Livestock Management in Fire-Prone Shrublands of Atlantic Iberia

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Contributor: Rafael Celaya

In the humid northwest of the Iberian Peninsula, large rural areas are being abandoned, mostly in less-favoured areas dominated by shrublands of low nutritive quality for livestock production. The high wildfire incidence has very negative environmental and economic effects. Aspects on wildfire occurrence and the potential of grazing livestock to reduce woody mass and fire risk whilst maintaining quality production and preserving biodiversity are summarized. Sustainable grazing systems are affordable in shrubland–grassland mosaics by selecting appropriate livestock species and breeds for quality production, thus favouring rural economies and lowering fire risk.

herbivore local breed grazing system animal production biodiversity

1. Introduction

The Atlantic region of the Iberian Peninsula extends from the inland mountain ranges in Portugal (Castelo Branco, Coimbra, Guarda, and Viseu districts) to the north through Porto, Vila Real, Braga, and Viana do Castelo, encompassing the Spanish regions of Galicia, Asturias, and Cantabria to the Basque Country and north-western Navarra to the east. Because of the oceanic influence, it is characterized by its humid climate, with mean annual rainfalls well exceeding 1000 mm and reaching 2200 mm in some areas [1], so geobotanically the whole territory is included in the European Atlantic Province within the Eurosiberian Region [2]. The region is quite mountainous and climax vegetation usually corresponds to deciduous forests, thus sharply contrasting with the rest of peninsular area (except the Pyrenees and other high mountain ranges) where dominant climax vegetation mostly corresponds to sclerophyllous woodlands typical of the Mediterranean Region. Apart from the relative abundance of woodlands (including natural forests and timber plantations) and semi-natural grasslands, shrublands occupy large areas throughout the Atlantic region, with heathland being the dominant vegetation type in the vast majority of acidic rangeland ecosystems. Heathlands are dominated by ericaceous shrubs and predominate on acid soils under humid conditions [3][4][5]. They spread across Western Europe from Portugal to Norway [6]; although, in northern areas their surface has been much reduced since the past century due to several causes such as agricultural intensification, eutrophication, overgrazing, and natural succession to woodlands after abandonment [4][5]. In contrast, heathlands are widespread in the Iberian Atlantic region probably because their history of grazing and fire management promoting their maintenance has lasted significantly longer than in northern Europe, while land use change through pasture intensification or afforestation has also been much lower in recent history [7][8].

Extensive livestock farming has been a fundamental pillar for the subsistence of rural population for centuries across Europe, especially in mountain areas, where biophysical constraints impose severe limitations for land uses other than grazing [9][10]. Heath-dominated mountain rangelands have a long history of grazing culture based on locally governed common lands [11][12]. Historical grazing cultures integrated active and targeted herding of different livestock species on different grazing routes to favour an efficient use of the available pasture resources. They also used fire at small spatial and short temporal scales to create heterogeneous heathlands where fire and grazing interacted through a series of feedback mechanisms [13]. These long-proven strategies generated mosaic landscapes of high natural value and biodiversity, the preservation of which is now claimed under several protection figures [14]. High nature value farmlands are the result of those low-input, extensive farming activities and are intended to be promoted by the European Union (EU) [15][16].

The benefiting effects of extensive grazing systems are increasingly recognized in recent years [17][18][19]. These systems, under proper management driven by farmers' experience and scientific knowledge, may play a crucial role in the near future under the auspices of the European Green Deal and its 'From Farm to Fork' and 'Biodiversity' strategies within the new Common Agricultural Policy (CAP 2021–2027) [20], which pursues a circular bioeconomy, healthy and sustainable food production, environmental protection, biodiversity preservation, and climate change mitigation. They offer multiple ecosystem services, including provisioning goods such as safe and quality food production, regulating processes such as carbon sequestration and fire risk reduction, supporting services, such as nutrient recycling and biodiversity conservation, and cultural benefits, such as aesthetic landscapes, ecotourism, and traditional heritage [7][21][22][23]. However, livestock farm numbers have been declining for decades in the less-favoured areas because of the low profit, high labour costs, marginality, and other socioeconomic reasons, so the survival of extensive grazing systems is highly compromised and marginal lands are prone to abandonment [24][25][26].

