

Unravelling opportunities, synergies, and barriers for enhancing silvopastoralism in the Mediterranean

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ABSTRACT

Silvopastoral systems combine wood perennials with forage and livestock. These multipurpose wood-pasture habitats represent an important part of European bio-cultural and ecological heritage. However, their gradual disappearance due to processes of farm abandonment and intensification as well as forestry abandonment threatens biodiversity conservation and bio-cultural heritages. The behaviours of forest owners and livestock farmers determine the success of silvopastoral systems since a productive coherence between forest management and livestock grazing is required for their optimal functioning. In this study, we investigate the livestock farmers' and forest owners' attitudes and opinions towards wood pasture grazing and their relationship with structural factors and farming objectives in two Spanish regions. We used data collected through surveys to identify opportunities, synergies, and barriers in the integration of these actors in joint silvopastoralism. The results reveal a relationship between production objectives and positive attitudes towards silvopastoralism and the environmental functions provided by this activity, in both farmers and forest owners. Cattle farmers express a greater economic interest in wood pastures, as compared to sheep farmers who perceive more difficulties in using them. Acknowledgement of the role of grazing in landscape maintenance is positively correlated with a wide spectrum of objectives of forest owners, from the economic-productivist to the more altruistic profiles. The most synergies are found between cattle farmers and small forest owners for joint silvopastoral management. However, the incorporation of sheep grazing is advisable for the sustainable management of these systems, and hence additional efforts may be required to integrate such farming systems into silvopastoral management. As it currently stands, the EU Common Agricultural Policy appears to be inadequate for maintaining silvopastoral systems.

1. Introduction

Silvopastoral systems represent an important part of European cultural-ecological heritage (Bergmeier et al., 2010), and can be seen as social-ecological systems shaped by the needs of local people over

thousands of years (Hartel and Plieninger, 2014; Plieninger et al., 2015; Roellig et al., 2018). Silvopastoralism is effectively a multi-purpose land management mechanism which combines woody perennials with forage and animal production (Den Herder et al., 2017). The highest concentration of these systems is in Mediterranean regions and is the dominant

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type of agroforestry in the EU (Mosquera-Losada et al., 2016; Den Herder et al., 2017). The livestock farming systems (LFS) that profit from such forests are pasture-based and thus play a central role in the management and conservation of large areas of high nature value (HNV) farmland in Europe (Bernués et al., 2011).

Despite their importance for biodiversity conservation and bio-cultural heritage, silvopastoral systems in Mediterranean regions are gradually disappearing due to simultaneous processes of farm abandonment and intensification. Similarly, the persistence of the forest element of silvopastoral systems is threatened by overgrazing and abandonment, which lead to diminished tree regeneration and encroachment of vegetation, respectively (Bergmeier and Roellig, 2014; Roellig et al., 2018). The abandonment of silvopastoral systems leads to the gradual disappearance of agro-forest and wood-pasture mosaics as well as biodiversity loss, which reduces the provision of ecosystem services (ES) and degrades bio-cultural heritage (Agnoletti and Rotherham, 2015; Cervera et al., 2015). Densification of existing forests and spontaneous forest expansion in former agricultural lands leads to highly homogenous forest stands (Varela et al., 2020) that usually exhibit low resilience to disturbances such as wildfires. This contrasts the increasingly prominent role played by woodlands and forests in delivering the regulating ES with a clear public-good dimension which benefit society as a whole (Feliciano et al., 2017). In this sense, silvopastoral management has been proposed as a viable solution to tackle a major challenge currently faced by the agricultural sector in the EU, which is to make production more sustainable by promoting diverse land-use practices that can enhance biodiversity (Burton, 2004; Saunders, 2016; Sandberg and Jakobsson, 2018). There are numerous synergies between forest production and livestock farming. The latter can control scrub encroachment and natural extension of woodlands (Riedel et al., 2013), while forest pastures may increase feed autonomy, reducing the vulnerability of livestock farms to variations in the availability and price of inputs (Ríos-Núñez et al., 2013; Aubron et al., 2016). However, the management of silvopastoral systems involves trade-offs, since it entails higher labour intensity both in tree and animal tending, potentially becoming financially unprofitable (Plieninger et al., 2015).

The ongoing intensification processes in agriculture are closely linked to with modern forestry and the compartmentalised model of land use governance in Europe, where agriculture and forestry are distinct land use categories that are managed by separate governing bodies and rationales (Hartel and Plieninger, 2014; Sandberg and Jakobsson, 2018; Stenseke et al., 2018). At the EU level, this division crystallizes in the absence of a common EU forestry legislation, where silvopastoral systems are separately regulated by the Common Agricultural Policy (CAP) and national forestry policies. While the CAP measures have been effective in delivering funds and incentives to support farmers' revenues and reduce market distortion (Pe'er et al., 2014; European Commission, 2021), the CAP has also contributed to the loss of biodiversity linked to agro-ecosystems through the promotion of intensification of farming practices (Navarro and López-Bao, 2018). Forests with more than 100 trees per ha are usually not eligible for the subsidies destined for agricultural land (the basic payment of the EU's CAP) (Beaufoy et al., 2015) due to the Pasture Eligibility Coefficient (PEC) introduced in the current CAP (2014–2020), thereby disincentivising silvopastoral models of land use (Mosquera-Losada et al., 2018). In the absence of a legally binding forest policy at the EU level, forest-related issues are further complicated by the different sectoral interests entailing multiple and often competing objectives (Lazdinis et al., 2019). EU funds related to forests are allocated to conservation, restoration, and fire prevention and extinction efforts, whereas sustainable forest management and the maintenance of multifunctional agro-silvopastoral mosaics are hampered by the lack of financial incentives and also by environmental regulations (Varela et al., 2020). The rural development programmes (RDP) funded by the CAP are the main providers of subsidies and incentives aiming to increase the social and

ecological resilience of European forests (Forest Europe, 2011).

Ultimately, and beyond policy incentives, the success of silvopastoral management systems is determined by the behaviours of forest owners and livestock farmers as well as their willingness to cooperate (Guerin et al., 2010), since they may have different attitudes, opinions, and objectives that may hinder the establishment of a productive coherence between forest management and livestock grazing. Among these behavioural factors, dispositional factors such as objectives and attitudes impact farmers' decisions (Willock et al., 1999; Ahnström et al., 2009; Dessart et al., 2019) and the managerial behaviours of forest owners (Dhubháin et al., 2007; Urquhart et al., 2012; Howley, 2013). Accordingly, objectives, attitudes, and opinions are frequently used in the literature as suitable proxies to explain the behaviour of different actors (Bergeroet et al., 2004). In contrast, the assessment of silvopastoral management and the motivations of the actors behind such systems has remained a more elusive topic (Rapey et al., 2001; Rois-Díaz et al., 2018), despite the fact that agroforestry land uses are becoming increasingly acknowledged in Europe (Mosquera-Losada et al., 2018).

To fill this knowledge gap, in this study we explored the attitudes and opinions of both forest owners and livestock farmers towards different dimensions of silvopastoral management and the CAP. Furthermore, we analysed whether or not these attitudes and opinions were linked to their unique structural and socioeconomic characteristics and their objectives. The ultimate goal was to disentangle the factors that may either facilitate or hinder the integration of these actors into joint silvopastoral management schemes. Our findings may help in identifying targets for policy measures aiming to foster such integration.

2. Material and methods

2.1. Description of case study areas

This study was undertaken in Mediterranean mid-mountain areas located in two different regions in the north-eastern part of Spain; Aragón and Catalonia (see Fig. 1).

The Sierra de Guara Natural Park (Guara) is located in the pre-Pyrenees, in the province of Huesca (Aragón). The park covers 81,491 ha and ranges in altitude from 430 to 2077 m. On average, 40% of forestland is public, with this percentage varying between municipalities from 13% to 100%. Shrub pastures account for 49% of the area of Guara, followed by grazed forestland (29%), open forest pastures (7%), croplands (7%), and summer mountain pastures (1%) (Asensio and Casasús, 2004). The climatic vegetation are oak forests of *Quercus rotundifolia* and *Quercus faginea* and pine forests of *Pinus sylvestris* in shaded areas, while in degraded lands gorse rosemary (*Ulex sp.*) and box (*Buxus sempervirens*) abound. Livestock activity is based on extensive sheep and cattle grazing systems (Bernués et al., 2005). In 2019, there were 143 sheep farms with a total of 51,242 heads, and 80 cattle farms with a total of 2462 heads (Gobierno de Aragón, 2019).

