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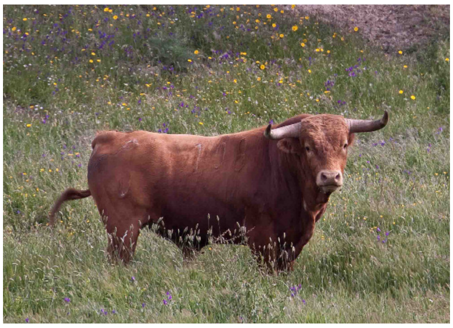










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PASTOS

N.º 46 (1). JUNIO 2016

En portada…

Los pastos españoles
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Este mosaico de fotografías habla por sí mismo de la diversidad de plantas, animales y paisajes que generan los pastos españoles e ilustra perfectamente los contenidos de este número especial.

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SUMARIO

EDITORIAL

Querido lector, como habrás intuido al observar la portada, tienes en tus manos un número especial de la revista Pastos. Consta de un único trabajo elaborado por Alfonso San Miguel, Sonia Roig y Ramón Perea, en el que presentan una síntesis de la información más relevante sobre los pastos españoles. El resultado es un documento imprescindible para dar a conocer las particularidades de nuestras comunidades vegetales pascícolas, de sus modos de gestión y de los herbívoros domésticos y salvajes que los aprovechan. Esta revisión, magníficamente ilustrada por las fotografías del primero de los autores, viene a cubrir una carencia que se había detectado en la Sociedad Española para el Estudio de los Pastos, y es por lo tanto para nosotros un motivo de satisfacción incluir este documento en la revista.

En este número también reseñamos la triste noticia del fallecimiento de Pedro Montserrat, que en la SEEP fue Socio Fundador (1960), Vocal de la Junta Directiva, Secretario, Vicepresidente, y Socio de Honor desde 1988. Durante su prolífica trayectoria todos hemos recibido de él innumerables enseñanzas y sus ideas y reflexiones en torno a los pastos han orientado nuestra actividad investigadora. Afortunadamente, su figura ya ha sido objeto de reconocimiento con diversos homenajes y distinciones, pero como los socios de la SEEP además de su labor científica fuimos testigos de sus lecciones de vida, siempre lo consideraremos un referente. Daniel Gómez y Federico Fillat, dos de sus compañeros más próximos en el Instituto Pirenaico de Ecología de Jaca, le dedican unas líneas en el "in Memoriam" con el que concluimos el 46(1) de Pastos.

Juan Busqué (juanbusque@cifacantabria.org)
Ramón Reiné (rreine@unizar.es)
Editores Principales de Pastos

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THE PASTURES OF SPAIN

PASTOS

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THE PASTURES OF SPAIN

Alfonso San Miguel*, Sonia Roig and Ramón Perea

Departamento Sistemas y Recursos Naturales. ETSI Montes, F y MN. Universidad Politécnica de Madrid. Ciudad Universitaria s/n. 28040 Madrid.

LOS PASTOS DE ESPAÑA

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*** Autor para correspondencia:**

alfonso.sanmiguel@upm.es

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Grassland, rangeland, meadow, browse, livestock, wild ungulate, Mediterranean.

ABSTRACT

Spain is a country with an extremely long history of pastoralism and with a high percentage of its territory covered by pastures. Pastures provide a wide variety of ecosystem services, and therefore significantly contribute to society well-being. They also support the essential sector of livestock farming and play a key role in Sustainable Rural Development. For almost 60 years, the Spanish Society for the Study of Pastures has been working with the aim of promoting the knowledge and improvement of Spanish pastures. The amount of information gathered after all those years is incredibly high. However, a document summarizing basic information about the Spanish pastures is still lacking.

Following the idea of FAO´s Country Pasture Profiles, this work provides a broad overview of relevant information about the Spanish pastures and the livestock and wild ungulate rearing systems they support.

Palabras clave:

Pastizal, pasto forestal, prado, ramón, ganado, ungulado salvaje, Mediterráneo.

RESUMEN

España es un país con una muy larga historia de pastoralismo y con un alto porcentaje de su territorio cubierto por pastos. Los pastos proporcionan una amplia variedad de servicios ecosistémicos y por tanto contribuyen de forma significativa al bienestar de la sociedad. También constituyen la base del sector esencial de la ganadería extensiva y juegan un papel fundamental en el Desarrollo Rural Sostenido.

