.049	0.108	0.648	0.086	0.109	0.429	-0.135	0.119	0.256
cut1	106,535	0.648	0.100	0.106	0.617	0.863	-162,389	0.626	0.010***	-0.877	0.642	0.172	-213,660	0.689	0.002***
cut2	388,574	0.674	<0.0001***	229,846	0.627	0.000***	0.844	0.624	0.176	203,629	0.649	0.002***	-0.238	0.678	0.726
Log-Likelihood ratio test:	123,929			112,665			92,231			143,348			833,572		
Chi-square (10)															
	Dependent variables														
	CULTURE			ENV_EDUCATION			ARTS			RECREATION			LANDSCAPE		
	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value
Residence	<b>-0.451</b>	<b>0.273</b>	<b>0.098*</b>	<b>-0.451</b>	<b>0.273</b>	<b>0.098*</b>	<b>-0.528</b>	<b>0.283</b>	<b>0.062*</b>	<b>-0.732</b>	<b>0.278</b>	<b>0.009***</b>	<b>-0.649</b>	<b>0.298</b>	<b>0.029**</b>
Gender	-0.177	0.173	0.306	-0.177	0.173	0.306	<b>-0.318</b>	<b>0.172</b>	<b>0.065*</b>	<b>-0.319</b>	<b>0.173</b>	<b>0.065*</b>	-0.246	0.179	0.170
Past_Prof_Experience	0.217	0.198	0.274	0.217	0.198	0.274	-0.164	0.200	0.412	-0.127	0.199	0.523	0.176	0.206	0.395
Education	-0.003	0.108	0.975	-0.003	0.108	0.975	0.049	0.109	0.654	-0.090	0.109	0.408	0.150	0.112	0.180
Sheepbreeder	-0.106	0.303	0.726	-0.106	0.303	0.726	-0.320	0.291	0.271	0.045	0.296	0.879	0.242	0.311	0.436
Farmer	0.148	0.659	0.822	0.148	0.659	0.822	-0.405	0.616	0.510	0.558	0.643	0.386	0.247	0.671	0.713
Past_Fam_Experience	0.307	0.191	0.108	0.307	0.191	0.108	0.261	0.190	0.170	0.154	0.191	0.420	0.239	0.198	0.228
Age	0.073	0.069	0.288	0.073	0.069	0.288	<b>0.202</b>	<b>0.069</b>	<b>0.004***</b>	<b>0.150</b>	<b>0.069</b>	<b>0.030**</b>	-0.008	0.072	0.915
Subject_Knowledge	<b>0.189</b>	<b>0.071</b>	<b>0.008***</b>	<b>0.189</b>	<b>0.071</b>	<b>0.008***</b>	<b>0.244</b>	<b>0.072</b>	<b>0.001***</b>	<b>0.260</b>	<b>0.073</b>	<b>0.000***</b>	<b>0.212</b>	<b>0.075</b>	<b>0.005***</b>
Frequency	-0.157	0.105	0.136	-0.157	0.105	0.136	-0.091	0.105	0.384	-0.095	0.104	0.362	-0.185	0.112	0.099*
cut1	-119,579	0.616	0.052*	-119,579	0.616	0.052*	-0.314	0.619	0.612	-0.533	0.625	0.393	-191,884	0.653	0.003***
cut2	100,348	0.615	0.103	100,348	0.615	0.103	181,040	0.625	0.004***	180,158	0.631	0.004***	0.208	0.646	0.747

**Table 6** (continued)

	Independent variables																	
	Dependent variables			CULTURE			ENV_EDUCATION			ARTS			RECREATION			LANDSCAPE		
	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value
Log-Likelihood ratio test:	916,621			951,135			102,057			952,683								
Chi-square (10)																		
	Independent variables																	
	Dependent variables			HERITAGE			TERRITORY			LOC_EMPLOYMENT			IMM_EMPLOYMENT			SOCIAL		
	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value	Coeff	S.E	p value
Residence	<b>-0.577</b>	<b>0.285</b>	<b>0.043**</b>	<b>-0.746</b>	<b>0.290</b>	<b>0.010**</b>	<b>-0.623</b>	<b>0.283</b>	<b>0.028**</b>	<b>-0.471</b>	<b>0.284</b>	<b>0.098*</b>	<b>-0.485</b>	<b>0.288</b>	<b>0.092*</b>			
Gender	-0.066	0.176	0.708	0.033	0.173	0.849	0.194	0.174	0.264	0.133	0.173	0.439	-0.041	0.175	0.814			
Past_Prof_Experience	-0.027	0.204	0.896	<b>0.377</b>	<b>0.200</b>	<b>0.059*</b>	<b>0.338</b>	<b>0.200</b>	<b>0.091*</b>	0.127	0.200	0.524	0.166	0.202	0.411			
Education	<b>-0.241</b>	<b>0.111</b>	<b>0.030**</b>	0.080	0.108	0.457	<b>0.234</b>	<b>0.110</b>	<b>0.033**</b>	<b>0.234</b>	<b>0.109</b>	<b>0.032**</b>	-0.012	0.108	0.913			
Sheepbreeder	0.006	0.300	0.985	-0.203	0.292	0.488	-0.130	0.299	0.665	-0.187	0.292	0.523	-0.655	<b>0.297</b>	<b>0.027**</b>			
Farmer	-0.333	0.694	0.632	-0.348	0.663	0.600	-0.536	0.706	0.448	-112,476	0.719	0.118	-0.329	0.636	0.605			
Past_Fam_Experience	0.305	0.195	0.118	0.021	0.190	0.912	0.026	0.192	0.893	-0.082	0.192	0.668	0.308	0.194	0.112			
Age	0.086	0.071	0.225	<b>0.244</b>	<b>0.070</b>	<b>0.001***</b>	0.105	0.069	0.131	0.087	0.069	0.202	0.010	0.069	0.887			
Subject_Knowledge	<b>0.163</b>	<b>0.073</b>	<b>0.026**</b>	<b>0.370</b>	<b>0.072</b>	<b>&lt;0.0001***</b>	<b>0.252</b>	<b>0.072</b>	<b>0.000***</b>	<b>0.285</b>	<b>0.073</b>	<b>&lt;0.0001***</b>	<b>0.120</b>	<b>0.072</b>	<b>0.095*</b>			
Frequency	<b>-0.254</b>	<b>0.107</b>	<b>0.018**</b>	-0.166	0.105	0.114	<b>-0.184</b>	<b>0.109</b>	<b>0.091*</b>	-0.145	0.108	0.178	-0.130	0.107	0.224			
cut1	-249,716	0.638	<0.0001***	0.606	0.614	0.323	-0.122	0.610	0.842	0.534	0.617	0.386	-113,554	0.610	0.063*			
cut2	0.041	0.627	0.947	234,727	0.623	0.000***	209,925	0.619	0.001***	269,764	0.629	<0.0001***	127,706	0.611	0.037**			
Log-Likelihood ratio test:	102,492			119,053			112,369			101,822			906,501					
Chi-square (10)																		

Significant values are highlighted in bold

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**Author contributions**

BA, RF, FAM and PP contributed to conceptualization; BA and FAM contributed to methodology, formal analysis, and writing—original draft preparation; BA, FAM and PS investigated the study; BA, RF, FAM, PS and PP helped in writing—review and editing; RF and PP supervised the study; PP administered the project and performed funding acquisition. All authors have read and agreed to the published version of the manuscript.

**Authors' information**

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**Availability of data and materials**

Not applicable.

**Declarations****Competing interests**

The authors declare that they have no competing interests.

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