El Lluçanès is located in the province of Barcelona (Catalonia) and covers an area of 40,000 ha. It constitutes a transitional mid-mountain area and is close to the pre-Pyrenean mountain range. 98% of the forestland is private and accounts for around 60% of the area of the region, followed by agricultural crops (30%) and shrubland (5%). The forests in this area host pine species (*Pinus sylvestris* and *Pinus halepensis*) and oak species (*Quercus humilis*, *Quercus ilex*). In 2019, there were 60 sheep farms with a total of 20,245 heads, and 191 cattle farms with a total of 29,000 heads (GENCAT, 2019).

2.2. Methodological approach

We adopted the approach proposed by Van der Ploeg and Douwe (1992) wherein farming systems are conceptualized as complex systems of attitudes, implicit rules, knowledge, experiences, and values in a specific area which describe the ways farming is practiced. Individual farms in a given farming system have broadly similar resource bases,

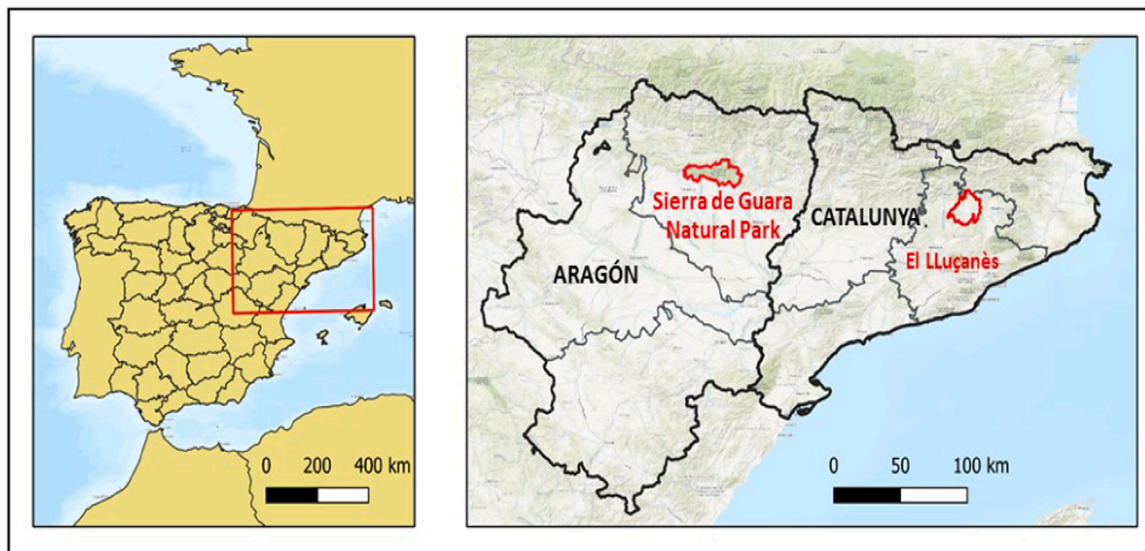


Fig. 1. Locations of the case study areas of Guara and Lluçanès.

enterprise patterns, and household livelihoods and constraints, and it is considered that similar development strategies and interventions would be appropriate for all of these individual farms (Mađry et al., 2013). To select the livestock farmers and forest owners that would be involved in our study to characterize the farming and forest systems, an expert-based typology was used (see Fig. 2) (Clavel et al., 2011). Local experts contributed to defining the discriminating characteristics that were used as reference points for aggregating the diversity of farm households and forest owners into specific farm and forest system types (Perrot, 1990). Following this, a case study approach (Yin, 2018) was adopted to identify a reduced number of observations per livestock farming and forest system type, which were representative of these systems based on the typical farm concept proposed by Feuz and Skold (1992). This approach allowed for mapping the heterogeneity of the farming and forest ownership systems towards silvopastoral management in the two case study areas.

In this study we elicited attitudes, opinions and objectives from farmers and forest owners. We followed Bergevoet et al. (2004), who defined attitude as the disposition to respond favourably or unfavourably to an object, person, institution, or event, and which in this sense can be represented as evaluations in terms of likes or dislikes (see e.g. Eagly and Chaiken, 1993). Opinion is a concept closely related to attitude, and following Oskamp and Schultz (2004), opinions can be regarded as evaluative beliefs that are narrower in content or scope than attitudes and which are often primarily cognitive. Lastly, by objectives we refer to the specific managerial and personal objectives pursued by farmers and livestock owners, which includes economic, lifestyle, and multifunctional objectives (Bergevoet et al., 2004; Willock et al., 1999; Blennow et al., 2014; Howley et al., 2013).

2.3. Data collection

First, a semi-structured questionnaire was designed (see Fig. 2) to gain understanding of the more salient features of forest ownership, livestock farming, and silvopastoralism in the study areas, and of the main barriers and synergies that farmers and forest owners may encounter in undertaking silvopastoral management (see Annex 1. Interview guides). The questionnaire was given to local experts and key stakeholders in each area through face-to-face interviews. Fifteen experts were interviewed in Aragón and sixteen in Catalonia. Their profiles ranged from foresters and livestock farming technicians working in the public administration at different levels (provincial, regional, county-level) to the heads of forest owners' associations and farmers'

associations. According to the results obtained from the local expert interviews, the criteria considered for characterizing forest system types were: i. forest grazing practices undertaken in the forest; ii. type of forest ownership (private or public)⁶; iii. having a management plan; iv. being a member of the forest owners' association; and v. location of the property (to ensure that different ecological conditions were represented). The criteria for characterizing livestock system types were: i. their productive orientation (cattle, sheep, or mixed cattle-sheep farming); ii. land ownership (owners vs. landless farmers); iii. location of the farm; and iv. participation in land stewardship agreements in the Lluçanès.

Next, face-to-face interviews with forest owners and livestock farmers were conducted using closed-ended questionnaires. The sample of forest owners and farmers was selected with the aim of representing the different combinations of the criteria described above. Nineteen livestock farmers (9 in Aragón and 10 in Catalonia) and 21 forest owners (10 in Aragón and 11 in Catalonia) were interviewed between July and October 2019. The questionnaire explored the attitudes and opinions of livestock farmers and forest owners towards different dimensions of silvopastoralism using statements evaluated on a six-point Likert scale (from 1. "Strongly Disagree" to 6. "Strongly Agree") (Chomeya, 2010). The statements were tailored to each profile (i.e. forest owners and farmers), although a few were common to both profiles (see full statements in Annex 1). In the case of farmers, the statements addressed economic interests in and the quality and role of wood pastures and their impact on the farming activity (22 statements), as well as the barriers to using these pastures (13 statements). In the case of forest owners, these statements covered interest in, benefits, and impacts of forest grazing on their activity (14 statements). The questionnaire also gathered their opinions towards the impact of agricultural policies, mainly the CAP, on their activity (10 statements for farmers and 3 statements for forest owners). Further, the questionnaire collected information about the main structural and socioeconomic characteristics of the farmers and forest owners in terms of farm or woodland size, herd size, length of the

⁶ According to Spanish Forestry Law, public forests are those belonging to either the Central State, regions, or municipalities. The latter is the more frequent type of public forest ownership in Spain. Those public administrations are responsible for managing and looking after their forests. Forest engineers appointed by those public entities are responsible for managing these forests and were the subjects interviewed as representing the forest ownership of public forests.

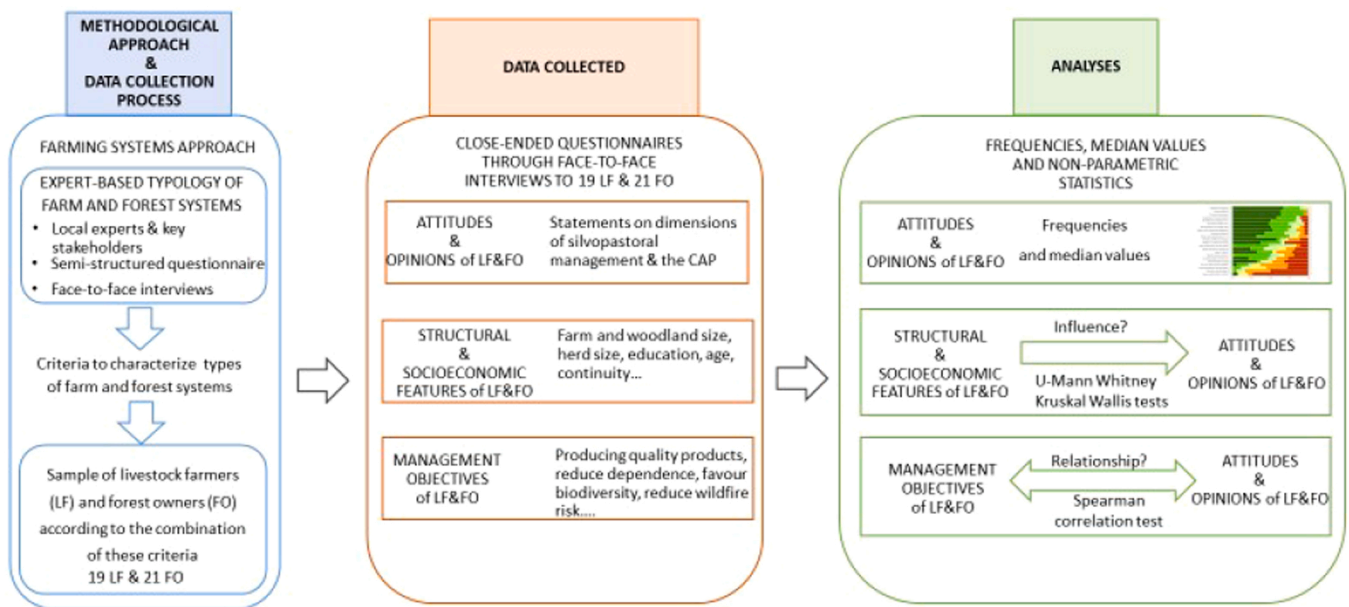


Fig. 2. Overview of methodological approach, data collection and analyses.