Durante casi 60 años, la Sociedad Española para el Estudio de los Pastos ha trabajado con el objetivo de promover el conocimiento y la mejora de los pastos españoles. La cantidad de información acumulada después de tantos años es grande. Sin embargo, faltaba un documento que resumiese la información básica sobre los pastos españoles.

Siguiendo la idea de FAO de los Perfiles de Pastos de Países, este trabajo proporciona una amplia revisión de la información más relevante sobre los pastos españoles y los sistemas de gestión ganadera y de ungulados salvajes que sustentan.

1. INTRODUCTION

Spain is a country with an extremely long history of pastoralism. As a result, pastures cover a high percentage of its territory. Pastures provide a wide variety of ecosystem (provisioning, regulating and cultural) services, and therefore significantly contribute to the Spanish society well-being. They also support important economic sectors (e.g. agriculture, livestock, hunting) and play a key role in Sustainable Rural Development. Finally, some types of natural and semi-natural pastures are considered Habitats of Community Interest by the European Union.

The Spanish Society for the Study of Pastures (SEEP), founded in 1959, has been working for almost 60 years with the aim of promoting the knowledge and improvement of

Spanish pastures. SEEP aims to address every aspect related to pastoral science: types, ecology and functions of pastoral ecosystems; plant production; feeding value; animal production; economics, sociology and agricultural policy, etc. However, until now a document summarizing basic information about the Spanish pastures, a first step to integrate their knowledge, was lacking.

Following the idea of FAO´s Country Pasture Profiles, this work provides a broad overview of relevant information about the Spanish pastures and the livestock and wild ungulate rearing systems they support.

2. SPAIN

2.1. Location, government and administration

Spain is located in southwestern Europe. It borders France and Andorra to the north, Portugal to the west and Morocco to the south. Part of its territory is comprised of islands (Canary Islands in the Atlantic Ocean and Balearic Islands and some other small islands in the Mediterranean Sea). There are also two autonomous cities, Ceuta and Melilla, located in North Africa (Figure 2.1).

Spain has an area of 505,992 km^2, the second largest country among the European Union member states. It is a democratic country organized as a constitutional monarchy. For administrative purposes it is composed of 17 Autonomous Communities and two autonomous cities (Figure 2.2). Autonomous Communities are subdivided into provinces, of which there are 50 in total.

2.2. History, population and land ownership

Humans have inhabited Spain since some 1.2 Ma (Mega annuum) (*Homo antecessor*, Atapuerca, northern Spain). In the Neolithic period, Iberians and Celts populated most of the Iberian Peninsula. After being submitted to strong influences by the Phoenicians, Carthaginians and Greeks for around seven centuries before Christ (BC), Iberia came under the rule of the Romans around 200 yr BC. In the early Middle Ages Iberia was conquered by Germanic tribes and later (in 711) by Moorish invaders from northern Africa. After more than seven centuries of war and peace (the Reconquista), the Christians regained control of the Peninsula in 1492, under the reign of the Catholic Monarchs, who unified Spain as a country for the first time. They also promoted the "discovery" and colonization of America. The powerful Spanish world empire of the XVI and XVII centuries was followed by a period of decadence in the XVIII and XIX centuries. The long lasting influence of the Reconquista (when fire was used as a weapon and a way to remove forests and therefore the risk of ambush) and the Mesta (1273 – 1836), a powerful association of sheep holders, resulted in a dramatic decrease of the forest cover of Spain, on

FIGURE 2.1. Satellite image of Spain. Source: Google Earth.

FIGURE 2.2. Spain´s Autonomous Communities and Cities. Source: Spanish Ministry of Education, Culture and Sports.

the one hand, and in a huge expansion of grazing lands, infrastructures (e.g. *cañadas*, or traditional rights-of-way for transhumant herds) and pastoral traditions, on the other (Figure 2.3). Transhumance, aimed at efficiently using the temporary variable productions of Mediterranean and temperate pastures, has been a major pastoral practice for centuries (Montserrat and Fillat, 1990). Its ecological, economic, and social effects have been remarkable and still remain, even though transhumance is today a marginal practice.

FIGURE 2.3. Network of first and second level transhumance paths (cañadas), covering more than 125,000 km in Spain. They are public domain lands. Source: Wikipedia.