In the last decades, traditional husbandry relying on efficient pasture use by rustic and adapted breeds has been transformed into more specialized, simplified, and production-oriented systems, mainly in the most favourable lands [24][25][26]. In Atlantic Iberia, livestock systems have been mainly oriented to cattle production, dairy in coastal areas, and suckler beef in mountain areas. Despite the abundance of pastures in the region, these systems depend largely on off-farm feed and are greatly supported by the subsidies from the EU, so their profitability and sustainability may be compromised by the low net economic margins, high fluctuations in feed prices, and the decoupling of subsidies from the CAP [25][26]. The abandonment of traditional grazing cultures in large rural areas, together with the weak demographic structure, has led to imbalances in land use with drastic changes in mountain landscapes and environment, with decreases in pasture productivity and grassland areas, increases in woody vegetation, loss of biodiversity and soil impoverishment among other problems, endangering the provision of key ecosystem services [7][24][27]. The encroachment of pasturelands by dense bracken (*Pteridium aquilinum*), bramble (*Rubus* spp.), or broom (*Genista spp.*, *Cytisus spp.*) formations is common in the Atlantic region [28][29]. Such changes decrease the resilience of the rural territories and the communities living there, and increase environmental risks such as wildfires, a widespread threat throughout the northwest of the Iberian Peninsula with dire consequences for the environment and rural economies [30][31][32][33].

2. Grazing Behaviour and Herbivory Effects on Atlantic Heathlands

Grazing affects the structure and composition of woody pastures by means of defoliation, treading, and excreta deposition [34][35][36]. Apart from the established grazing regime and stocking rate, the type of herbivore (species, breed, body size, and nutritional status) and associated foraging behaviour greatly determine the effects on vegetation [35]. Domestic herbivore species (namely, cattle, sheep, goats, and horses) differ in their dietary preferences, thus affecting the grazed pastures in different ways. Cattle are considered as grazers (in the sense of grass eaters), usually rejecting woody species such as heathers and gorses, and show a less selective ability than small ruminants because of their muzzle anatomy and form of prehension [37][38][39]. Cattle graze preferentially on grasslands over heathlands [40][41], with open heathlands being much more utilized than close and dense heathlands [42]. Sheep also prefer grasslands compared to shrublands and show a high selective capacity to ingest the most nutritive plant items from the available pasture [37][43]. Goats are well known to use woody species in a higher degree than other domestic herbivores, even when herbaceous pastures are available, and thus they are regarded as intermediate feeders (grazer-browser) [39][40]. Particularly, goats use heathland resources more than other species [8][40] and may consume heather plants as a way of self-medication to reduce their parasitic infections by gastrointestinal nematodes [8]. Horses selectively feed on herbaceous plants such as grasses and other graminoids such as sedges (*Carex spp.*) [40][41][44], and show a high intake capacity due to their fast digestive passage rate that outweighs their lower digestive efficiency compared to ruminants [45][46][47], so they are strong competitors of other herbivores such as cattle or sheep for grassland use [46]. In Cantabrian heathlands, horses are able to select greater percentages of heath-grasses than cattle while rejecting heather plants [48]. The autochthonous pony-type breeds of the Iberian Atlantic area may utilize woody pastures when grass availability becomes limited [49][50]. In heather–gorse shrublands, Galician crossbred horses preferentially feed on herbaceous plants and select greater dietary percentages of gorses than heathers [51]. In heathland–grassland mosaics, horses were found to select more gorse and less heather than cattle when herbage availability decreased [46]. Basque ponies (Pottoka breed) were observed to browse gorse more intensively at the edges of the most used grass patches [49]. The willingness of these ancestral pony-type breeds to eat gorse once grass is depleted was also observed in southern England [41].

The foraging behaviour of each animal species determines the degree of complementarity among them for the use of pasture resources. In general, goat is the species that show the lowest overlap in diet composition or plant community selection with the other domestic herbivores due to their greater willingness to feed on woody vegetation, so they complement better for the use of grassland–shrubland mosaics in mixed grazing systems [8][46]. Nevertheless, it is important to remark that, within the same species and breed, important variations in grazing behaviour and diet preferences can be found between individuals, both because of genetic differences, but also because of herd management and animal past experiences [52][53].

According to the specific grazing-browsing behaviour, marked differences between herbivore species have been observed with respect to their impacts on heathland dynamics. In previously burnt or mechanically cleared heathlands in Asturias, goat grazing achieved a greater control of woody plant regrowth, especially of gorse, resulting in greater herbaceous percentages in the canopy and lower fuel amounts than sheep grazing [54][55] (**Figure 1**). Comparing sheep and cattle management mixed or not with goats in mechanically cleared heathlands with adjacent grasslands, there were no marked differences between sheep and cattle in shrub encroachment; although, the mean height of gorse increased more under cattle grazing, whereas heather cover was maintained at lower levels under sheep grazing. Mixed grazing with goats resulted in lower aerial phytomass amounts, with lower gorse percentages than single sheep or cattle grazing [56] (**Figure 1**). The usefulness of goats as a tool to reduce woody mass accumulation and thus fire hazard has been proven in different plant communities [29][57][58][59][60].