grazing period in wood pastures, level of education, age, and continuity in order to analyse their relationship with attitudes and opinions. Finally, the farmers and forest owners were shown a series of managerial and personal objectives and asked to score their relative importance on a five-point scale (from 1. “Not Important” to 5. “Very Important”).

2.4. Data analysis

We first characterized the structural profiles of livestock farming and forest ownership systems in Guara and Lluçanès (see Fig. 2).

Second, we analysed farmers’ and forest owners’ attitudes towards wood pasture grazing and their opinions about the impact of policies (mainly the CAP) on wood pasture grazing, using descriptive statistics. For the statements on attitudes and opinions that were common across the questionnaires for livestock farmers and forest owners (see Annex 1), a U-Mann-Whitney test was used to assess whether any differences observed were significant.

Third, we assessed whether the structural and socioeconomic characteristics of the farming and forest ownership systems were influencing their attitudes towards wood pasture grazing and their opinions about policy impacts using U-Mann Whitney and Kruskal-Wallis tests. In the case of livestock farmers, due to the large number of statements that were used for measuring their attitudes and opinions, most of them were grouped according to eleven main blocks, and the median score on the Likert scale was calculated for each of them (see Tables 1, 2 and 3 in Annex 2). The eleven blocks were: i) economic interest; ii) negative impacts on farm performance; iii) strategic nature of the resource; iv) quality of the resource; v) interest in grazing of wood pastures; vi) non-interest in grazing of wood pastures; vii) Difficulties in/barriers to grazing wood pastures; viii) environmental and social functions of wood pasture grazing; ix) potential conflicts with other activities; x) positive impacts of the CAP in using wood pastures; and xi) negative impacts of the CAP in using wood pastures.

Finally, we assessed the relationship between livestock farmers and forest owners’ objectives and their attitudes towards wood pasture grazing and opinions on policy impacts using two-tailed Spearman correlation tests. For livestock farmers, the eleven groupings of attitude dimensions described above were employed.

Table 1

General structural and socioeconomic characteristics of the livestock farming systems sampled in the two case studies. Mean values (standard deviation).

	Guara	Lluçanès
Sample size	9	10
Cattle farms (%)	11.1	50.0
Sheep farms (%)	44.4	30.0
Mixed cattle-sheep farms (%)	44.4	20.0
Livestock units (LU)	157.5 (60.3)	87.7 (52.0)
Utilised Agricultural Area (UAA) (ha)	127.1 (43.6)	39.9 (23.2)
Total land available ^a (ha)	2310.7 (2300.8)	267.1 (163.5)
Total land available/LU (ha)	13.4 (12.0)	5.0 (6.2)
Own land/UAA (%)	42.5 (34.9)	18.3 (29.3)
Length of grazing period		
≤ 4 months (%)	44.4	30.0
> 4 < 8 months (%)	33.3	30.0
≥ 8 months (%)	22.2	40.0
Farmer’s age (years)	42.5 (8.4)	46.1 (11.5)
Farmer’s education level		
Primary (%)	22.2	30.0
Secondary and higher education (%)	77.8	70.0
Likelihood of farm continuity ^b		
Low (%)	0	20
Medium (%)	66.7	40
High (%)	33.3	40

^a Total land and Temporarily leased grazing areas included.

^b Likelihood of continuity with their activity in the next 10 years combining age of farmer and generational turnover: Farmer age (years) = 0 ≥ 55; 1. 40–55 2 ≤ 40 + Children = 0. Without; 1. Children < 16 years old; 2. Children working on the farm.

3. Results

3.1. Structural profiles of livestock farming systems and forest ownership systems

The livestock farming systems (LFS) studied comprised cattle, sheep, and mixed sheep-cattle farms, with cattle being more prominent in Lluçanès (50%) than in Guara (11%), while sheep and mixed farms predominated in Guara (44). These proportions are in accordance with the diversity/distribution of livestock farming systems in each study area (Table 1). Average farm size and herd size of the LFS were also larger in Guara than in Lluçanès. Most farmers in both areas studied had

Table 2

General structural characteristics of the forest ownership systems sampled in the two case studies. Mean values (standard deviation).

	Guara	Lluçanès
Sample size	10	11
Private owners (%)	40	100
Public owners (%)	60	0
Property area (ha)	1317 (1316)	178 (123)
Grazing of wood pastures		
Properties with woodland grazing (%)	80	82
Type of livestock		
Cattle grazing (%)	62.5	33
Sheep grazing (%)	37.5	67
Length of grazing period		
< 6 months (%)	0	89
6–9 months (%)	57	0
> 9 months (%)	43	11

secondary education, and the farms exhibited medium to high levels of expected continuity for the following ten years.

In relation to the forest owners, the sample in Lluçanès was composed exclusively of private forest owners, while in Guara, public forest owners represented 60% of the sample (Table 2). Likewise, woodland size was larger in Guara than in the Lluçanès sample on average, although there was large variability in woodland size. Eighty percent of woodlands in Guara were grazed by livestock (63% by cattle and 33% by sheep/goats), and 82% of woodlands in Lluçanès were grazed (33% by cattle and 67% by sheep/goats).

3.2. Attitudes towards wood pasture grazing and opinions on the impacts of the CAP

Most livestock farmers (> 75%) strongly agreed with the environmental benefits of forest grazing (maintaining biodiversity, preserving the landscape, and reducing the risk of wildfire) (Fig. 3) (see full statements and median values in Table 1 in Annex 3). Most farmers also agreed with an eventual need for adapting herd management practices, and more than half of the sample agreed with the difficulties that may arise in doing so, for example in managing the animals (monitoring and location). More than 60% of the sample also strongly agreed that the use of wood pastures reduces feeding costs and improves farm profitability, while half of the farmers opined that it increases the labour requirements in the farm. The presence of wild fauna and the increase in hunting species were perceived as a threat more in relation to predation than in terms of health risks; however, more than 25% of the sample strongly disagreed that the presence of fauna and increased hunting species posed a threat at all. Other activities such as hunting were not perceived as a conflictive issue by nearly 50% of the sample.

Regarding perceived barriers to implementing silvopastoralism practices, most farmers expressed a favourable attitude towards the use of wood pastures (Fig. 4) (see full statements and median values in Table 2 in Annex 3). Half of the sample agreed with the existence of certain barriers to a more intense usage of these pastoral resources, namely: long distances from the farm, lack of water points in these areas, and the growth of shrubland vegetation that closes paths and makes accessing these areas difficult.

In relation to the impacts of policies on their activities, only 30% of the farmers sampled perceived the CAP as a key factor involved in maintaining livestock farming in their local areas, and only 25% considered that it plays a role in promoting grazing in wood pastures (Fig. 5) (see full statements and median values in Table 3 in Annex 3). Likewise, agro-environmental payments received by farmers were mostly considered non-essential for grazing in shrubland and wood pastures. Similarly, the application of the PEC in last CAP reform was not perceived as having impacted the practice of wood pasture grazing. However, most farmers expressed a high degree of agreement about the possibility of setting up subsidies in RDP to compensate them for

biomass reduction in forests.