During the 20th century, Spain remained neutral in World War I and II but suffered a terrible civil war (1936-1939) followed by a dictatorship led by General Franco until his death in 1975. After a peaceful transition to democracy and a rapid social and economic modernization, Spain joined the European Economic Community (renamed European Union in 1992) in 1986, which in turn has introduced deep changes in social, economic and environmental structures and policies. A severe economic recession that began in 2008 led the Spanish government to take measures with the aim of reducing a large budget deficit and a very high (26%) unemployment rate.

The Spanish population, around 47 million people, is unevenly distributed over its territory. While there are high population densities (more than 500 people/km^2) around the major cities (Madrid, Barcelona, Bilbao) and almost all along the coast, there are still large, thinly populated (less than 30 people/km^2) areas, mostly located in central Spain, whose population is actually decreasing. Some 62% of the population is dedicated to the tertiary sector (increasing), 31% to the secondary sector (rather stagnating) and 7% to the primary activities (decreasing).

About 75% of the land in Spain is privately owned. The State, Autonomous Communities and Municipalities own 20% of the Spanish territory, most of it being non-cropped land: forest, woodland, scrubland or permanent pasture. Common land in Spain is usually permanent grasslands used as pasture for livestock. The number of agricultural holdings has decreased for the last decades, while their average individual area has increased. According to the Spanish Ministry of Agriculture, Food and Environment (MAGRAMA, 2015a), 9% of the Spanish territory is occupied by urban or industrial uses, 34% by agricultural o arable areas and the rest (67%) by non-agricultural areas: forest, woodland, scrubland, natural and semi-natural grassland, rocky or sandy areas and water bodies (Figure 4.1).

3. ECOLOGICAL CONDITIONS

3.1. Topography

Mainland Spain is a land of high plateaus and mountain areas. Most mountain ranges, formed during the Alpine (or Alpide) orogeny, some 25 Ma ago, are oriented in an east-west direction. Therefore, they have resulted in serious obstacles for animal and plant migrations in past climate changes, and especially during the glaciations of the Quaternary. The Pyrenees, with some peaks over 3,300 m, and the Cantabric Mountains (highest peak: 2,650 m) are located in northern Spain. The Central and Iberic Systems, with peaks over 2,000 m are located in Central Spain, as well as the Montes de Toledo and Sierra Morena, with considerably lower summits, below 1,500 m. The Baetic Ranges, a complex group of mountain ranges, are located in southeastern Spain. Their highest summit (also the highest in the Iberian Peninsula) is the Mulhacén (3,478 m), located in Sierra Nevada, the Penibaetic System. The highest point in Spain is the Teide (3,718 m), in Tenerife, Canary Islands. The Meseta is a broad, high plateau located in the centre of the Iberian Peninsula, which is surrounded by mountain systems.

The Iberian Peninsula waters flow into two seas: the Atlantic Ocean and the Mediterranean Sea. The watershed line between them crosses the Peninsula from north to south, being clearly displaced eastward. As a result, the extent of both watersheds is unequal, the Atlantic being much bigger (more than twice the size) than the Mediterranean. There are several major rivers: the Miño, Duero, Tagus, Guadiana and Guadalquivir flow westward and end in the Atlantic Ocean; the Ebro flows eastward and empties into the Mediterranean Sea (Figure 3.1).

3.2. Geology and soils

The Iberian plate is located between the Eurasian and the African plates. The Iberian Peninsula has constituted an independent secondary plate, segregated from the Eurasian plate since the Cretaceous period (more than 100 Ma). After the Alpine orogeny, it has remained united to the Eurasian plate and is separated from the African plate by the narrow Strait of Gibraltar. The Canary Islands have been formed by an intense and almost continuous volcanic activity since the Miocene.

The Spanish geological substrate is highly diverse. Geological surface layers cover all periods, from the Pre-Cambrian to the Quaternary. Palaeozoic acidic materials, deformed by the Hercinian orogeny, are the original components of the Iberian plate and outcrop mostly on western Iberia in the so-called Hesperian Shield, which is the core of the Iberian Peninsula. Sedimentary (and alkaline) rocks from the Secondary and Tertiary periods are dominant on eastern Spain and the Balearic Islands. The Alpine orogeny of the late Mesozoic period led to the formation of the mountain ranges of the Alpide belt, such as the Baetic Cordillera, the Cantabrian Mountains and the Pyrenees. There is also one more basic geologic assembly constituted by more recently originated (mostly Quaternary) and not deformed materials.