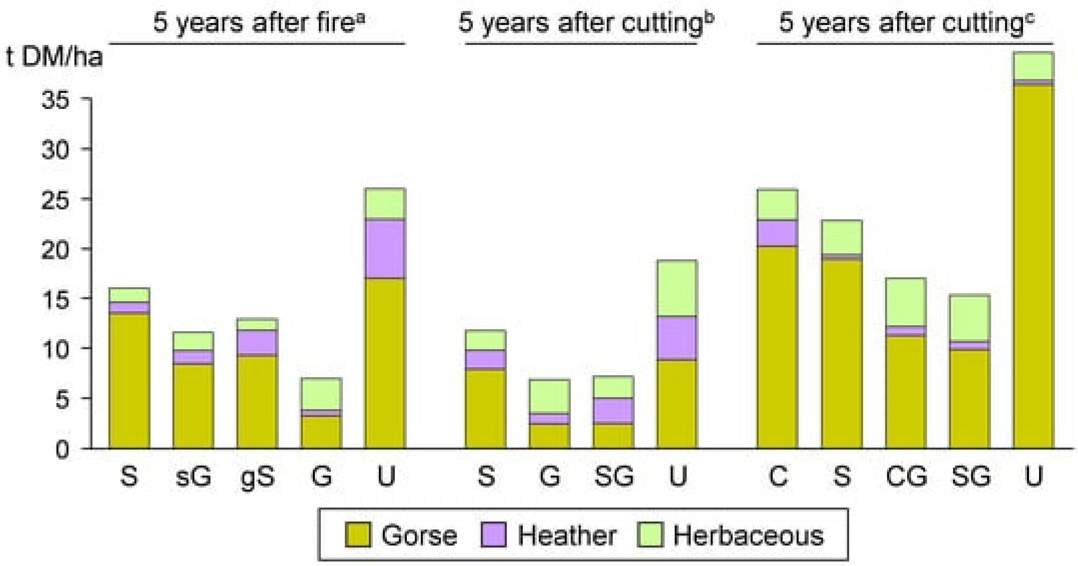

Figure 1. Woody (gorse *Ulex gallii* and heather species) and herbaceous biomass accumulation after superficial burning or mechanical clearing of heathlands subjected to different grazing managements. S: sheep; G: goat; sG: goat after initial sheep grazing; gS: sheep after initial goat grazing; SG: mixed sheep and goat; C: cattle; CG: mixed cattle and goat; U: ungrazed. a [54]; b [55]; c [56].

Despite horses' high preference for grasslands, they can be an effective shrubland management tool. Galician semi-feral ponies (Cabalo de Pura Raza Galega) have shown positive effects on plant diversity of wet heathlands dominated by *Erica mackaiana* as a consequence of increased habitat heterogeneity, thus favouring the presence of several herbaceous species typical of heath communities such as *Cirsium filipendulum, Gentiana pneumonanthe, Serratula tinctoria,* or *Scorzonera humilis* [50]. On better quality soils where common gorse is usually the dominant species, horses were much more efficient in controlling gorse regrowth after burning and clearing than cattle and sheep [61]. In Galician *Pinus radiata* stands with a common gorse-dominated understory, plant species richness and diversity increased under horse grazing, with rotational management showing greater effects than with continuous grazing because of the more intensive gorse browsing in the first case, reducing its biomass and thus forest fire risk [62]. Six years after horse grazing was stopped, although differences between grazing regimes were diluted, grazed sites still showed higher plant species richness and diversity and lower gorse dominance compared to ungrazed sites [63]. In different types of Cantabrian heathlands, horse grazing resulted in decreases in gorse cover and height and increases in heather and herbaceous cover, enhancing floristic diversity with respect to ungrazed paddocks. The reduced gorse dominance promoted the presence of heath species of conservation interest while controlling excessive fuel accumulation [51], so horses could be used as a management tool for the restoration of heathlands and their biodiversity [47][50][62].

3. Final Reflections on the Future Sustainability of Livestock Production Systems in Fire-Prone Heathlands

The mighty limitations of heathland-dominated areas to support sustainable livestock production systems are causing imbalances in rangeland use that are leading to several environmental risks, of which wildfires appear the most severe, though not the only one. The abandonment of traditional grazing systems towards free-ranging herds, mainly of cattle and horses, has led to undesirable changes such as scrub invasion and decreased pasture productivity, restraining their use by livestock. The recovery of these sites, usually in mosaic with the heathland, is key to attain sustainable grazing systems, as it would allow meeting animal daily requirements and also would facilitate the consumption of heathland herbaceous and woody vegetation near the patches of better pasture [42][49]. The use of small ruminants guided by herders on well planned routes [64] seems almost inescapable, as low-quality heathland will almost always be the main component of the landscape. The added cost of herding should be assumed by the increase in the pool of ecosystem services it provides, both provisioning (increase in animal productivity) and non-provisioning (e.g., fire prevention, pastoral culture maintenance, etc.). Examples of quantification and public payment of non-provisioning ecosystem services produced by herders and their herds in other mountain areas of Spain [65][66] could as well be implemented in conditions. Partial improvement of heathlands has been successful in some mountain areas to maintain productive mixed herds, including sheep and goats, in a sustainable way [46]. The multifunctionality of interspersed herbaceous pastures within heathlands as cheap firebreaks and landscape diversifier provides more ecosystem services than those of merely provisioning. Nevertheless, the suitability of a particular area to sustain this type of land intensification should first be carefully assessed.