Most forest owners (>75%) agreed with the environmental benefits of forest grazing (i.e. prevents wildfires, improves soil fertility, preserves landscapes), considering it to be a cheap and effective way to reduce and control (manage) brush, with the lack of farmers being the main cause for not grazing these pastures (Fig. 6) (see full statements and median values in Table 4 in Annex 3). Most of the sample also believed that mechanical clearing of forest undergrowth is not better than grazing. Accordingly, they stated strong support for the role that the regional administration can play in promoting agreements between forest owners and farmers for reducing biomass in forests as well as in setting up subsidies for forest owners to hire local farmers for purposes of understorey biomass reduction.

The comparative analysis of the statements about the environmental benefits of grazing of wood pastures that were common to the questionnaires given to both the farmers and forest owners did not reveal any statistically significant differences. Likewise, livestock farmers and forest owners mostly believed that their interests were not different (Figs. 4 and 6). In contrast, regarding the impacts of the CAP on the use of wood pastures, most forest owners (66%) considered that the implementation of the PEC led to a reduction in leasing of wood pastures, while most farmers (75%) stated that the PEC did not reduce their interest in grazing these areas (here, the differences were statistically significant).

3.3. Structural and socioeconomic characteristics affecting attitudes towards the use of wood pastures and opinions on the impacts of CAP

3.3.1. Livestock farmers

Differences were found in the farmers' attitudes towards the statements related to the economic interests in the use of wood pastures, largely depending on the productive orientation of the farm (see Table 3; only statistically significant results are shown). Cattle farmers stated greater economic interest than mixed cattle-sheep farmers and sheep farmers in using wood pastures. Similarly, farms wherein own land was dominant ($\geq 67\%$ Own area/UAA) and farmers with higher levels of education expressed greater economic interest in the use of wood pastures.

The farming systems wherein own land was less dominant (< 67% Own area/UAA) and which had less land available in relation to herd size (<12 ha total land available / LU) stated significantly stronger agreement with the negative impacts that grazing of wood pastures produced on their farms (e.g. increasing the labour requirements). Farming systems with a greater availability of land (≥ 70 ha UAA) and larger herds (≥ 160 LU) expressed more agreement with the strategic role of wood pastures in periods of shortage in other pastures or crops. Farms with large herd sizes (≥ 160 LU) gave a slightly higher scoring than small farming systems in terms of their perception of the quality of these pastures, even though wood pastures were not perceived as a high-quality feed resource overall.

The difficulties in grazing shrubland and wood pastures (distance to the farm, lack of water, accessibility) were perceived to be greater by farms with intermediate relevance of own land (between 0% and 67% Own area/UAA) (Table 4; only statistically significant results are shown). Farms with an intermediate level of continuity (either younger farmers without descendants or those with small children) and farmers with higher levels of education also perceived these difficulties to be greater.

With respect to the differences observed amongst opinions on the impacts of the CAP, specialised cattle or sheep farms and those with smaller herd sizes (< 80 LU) expressed greater agreement with the idea that the impacts of the CAP were positive. In contrast, mixed sheep-cattle farmers tended to consider that CAP did not have a favourable impact on grazing of wood pastures. Larger farms (≥ 70 ha) and those with a lesser relevance of own land (< 67% Own area/UAA) stated a greater degree of support for the undertaking of controlled burning, ploughing, or wood pasture clearing, if it were allowed.

Table 3
Differences in attitudes towards wood pastures and opinions on the impacts of the CAP between farmers, according to structural characteristics of their farms (median values).

Grouping of statements related to wood pastures	Cattle			Sheep			Productive orientation			UAA (ha)			% Own land/UAA			Livestock Units (LU)			Total land available (ha)/LU			Length of woodland grazing (months)					
	5.5	5.8 ^a	5.5 ^{ab}	4.3 ^b	*	5.5	5.0	5.5	5.5 ^{ab}	4.5 ^a	6 ^b	> 0	< 67	≥ 67	Sig.	0	< 80	≥ 80	< 160	≥ 160	< 12	≥ 12	Sig.	≤ 4	> 4	< 8	≥ 8
Economic interests	5.5	5.8 ^a	5.5 ^{ab}	4.3 ^b	*	5.5	5.0	5.5 ^{ab}	4.5 ^a	6 ^b	> 0	< 67	≥ 67	Sig.	0	< 80	≥ 80	< 160	≥ 160	< 12	≥ 12	Sig.	≤ 4	> 4	< 8	≥ 8	Sig.
Negative impacts on farm	4.5	4.3	6	3.8	ns	4.0	4.8	5 ^{ac}	5 ^{ac}	3 ^{bd}	5.5 ^{ab}	4.5 ^a	6 ^b	3 ^{bd}	6 ^b	5.5	5.5	6	ns	5.5	6	ns	5.5 ^{ab}	4 ^a	5.8 ^b	**	
Strategic resource	4	3.8	5	4	ns	3.5	5.5	**	3.5 ^{ac}	6 ^{bd}	5 ^{ac}	5 ^{ac}	3.8 ^{ac}	3.8 ^{ac}	**	4.5	5	3	**	3.8	ns	5	5	4.3	4.3	ns	
Quality of the resource	3	3	3	3.5	ns	3.0	3.5	ns	3.5 ^{ac}	3.3	3.5 ^{ac}	3.5 ^{ac}	3.8 ^{ac}	3.8 ^{ac}	**	3.8 ^{ab}	3.5 ^a	4	5	ns	5.5 ^b	*	6	4	3.5	ns	
Interest in grazing of wood pastures	6	5.8	6	4.5	ns	6.0	5.3	ns	5.5 ^{ab}	5 ^a	6 ^b	5.5 ^{ab}	5 ^a	6 ^b	*	5.8	6	ns	5.5	6	ns	5.5	5	6	ns		
No interest in grazing of wood pastures	2	2.8	2	3.8	ns	2.0	3.8	*	2.8	4	2	2.8	4	2	ns	3.5	2	ns	3.5	2	ns	3.5	3	2	ns		
Difficulties in/barrriers to grazing of wood pastures	3.5	3.3	4	2.3	ns	1.5	4.8	ns	2.8 ^{ab}	5 ^a	1 ^b	2.8 ^{ab}	5 ^a	1 ^b	*	1.3	2.5	5	ns	3.3	3.5	ns	4	2.3	3.3	ns	
Positive impacts of the CAP	2.5	4 ^a	5	1.3 ^b	*	2.5	1.8	ns	2.3	2	2.8	ns	2.3	2	ns	5 ^a	2 ^b	1.8 ^{ab}	*	2.75	2	ns	4	1.8	2.5	ns	
There are shrubland/ wood pastures where I would do controlled burning, ploughing, or clearing, if allowed	5	5	5	6	ns	5.0	6.0	*	5 ^{ac}	6 ^{bc}	4.5 ^{ad}	**	5	5	6	ns	5	6	ns	5	6	ns	6	5	5	ns	
The interests of farmers and forest owners are very different and even opposed	2	3 ^a	2 ^{ab}	1 ^b	*	3.0	1.0	ns	2.5 ^{ac}	1 ^{bc}	3 ^{ad}	*	2	3	1	ns	2	1	ns	2	1	ns	2	1	2.5	ns	

CAP: Common Agricultural Policy; Sig.: Significance; *** p < 0.01; ** p < 0.05; * p < 0.1; ns: not statistically significant. Scores on Likert scale: 1. Strongly disagree; 2. Disagree; 3. Somewhat disagree; 4. Somewhat agree; 5. Agree; 6. Strongly agree. Kruskal-Wallis and U-Mann Whitney tests for differences between groups. ^{a b c d} Different superscripts indicate differences between groups. Values with the same superscript letters indicate no significant differences in the group means, and those with different superscript letters indicate significant differences in the group means

3.3.2. Forest owners

Different structural characteristics of the forest systems did not appear to influence the forest owners' opinions towards the environmental functions of wood pasture grazing, except in relation to improvements in soil fertility (Table 5, only statistically significant results are shown). Small forest owners (< 100 ha woodland) expressed relatively greater interest in renting their wood pastures. They strongly agreed with the implementation of subsidies for hiring local farmers for shrub clearing efforts. Forest owners with cattle grazing their properties were more supportive of reducing tree density to favour pasture grazing in comparison to forest owners whose lands host small ruminants. The former also strongly agreed with the idea that public administration has a role as a facilitator of agreements with farmers.

3.4. Relationship between attitudes and opinions towards wood pasture grazing and objectives

3.4.1. Livestock farmers

The two most important objectives for farmers were reducing the dependence on purchased feed inputs and producing quality animals and products. These objectives were positively correlated with higher interest in grazing of wood pastures (Table 6). A positive attitude towards the quality of wood pastures as a feed source was noted amongst those farmers with objectives of attaining self-sufficiency in terms of feed inputs and increasing the farm size, while the opposite was observed (i.e. a likely trade-off scenario) for those primarily pursuing the production of quality products.