As a consequence of its mountainous nature and highly diverse geological substrates, the pattern of soil types in Spain is extremely intricate, even within relatively small areas. And this, in turn, contributes to the varied patterns of agriculture and land use. Acidic nutrient-poor soils dominating in western Spain have led to forest and pastoral landscapes, while fertile soils, dominant on the Meseta and eastern Spain, have led to agricultural landscapes, sometimes under the form of intricate patchworks of cropland, forest and scrubland as a result of a rough topography.

FIGURE 3.1. Physical map of mainland Spain, showing the most important cities, rivers and mountain ranges. Source: Google Earth.

3.3. Climate

The climate of Spain is roughly determined by its geographical position and topographic characteristics. The dominant winds are the so-called westerlies: western winds. Thus, the most important precipitations originate from the Atlantic Ocean and show a strong seasonality, while being also affected by the distribution of mountain ranges. They have less influence in eastern Spain, where the influence of the Mediterraneasn Sea is greater. Therefore, according to the Bioclimatic Map of Europe (Figure 3.2) and the Worldwide Bioclimatic Classification System (Rivas-Martínez and Rivas-Sáenz 2014), the dominant bioclimatic type is Mediterranean pluviseasonal, with a minimum of two consecutive dry summer months. Temperate bioclimates (without or with less than two summer dry months), which dominate Central and Western Europe, affect exclusively the northern part of the Iberian Peninsula as well as the Central and Iberic Ranges. Areas with summer drought under two months are considered as sub-Mediterranean. Mediterranean xeric types are concentrated in some areas of eastern Iberia, especially the low Ebro basin and southeastern Iberia, and the Canary and Balearic Islands. The only European areas affected by Mediterranean desertic types are located in a few scattered locations in southeastern Spain.

The thermoclimatic belts represent the distribution of the thermic regimes according to their influence on vegetation types. They are determined through the thermicity index (Rivas-Martínez and Rivas-Sáenz 2014). Their names are constituted by a prefix (infra-, thermo-, meso-, supra-, oro- and cryoro-, according to a scale of increasing cold) followed by the name of the bioclimate type. Infra- and thermo- types are frost-free; meso- is affected by light freezing and supra- by rather intense freezing. Oro- is affected by such an intense cold that the potential vegetation is taiga-like (coniferous forest) or shrub-like (tundra). In the cryoro- thermoclimatic belt, the cold is so severe that the potential vegetation is mountain grassland with or without dwarf cushion-shaped woody plants. The distribution of thermoclimatic belts in Spain is showed in Figure 3.3.

3.4. Biogeography

There are four Biogeographic Regions in Spain. The Alpine is present only in the Pyrenees; the Atlantic, in northern and northwestern Spain; the Mediterranean dominates over most of the Iberian Peninsula and the Balearic Islands, and the Macaronesian in the Canary Islands (Figure 3.4).