In addition to the natural biotic and abiotic limiting factors, socio-economic factors derived from the CAP greatly influence the farmers' decisions on land use and animal management, and many times the proposed guidelines are not the most appropriate in terms of a sustainable use of the territory [20][67]. Nowadays, CAP payments are crucial to the survival of the extensive livestock farming systems using the rangelands of northern Spain and Portugal. Up to now, most of the annual CAP payments received by livestock farmers depend upon the forage land they use. Heathlands and other types of woody vegetation have been questioned in the last years as being eligible pasture. In general, the determination of pasture eligibility in shrub formations has been biased towards the grazing behaviour of cattle and horses, not considering that, in the case of small ruminants (especially goats), browsing high thicket stands, which are currently considered totally ineligible as pasture, is more a norm than an exception. In order to improve the relationship between CAP payments and the provision of ecosystem services promoted by farmers in these rangelands, there is a need to address their functioning at the whole landscape level and not merely at each of the land parcels in which is administratively divided. These payments should be received according to well-defined targets and grazing management plans that improve or maintain the provision of ecosystem services at the landscape level. These plans should consider (i) the promotion of small ruminant grazing as the most efficient in these ecosystems while at the same time highly threatened by wild predators; (ii) the adoption of targeted grazing through the promotion of a renewed profession of skilled herders aided by valuable innovations, such as GPS collars and other sensors attached to animals, or remote sensing devices capable of predicting the spatiotemporal distribution of forage productivity; and (iii) boost the local governance of the rangelands and the engagement of farmers and other neighbours in their correct functioning.

Forestry per se has not been dealt with in this work; although, it is also part of the fire problem due to the great amounts of highly combustible phytomass in the understory in poorly managed stands [31][33]. The multifunctionality of forest lands should be encouraged to maintain clearer understory vegetation. Silvopastoral systems are affordable in many forest types, in which grazing animals can remove much of the standing fuel while enhancing biodiversity and soil fertility [68][69][70].

The choice of grazing systems to implement in heathland areas should consider both the productive capacity of the different animal species and breeds and their ability to efficiently use the available vegetation, so that productive pastures are maintained while controlling the expansion of woody pastures and associated fire hazard. Future policies should encourage those extensive systems, especially mixed grazing systems with well adapted local breeds, to maintain sustainable livestock farms in both economic and environmental terms, so the delivery of multiple ecosystem services such as provision of quality food, fire risk reduction, and biodiversity conservation is ensured or even enhanced. From the productive point of view, meat quality must be appreciated appropriately reflecting its safety, health, and sensory attributes, while not forgetting other highly valued products such as traditional cheeses. In addition to the product intrinsic quality, the production system has to be clearly identified and differentiated, so consumers can value the beneficial effects of extensive systems in its fair measure. Product quality certifications such as PDO (protected designation of origin), PGI (protected geographical indication), or ‘Mountain product’ should be promoted for that purpose. The promotion of these products must be facilitated and subsidized by government bodies. As well, the conservation of endangered indigenous breeds should be encouraged because of their specific food characteristics regarding consumer preferences, which may not be found in commercial breeds, and their environmental role. However, the monetary valorisation of non-provisioning ecosystem services is very difficult due to multiple focusing criteria according to the different objectives and social demands [71][72].

On the other hand, some productive strategies could be adopted to increase the revenues of extensive farms. For example, many regional farms sell their animals (weaned offspring) to enterprises of other regions for fattening, thus losing potential market value [73]. Although pasture-based fattening in the region of origin could be an option, it would mostly rely on commercial feeds during finishing to ensure product acceptance by consumers, meaning increased costs. Producing other meat types, such as steer or ox meat, could be an alternative given the high market demand for this type of product, but farmers need to ensure its commercialization to safeguard their investment. Local or regional commercial circuits should be encouraged to trade extensively produced meat at fair sales prices. A mutual support between local farmers, public administration and trading circuits is essential to achieve sustainable animal production systems in less-favoured mountain areas. In addition, governments must promote and activate strategies to reduce existing inequalities between rural and urban areas. Modern technological means must be provided to rural population (e.g., access to broadband internet) and, specifically, to farmers (funding for the acquisition of IoT sensors and access to GIS platforms for remote pasture monitoring) to improve their living, social, and working conditions, whilst offering a fair and stable income, so that they can maintain their economic activity for global social benefit.

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