The farmers who attached more importance to preserving and improving biodiversity and taking care of landscapes for citizens (the environmentalist profile), focused more on the negative effects of grazing of wood pastures on farm performance. Surprisingly, a more positive perception of the importance of the environmental and social functions of grazing these pastures was negatively correlated with the objective of increasing the subsidies received.

The objectives of increasing farm size, receiving larger subsidies, and reinvesting profits in the farm were positively correlated with negative opinions about the impacts of the CAP on wood pasture grazing. In addition, farmers who attached more importance to self-sufficiency in feed inputs agreed more with the idea that subsidies should exist to compensate them for forest grazing services.

Finally, economic objectives of increasing farm size and reinvesting profits in the farm were positively correlated with willingness to undertake prescribed burning, ploughing, or clearing in some shrublands and wood pastures, if allowed.

3.4.2. Forest owners

The correlation analysis showed that several objectives (producing biomass, mushrooms, and livestock, and enhancing and preserving the landscape and offering spaces for tourism purposes) were positively correlated with acknowledgement of the key role played by grazing in maintaining the landscape (Table 7).

Forest owners who attached more importance to livestock production were more concerned about the lack of farmers, showing also a negative correlation with the statement on interests of farmers and forest owners being different. The same was true for forest owners who expressed a belief that keeping the family heritage is important. The importance placed on livestock production was also positively correlated with interest in renting woodlands for grazing. Wanting to reduce wildfire risk was positively correlated with acknowledgement of the importance of grazing for maintaining biodiversity and with positive opinions towards the implementation of subsidies for hiring local farmers for shrub clearing services. The objective of producing mushrooms was positively correlated with the perception that grazing does not contribute to improving soil fertility, while the objective of offering

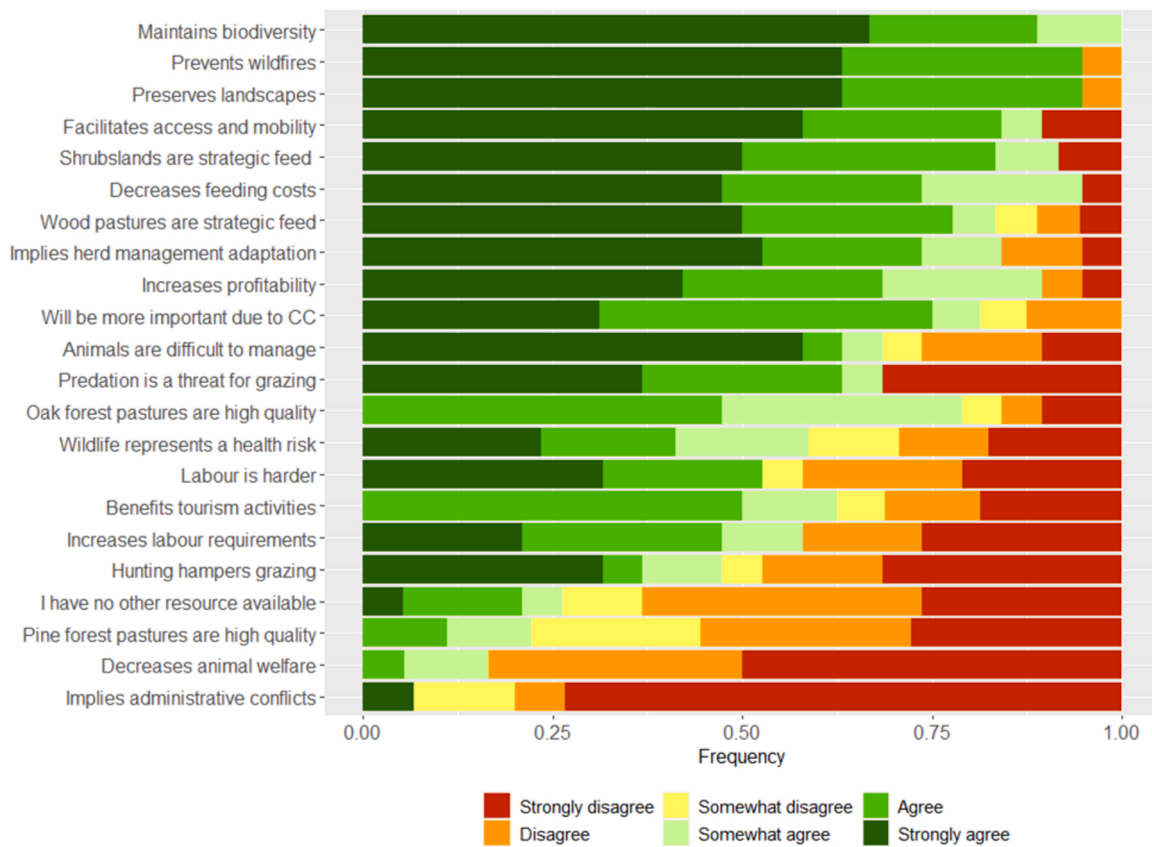


Fig. 3. Attitudes of livestock farmers towards economic interests, the quality and role of wood pastures, and their impacts on farming activities. C: Climate Change.

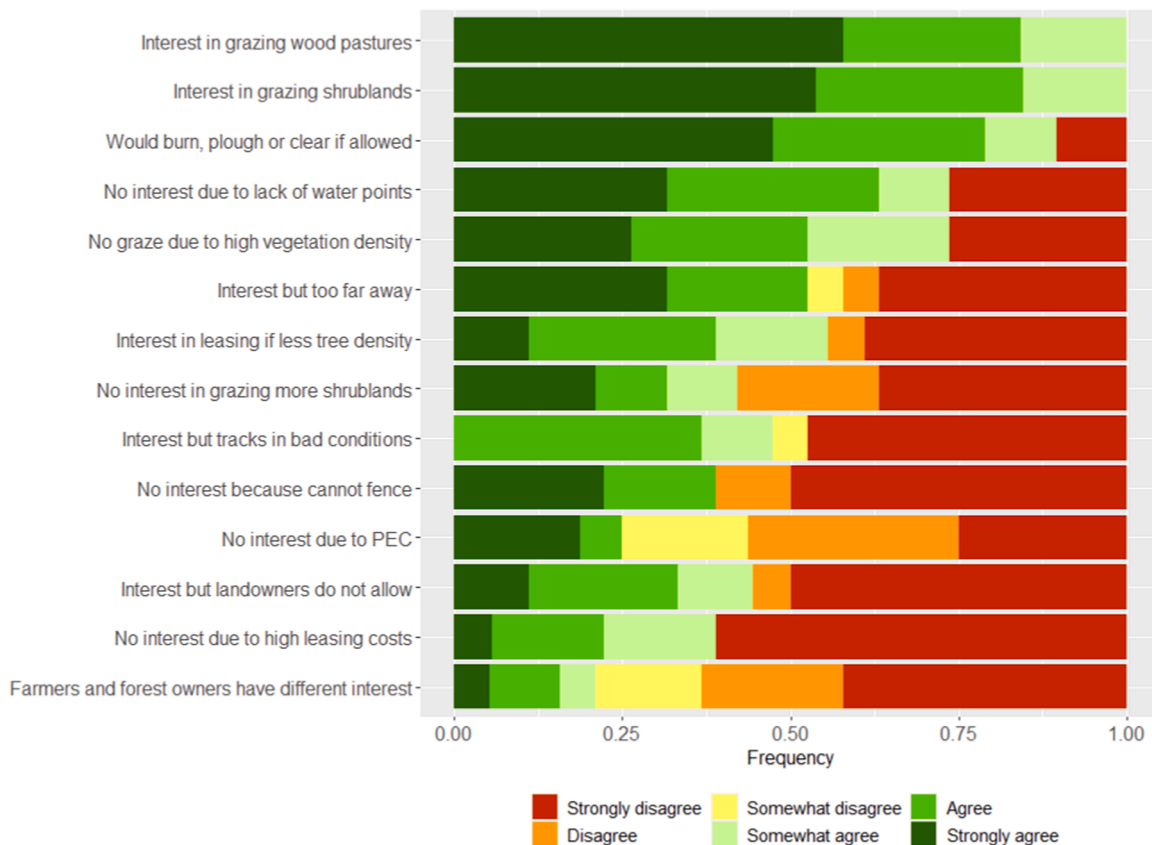


Fig. 4. Interest of livestock farmers in grazing shrublands and wood pastures, and the barriers to profiting from them. PEC: Pasture eligibility coefficient.