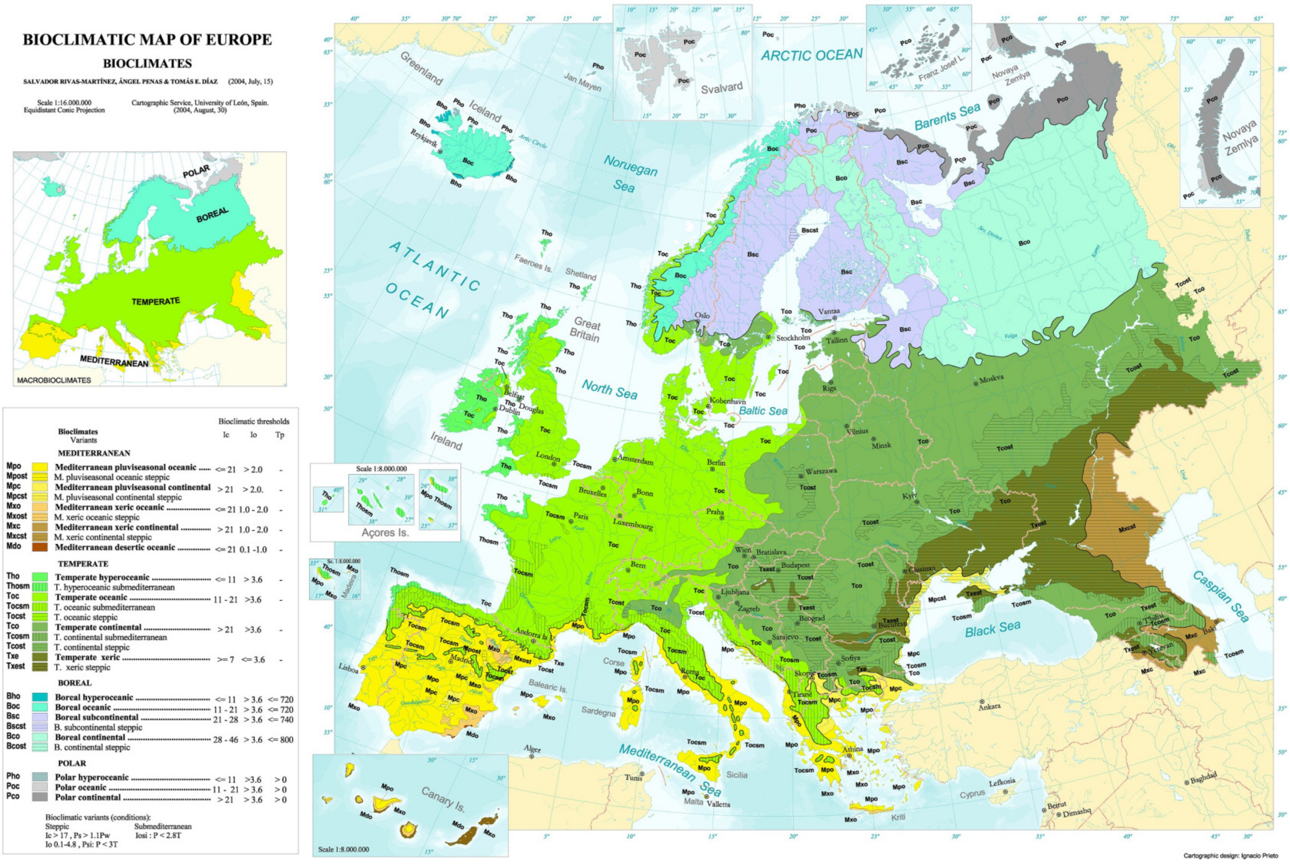

FIGURE 3.2. Bioclimatic map of Europe. Spanish Bioclimates (Rivas-Martínez & Rivas-Sáenz, 2014).

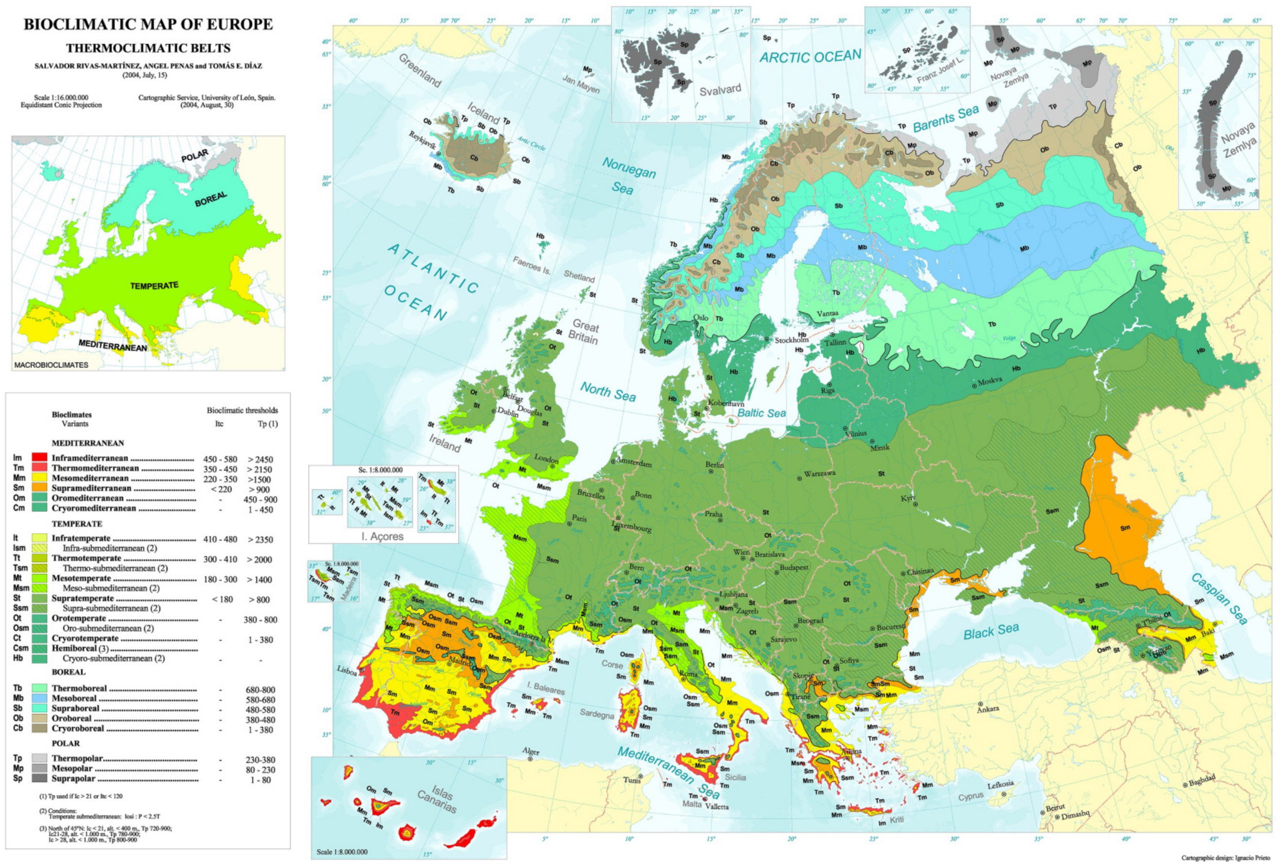

FIGURE 3.3. Bioclimatic map of Spain. Thermoclimatic belts (Rivas-Martínez *et al.* 2004).

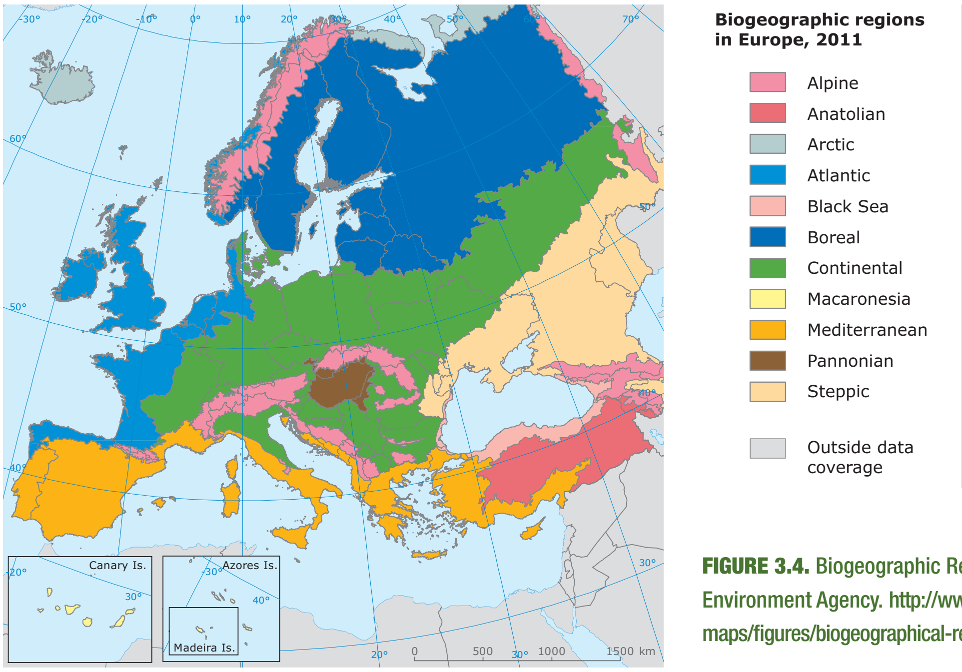

FIGURE 3.4. Biogeographic Regions of Europe. Source: European Environment Agency. http://www.eea.europa.eu/data-and-maps/figures/biogeographical-regions-in-europe-1

3.5. Vegetation

The potential vegetation of Spain is mostly forest. Deciduous forests (*Quercus robur, Q. petraea, Fagus sylvatica, Betula, Acer,…*) dominate in northern Spain, and also sometimes in mountain ranges of the centre and south of the Iberian Peninsula, where the bioclimate is temperate (Figure 3.5), but also on valley bottoms, over deep and wet soils (*Populus, Salix, Fraxinus angustifolia*,…) (Figure 3.6).

Sclerophyllous evergreen forests (Figure 3.7) grow under Mediterranean bioclimates, being holm oak (*Quercus rotundifolia*) the most abundant tree species of the Iberian Peninsula. On acidic soils and under less continental climate, cork oak (*Quercus suber*) is another important Mediterranean tree species, both in Spain and Portugal.