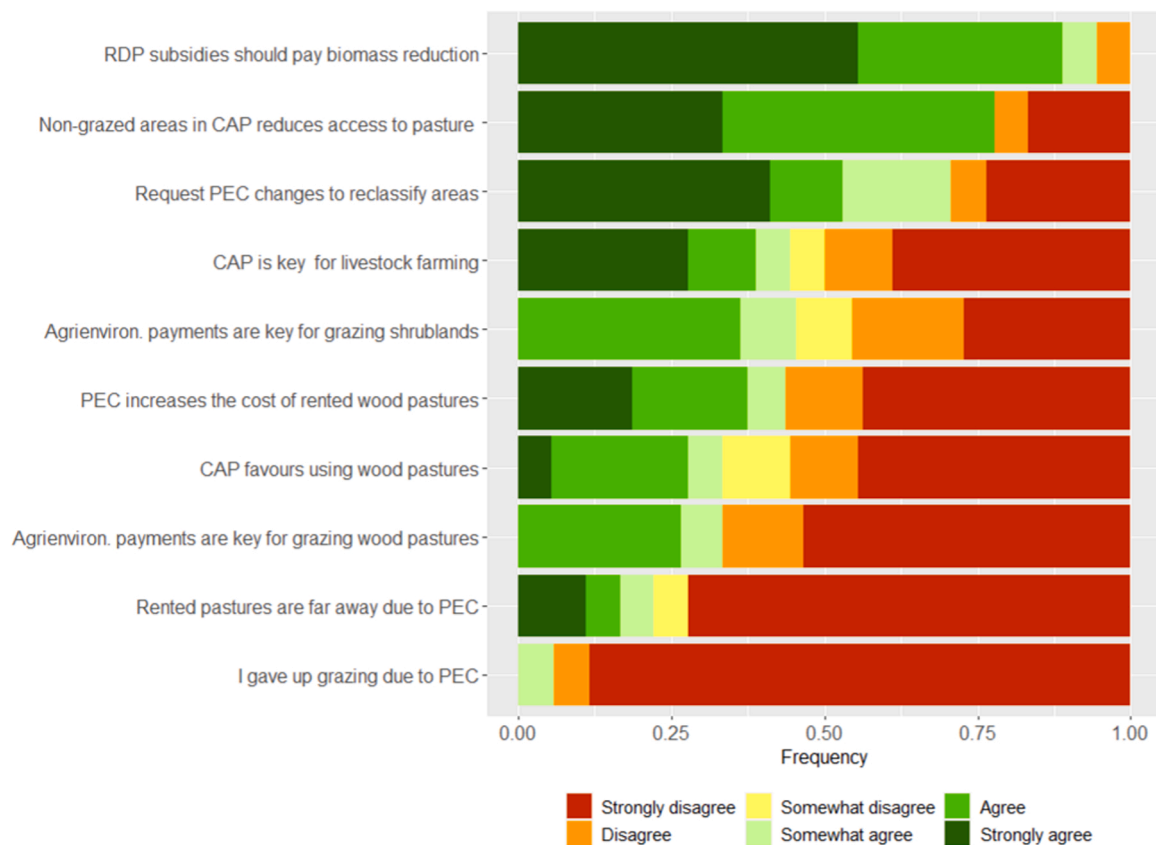


Fig. 5. Livestock farmers' opinions towards the impacts of the CAP on grazing of wood pastures and their activities. RDP: Rural development programmes; CAP: Common Agricultural Policy; PEC: Pasture eligibility coefficient.

spaces for tourism was associated with lower interest in renting wood pastures.

4. Discussion

Agroforestry, and silvopastoral systems in particular, are recognised as sustainable land-management techniques that can provide multiple ecosystem services (Hernández-Morcillo et al., 2018). The behaviours of livestock farmers and forest owners, which are heavily influenced by their attitudes, opinions, and objectives, are key determinants of the success of silvopastoral systems (Guerin et al., 2010; Rois-Díaz et al., 2018). Our study aimed to disentangle the factors that may either facilitate or hinder the integration of livestock farmers and forest owners into joint silvopastoral management systems in Europe, to complement the broad array of studies that have separately assessed the motivations of livestock farmers (Reimer et al., 2012; Howley et al., 2015) and forest owners (e.g. Domínguez and Shannon, 2011; Howley, 2013; Feliciano et al., 2017). Below we discuss the barriers or potential trade-offs and the opportunities and synergies in silvopastoral systems integrating livestock farmers and forest owners, as well as the impacts of agricultural policies and the implications of our findings.

4.1. Barriers to and opportunities/synergies in silvopastoralism: Views of farmers and forest owners

4.1.1. Barriers and trade-offs

Rural mid-mountain regions in the Mediterranean have undergone significant socioeconomic and ecological changes in the last decades, especially since the second half of the 20th century, leading to a dynamic of abandonment and intensification (Bernués et al., 2011; Plieninger et al., 2014). The forest owners surveyed in our study agreed to a high extent with the idea that the lack of livestock farmers is a main cause for

the lack of woodland grazing. Extensive livestock systems in Europe are declining in number, with labour being one of the most critical factors acutely affecting sheep farming systems (Olaizola et al., 2015). In addition to the lack of farmers, we should consider the increased labour requirements involved in woodland grazing compared to grazing open, flat pastures (García de Jalón et al., 2018; Rois-Díaz et al., 2018), which could effectively halve the number of animals that the farmer can manage (Aubron et al., 2016).

Some external factors may also hinder the use of wood pastures by livestock farmers. Despite the farmers' acknowledgement of the environmental function served by wood pasture grazing, the presence of wild fauna in forest areas is perceived as a threat, mainly due to predation, as also pointed out in previous studies (Rois-Díaz et al., 2018). Furthermore, structural deficiencies such as a lack of water points and the encroachment of vegetation that impedes access to these areas make the use of wood pastures more difficult for livestock farmers, although these barriers are relatively easy to solve.

Our results indicate that the farmers who considered environmental and social objectives as being important also perceived a negative impact of grazing of wood pastures on the farm activity (e.g. increased labour and management requirements). Surprisingly, these objectives were inversely correlated with support for subsidies in RDP to compensate farmers for biomass reduction in forests. This could indicate that maximization of subsidies received, a farming objective also described by Veysset et al. (2005), operates as a method for increasing farm income with minimal consideration of the social return underpinning public funding mechanisms. Concerning forest owners, although forest grazing may simultaneously enhance the environmental and recreational value of the forest (Casasús et al., 2007; Varela et al., 2018), our results indicate a potential trade-off between offering spaces for tourism and the interest of owners in renting wood pastures.



Fig. 6. Forest owners' attitudes towards wood pasture grazing and opinions on the impacts of the CAP. PEC: Pasture eligibility coefficient.

Table 4

Differences in attitudes towards wood pastures and opinions on the impacts of CAP between farmers, according to socioeconomic characteristics (farm continuity, educational level, and farm diversification) (median values).

Grouping of statements related to wood pastures	Likelihood of farm continuity ¹				Farmer's education level			Agricultural activities' diversification ²		
	Low	Medium	High	Sig.	Primary	Secondary and higher education	Sig.	No/ One more product	Two or more products	Sig.
Economic interest	5.5	5.5	4	ns	4	5.5	*	5.5	5.5	ns
Quality of the resource	3.8 ^{ab}	3.5 ^a	3 ^b	**	3	3.3	ns	3.5	3	ns
Environmental and social functions of wood pasture grazing	5 ^a	6 ^b	5 ^{ab}	*	5	6	ns	6	6	ns
Interest in grazing of wood pastures	6	5.8	5.5	ns	6	5.5	ns	6	5.3	*
No interest in grazing of wood pastures	3.5	2	2	ns	2	2.8	ns	2	3.8	**
Difficulties in/barriers to grazing of wood pastures	1.3 ^a	5 ^b	1 ^{ab}	**	1	4.3	*	4	3	ns
Negative impacts of the CAP	1 ^a	2.8 ^b	1 ^{ab}	**	1.5	2.5	ns	1.5	1.5	ns

CAP: Common Agricultural Policy. ¹ Likelihood of continuity with their activity in the next 10 years obtained by adding scores calculated as follows for the farmer's age and generational turnover. Farmer's age (years): ≥ 55, 0 points; 40–55, 1 point; ≤ 40, 2 points. Children: None, 0 points; children < 16 years old, 1 point; children working on the farm, 2 points. ² Agricultural diversification is related to whether the farmer sells any other product(s) in addition to their main product(s). Sig.: Significance; *** p < 0.01; ** p < 0.05; * p < 0.1; ns: not statistically significant. Scores on Likert scale: 1. Strongly disagree; 2. Disagree; 3. Somewhat disagree; 4. Somewhat agree; 5. Agree; 6. Strongly agree. Kruskal-Wallis and U-Mann Whitney tests for differences between groups. ^{a b} Different superscripts indicate differences between groups. Values with the same superscript letters indicate no significant differences in the group means, and those with different superscript letters indicate significant differences in the group means.

4.1.2. Opportunities and synergies

Success in the adoption of management practices that promote the delivery of ES is more likely when these practices align with the objectives pursued by the farmers and forest owners (Kachergis et al., 2013). Our results reveal an overall positive attitude of farmers and forest owners towards wood pasture grazing and the environmental function served by this activity, which is also linked to their productive objectives. This indicates that efforts in promoting silvopastoralism as a means of providing multiple ES could be a successful strategy (Rois-Díaz et al., 2018).

Farmers expressed a positive attitude towards wood pastures because of their positive economic impacts and their strategic role in periods of shortage of other resources. Grazing of wood pastures contributes to self-sufficiency in farm feed, a key element for farm sustainability (Bernués et al., 2011), and it is critical for explaining labour productivity in pasture-based livestock systems (Ripoll-Bosch et al., 2014). However, there are differences in the consideration of wood pastures due to the farmers' agricultural holdings (Piwowar, 2020) and due to socioeconomic factors that affect their behaviour (Ahnström et al., 2009). In this respect, the farm's specific structural characteristics and the farmer's

Table 5

Differences in attitudes and opinions of forest owners towards wood pastures, according to structural and managerial characteristics (median values).

Statements related to wood pastures	Size of woodland (ha)				Management Plan			Livestock grazing in woodland			Type of livestock			Length of grazing period (months)			
	< 100	≥ 100 ≤ 300	> 300	Sig.	No	Yes	Sig.	No	Yes	Sig.	Sheep	Cattle	Sig.	< 6	≥ 6 < 9	≥ 9	Sig.
The lack of livestock farmers is the main cause for no woodland grazing	5.5 ^{ab}	6 ^a	5 ^b	*	5	6	ns	5	6	ns	5.5	6	ns	6	5.5	5.5	ns
I am not interested in renting wood pastures because the income I get from it is very low	5 ^a	2 ^b	4 ^{ab}	*	3	3	ns	3	3	ns	2.5	3	ns	2.5	4	3	ns
Overall, it is difficult for farmers to properly manage their livestock to avoid damaging the trees	1.5	2.5	1	ns	1	2	ns	2	2	ns	2	1.5	ns	2 ^a	1 ^b	2.5 ^a	**
The interests of farmers and forest owners are very different and even opposed	2	2.5	4	ns	2	2.5	ns	3.5	2	ns	3	1	*	2.5	1	1.5	ns
Grazing contributes to improving soil fertility	6 ^a	5 ^b	6 ^{ab}	*	5	6	ns	4.5	6	ns	6	6	ns	6	5	5.5	ns
I prefer mechanical brush clearing over grazing because livestock damage the trees	2.5	2	1	ns	2	2	ns	3.5	2	ns	1	2	ns	1.5 ^{ab}	1 ^a	3 ^b	***
Grazing is effective if mechanical brush clearing is conducted previously	6	5	5	ns	5	6	**	4.5	5	ns	5	5	ns	6 ^a	5 ^b	5 ^b	**
Public administration should facilitate agreements between forest owners and livestock farmers to reduce biomass in forests	5.5	5	5	ns	5	5	ns	5	5	ns	5	6	**	5	5.5	5	ns
Public administration should implement subsidies for forest owners to hire livestock farmers for shrub clearing	6 ^a	5 ^b	5 ^{ab}	*	5	5	ns	5.5	5	ns	5	5	ns	5	5	5	ns
I am willing to reduce tree density to favour pasture for grazing	5.5	3.5	2	ns	6	5	ns	3.5	5	ns	3.5	6	**	5	6	6	ns

Sig.: Significance; *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$; ns: not statistically significant. Scores on Likert scale: 1. Strongly disagree; 2. Disagree; 3. Somewhat disagree; 4. Somewhat agree; 5. Agree; 6. Strongly agree. Kruskal-Wallis and U-Mann Whitney tests for differences between groups. ^{a b} Different superscripts indicate differences between groups. Values with the same superscript letters indicate no significant differences in the group means, and those with different superscript letters indicate significant differences in the group means.

education could positively or negatively influence interest in using wood pastures, although our findings indicate that cattle farming systems are more suitable for silvopastoralism activity (since sheep farmers perceive more difficulties therein).

Positive correlations were found between livestock production goals (i.e. achieving self-sufficiency and increasing the farm size) and a positive appreciation of the quality of wood pastures, since they may contribute to the achievement of economies of scale in extensive farming systems (Aubron et al., 2016). Our results also show that the most synergies were found between forest owners and cattle farmers, in terms of joint silvopastoral management systems. Similarly, forest owners with cattle grazing their forests were more supportive of reducing tree density and of intervention by the public administration as a facilitator of agreements. They also more commonly acknowledged the presence of shared or equal interests between forest owners and livestock farmers. The greater extent of integration of cattle herds (as compared to sheep herds) into silvopastoral management systems in Catalonia was already signalled by Taüll et al. (2009). However, sheep grazing, either alone or in combination with cattle, offers important benefits, since sheep cause

less soil compaction and less tree damage than cattle. Incorporating sheep grazing seems advisable, and hence additional efforts may be needed to integrate such farming systems into silvopastoral management. In this sense, further research is needed to determine the structural farm characteristics and potential strategies that could increase the interest of sheep farmers in using wood pastures.

Owners of small forests acknowledged the environmental functions of grazing to a greater extent and were significantly more interested in subsidies for grazing as compared to owners of larger forests, which is understandable since income from timber harvesting is sporadic and experiencing declining revenues (Lunnan et al., 2006; Feliciano et al., 2017). Hence, public support is often needed in order to promote active management (Górriz-Mifsud et al., 2016). Forest owners' preferences for animal over mechanical browsing for controlling brush accumulation goes hand in hand with their positive outlook on prior mechanical browsing for improving the effectiveness of animal browsing, especially in the case of small forest owners. Thereby, small forest owners may participate in controlled grazing programs with prior mechanical browsing in order to maximize the effect of grazing as a means of

Table 6
Relationship between livestock farmers' objectives, attitudes towards wood pastures, and opinions on impacts of the CAP.

	Livestock farmers' objectives							
	Producing quality products and animals	Increasing farm size	Reinvesting profits in the farm	Reducing dependence on purchased feed	Receiving more/larger subsidies	Contributing to preserving and improving biodiversity	Taking care of the landscape for citizens	Offering areas for recreational or touristic use
Importance of objective ^a (median values)	4.9	3.0	4.0	4.6	4.1	4.6	3.7	2.5
Grouping of statements related to wood pastures								
Negative impacts on farm performance						0.66 ***	0.65 ***	
Strategic nature of the resource								0.44 *
High quality of the resource	-0.55 **	0.58 ***		0.61 ***				
Environmental and social functions of wood pasture grazing					-0.51 **			
Interest in grazing of wood pastures	0.43 *			0.57 **				
No interest in grazing of wood pastures				-0.47 **				
Negative impacts of the CAP		0.55 **	0.42 *		0.42 *			
There are shrubland/ woodland pastures wherein I would undertake controlled burning, ploughing, or clearing if allowed		0.51 **	0.43 *					
Subsidies should exist in the RDP to compensate farmers for biomass reduction in forests			-0.39 *	0.59 ***				

CAP: Common Agricultural Policy RDP: Rural Development Programmes Significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Scores on Likert scale: 1. Not important; 2. Less important; 3. Somewhat important; 4. Quite important; 5. Very important. Two-tailed Spearman tests were performed to assess the significance of correlations.

controlling biomass (Varela et al., 2018).

The most important objectives for forest owners were reducing wildfire risk and maintaining the family heritage (Domínguez and Shannon et al., 2011), while they placed lower importance on their productive objectives. The dimensions of mobility and accessibility offered by grazing were acknowledged by owners prioritising wildfire protection objectives, which is in line with previous findings (Bernués et al., 2011; Camilli et al., 2018). Acknowledgement of the role of grazing in landscape maintenance was positively correlated with several objectives held by forest owners, from the economic-productivist profile (biomass, mushroom, and livestock production) to the profiles with a more altruistic orientation (taking care of the landscape, offering areas for recreational use).

Finally, silvopastoral management can support the increasing needs for wood mobilization to achieve renewable energy targets at the EU level (Lawrence, 2018). The forest owners pursuing economic objectives (i.e. producing more and/or better-quality wood) also engaged in more active management of their forests, which is in accordance with previous studies (Howley, 2013). They can be seen as potential candidates for increasing the presence of livestock in the forest, since livestock grazing facilitates silvicultural interventions (Guerin et al., 2010).

4.2. Silvopastoralism and policies: outcomes and implications of our findings

The marginalisation of Mediterranean forests (Rey-Benayas et al., 2010) together with the difficulties currently being experienced by the extensive livestock farming sector set the context for a renewed vision of silvopastoralism and provides an opportunity for policy measures that can help tackle land abandonment in disadvantaged areas (Guerin et al., 2010; Rapey et al., 2001).

The CAP largely determines the configurations of farming and forestry systems in Europe. For European LFS, the CAP is one of the

principal factors explaining their development (Matthews et al., 2006) and has thus become the main driving force, with subsidies being key determinants for the viability of extensive LFS (Muñoz-Ulecia et al., 2021). Although the role of CAP in maintaining livestock farming activity was acknowledged by half of the farmers surveyed, they do not consider it to be an effective tool for promoting grazing in the studied areas, as also pointed out by Bernués et al. (2016), despite the multiple environmental and social benefits of wood pasture grazing (Casals et al., 2009; Bernués et al., 2014; Plieninger et al., 2014; Cervera et al., 2015; Aubron et al., 2016). Furthermore, the PEC implemented in the current CAP (Pillar I) penalizes silvopastoral systems since trees result in a reduction in the direct area payments, unless they are considered landscape features (Mosquera-Losada et al., 2018). Our study shows how the currently used PEC has led to a decrease in leasing of wood pastures. Grazing of wood pastures is not funded by Pillar I of the CAP, except by an agro-environmental measure included in RDP for enhancing agroforestry in silvoarable systems (Santiago-Freijanes et al., 2018). Thus, the promotion of agroforestry practices at the EU level is a pending topic (Santiago-Freijanes et al., 2018), while concerns arise regarding the efficacy of current forest policy tools in encouraging sustainable management (Lawrence et al., 2020).

Our results show that wood pasture grazing can be a win-win activity for both forest owners and farmers, revealing a potential common ground for understanding. However, it also entails potential challenges in bringing these actors together and integrating private (or public) land with animal tenure in the same place, which is complexified further by the fact that forest ownership is changing with heirs following different lifestyles compared to those of their forebearers (Lawrence et al., 2020). The forest owners surveyed in our study highlighted the mediating role that public administration should play to incentivize such activities. The role of public administration is crucial for establishing the framework/rules and determining who bears the costs of the different interventions, which after all are aimed at providing benefits for farmers,

Table 7
Relationship between forest owners' objectives, attitudes towards wood pasture grazing, and opinions on impacts of the CAP.

	Forest owners' objectives									
	Wood production	Biomass production	Hunting production	Mushroom production	Livestock production	Reducing wildfire risk	Favouring biodiversity	Keeping the family heritage/property	Taking care of the landscape	Offering areas for recreational or touristic use
Objectives' importance (median values)	2.0	2.0	3.0	2.0	4.0	5.0	4.0	5.0	3.5	2.5
Forest owners' attitudes and opinions towards wood pasture grazing										
Forest grazing is essential for maintaining the landscape in this area		0.46**		0.44 *	0.47**				0.44 *	0.75***
Grazing is key for facilitating access and mobility in the woodlands						0.65**				0.54**
The lack of livestock farmers is the main cause for lack of woodland grazing		0.43 *			0.49**					
I am not interested in renting wood pastures because the income I get from it is very low								-0.74**		0.53**
The interests of farmers and forest owners are very different and even opposed						-0.60***		-0.52 *		
Grazing contributes to improving soil fertility				-0.45 *						
Grazing in woodlands is essential for maintaining biodiversity						0.79**				
I prefer mechanical brush clearing because it is more effective than livestock browsing.						0.65**				
Regional administration should implement subsidies for forest owners to hire livestock farmers for shrub clearing						0.77***				
The last CAP reform, specifically the PEC, has reduced leasing of wood pastures								-0.64**		

CAP: Common Agricultural Policy PEC: Pasture eligibility coefficient. Significance: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Scores on Likert scale: 1. Not important; 2. Less important; 3. Somewhat important; 4. Quite important; 5. Very important. Two-tailed Spearman tests were performed to assess the significance of correlations.

forest owners, and society at large. Thereby, appropriate payment schemes or compensation strategies can be designed to reward those involved with wood pasture grazing for the potential trade-offs they may make when pursuing certain management objectives, aiming for the design of more efficient and effective agro-environmental policies (Dessart et al., 2019).

Forest owners' and farmers' objectives will determine or influence their responses to different policy measures (Feliciano et al., 2017). For farmers, those interested in increasing self-sufficiency and reducing dependence on external feed made claims about the societal values of

their activity and demanded other types of compensation from society in relation to wood pasture grazing. Farmers' economic objectives were positively correlated with support for proactive management of wood pastures. Since they largely considered that the CAP is affecting them negatively, these farmers can be potential candidates for results-based measures focused on reducing wildfire vulnerability of landscapes. This could be also the case for farmers with a more environmentally oriented profile who disagreed with current CAP payments and would prefer other payment schemes. As for forest owners, there was an overall positive view of the role of grazing in the forest, with the owners who are

interested in reducing wildfire risk being most in favour of policy measures favouring the involvement of local farmers in forest grazing. This is aligned with the objectives of the Wood Pasture Scheme currently ongoing in the Lluçanès region, suggesting that the topic of wildfire risk may work as a common motivator for establishing new alliances and agreements (Darnhofer, 2014).

The upcoming CAP (2023–2027) will introduce the legal instrument of eco-schemes. These schemes have a great potential to promote more targeted and tailored farming practices for addressing environmental and climate challenges (Meredith and Hart, 2019). This new delivery model proposes a looser legal framework at the EU level, where the member States can set up their own rules/limits (European Commission, 2019), allowing for the potential removal of the boundaries around the funding of grazing activities in forest areas which currently exist as a result of the PEC. The final eco-schemes supported by the CAP will be defined by each Member State in a process that is currently underway. Agroforestry appears to be a practice that eco-schemes could potentially support (European Commission, 2021), and may represent an opportunity for silvopastoralism, especially if they include flexible measures that can be tailored to the specificities of each country/region. Nevertheless, a mixture of local/regional initiatives (e.g. Varela et al., 2018; Varela et al., 2020) that complement the eco-schemes may provide broader opportunities for the different profiles of farmers and forest owners, while adapting more accurately to unique local contexts.

Finally, our results provide an overview of the diversity of livestock farmers and forest owners in silvopastoral systems, which could help in designing more effective policies by considering the specific socio-economic context of Mediterranean mid-mountain silvopastoral systems. The results obtained herein can be further strengthened by replicating this study in other Mediterranean regions.

5. Conclusions

The coexistence of forestry and extensive livestock farming in the Mediterranean under silvopastoral management schemes is a long-standing and sometimes conflicting issue. Nevertheless, wood pasture grazing may represent a win-win situation for forest owners, livestock farmers, and society as a whole.

Our study provides first insights into the attitudes of livestock farmers and forest owners as well as the difficulties and benefits perceived in silvopastoral management, which can help in identifying potential barriers and synergies between different management objectives for farming and forestry. Overall, productive objectives and positive attitudes towards silvopastoralism and the environmental functions it provides were consistent across farmers and forest owners, indicating that efforts in promoting silvopastoralism for the provision of multiple ES may be a successful strategy.

The broadly recognised role of extensive livestock grazing in reducing forest biomass and hence wildfire risk is augmented by other potential benefits such as mosaic landscape maintenance and improved accessibility that can enable activities such as tourism. Simultaneously, forest owners offering their forests for grazing represents an opportunity for landless farmers aiming for self-sufficiency to thrive.

Certain barriers limit the use of wood pastures by livestock farmers, and they were perceived as more severe amongst sheep farmers due to potential predation by wild fauna and the increase in hunting species. Overall, cattle farming systems and forest owners with cattle grazing on their properties appear to be more suitable for joint silvopastoralism. These synergies can be enhanced or attenuated depending on the structural characteristics of the farms and forest properties.

Despite the solid base for mutual benefits for both forest owners and extensive livestock farmers identified through this work, current policies, mainly the CAP, are inadequately addressing the multiple uses and benefits of forests. In turn, excellent opportunities for expanding silvopastoral practices and increasing the provision of public goods to society are being overlooked or missed.

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Ethics approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the research ethics committee of CREDA.

Consent to participate

Informed consent was obtained from all individual participants included in the study.

Declaration of Competing Interests

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Data Availability

Data related to this study can be made available upon request to the corresponding author.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.landusepol.2022.106140](https://doi.org/10.1016/j.landusepol.2022.106140).

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