Semi-deciduous forests (*Quercus pyrenaica, Q. faginea, Q. pubescens,…*) are present under sub-Mediterranean bioclimates (Figure 3.8).

Conifers dominate immediately under the timberline, both in oro-temperate (*Pinus uncinata, P. sylvestris)* and oro-Mediterranean (*P. nigra*) thermo-climatic belts, but also under dry or semi-arid ombro-types (*P. halepensis*), hard continental climates (*Juniperus thurifera*) and over rocky, sandy and ultra-acidic or ultra-basic soils (*Pinus pinaster, P. pinea, P. halepensis*). *P. canariensis* sets the timberline in the Canary Islands at some 2500 masl under meso-Mediterranean thermo-climate (Figure 3.9).

However, the long history of human activity in Spain has resulted in a dramatic decrease of the forest cover. As a consequence,

FIGURE 3.5. On the left, deciduous forests in northern Spain: Pyrenean mixed forest with *Fagus sylvatica, Abies alba, Sorbus aria, Pinus uncinata, Fraxinus excelsior* and *Acer platanoides*; on the right, Cantabrian forest with *Quercus petraea, Betula pubescens* and *Sorbus aucuparia*.

FIGURE 3.6. Willows (*Salix salviifolia*, *S. fragilis*, *S atrocinerea*) bordering a mountain river in Central Spain.

the forest area with a canopy cover over 20% amounts only to 30% of the Spanish territory (mostly on terrain unsuitable for agriculture), although it is recovering rapidly. A significant part of the forest area is included in patchwork landscapes, alternating forest and woodland patches with scrubland, grassland and cropland.

Permanent scrub is the potential vegetation both in the upper oro-temperate and oro-Mediterranean belts (high mountain ranges) as well as under semiarid ombro-climates (Ebro depression, South-eastern Spain and Canary and Balearic Islands) (Figure 3.10).

The areas submitted to cryoro-temperate and cryoro-mediterranean bioclimates show a potential vegetation constituted

FIGURE 3.7. Open *Quercus rotundifolia* woodland: dehesa (left) and *Quercus suber* forest (right).

FIGURE 3.8. Semideciduous oak (*Quercus pyrenaica*) coppice forest in the Spanish Central Range.

FIGURE 3.9. Upper mountain pine forests: Pyrenean *Pinus uncinata* forest (top left), Central Range *Pinus sylvestris* forest (top right) and Canarian *Pinus canariensis* forest (bottom right). *Pinus pinaster* forest growing on dolomitic rocky slopes in southeastern Spain (bottom left).

FIGURE 3.10. Permanent mountain (orotemperate subMediterranean) scrubland with *Juniperus communis* and *Cytisus oromediterraneus* (left). Permanent semiarid scrubland with *Chamaerops humilis*, *Rhamnus oleoides subsp. angustifolia* and *Periploca angustifolia* in Murcia, southeastern Spain (right).

by graminoid and dwarf-camaephyte grassland-like communities (Figure 3.11).

3.6. Biodiversity

Spain is most probably the European Union (EU) Member State with the highest level of ecological and biological diversity (European Commission, 2016). A significant part (28%) of its territory (14.8 Mha) is protected under different legal figures, most of them included in the European Nature 2000 network, and flora has around 10,000 taxa, with a high percentage of endemisms. Part of the Spanish biological diversity is due to its location at intermediate latitude and between two continents, in addition to its natural ecological diversity and its long history of climatic and topographic change for millions of years.

FIGURE 3.11. Permanent cryorotemperate grasslands dominated by *Festuca eskia*, *Festuca scoparia* and *Nardus stricta* in the Pyrenees (N Spain) over 2,200 m above sea level (masl) (left). Permanent cryoro-Mediterranean grasslands dominated by *Festuca clementei* and *Nardus stricta* (green patches) in Sierra Nevada (SE Spain), over 3,000 masl (right).

However, Spain has been deeply transformed by a long history of human population and activity (fire, agriculture, livestock grazing and browsing, etc.). As a consequence, much of its current high biological diversity is dependent on traditional land-use systems and the so-called cultural landscapes and High Nature Value Farmland (Figure 3.12).

Spain holds 13 of the 31 Habitat Types of Community Interest listed in Group 6 (Natural and semi-natural grassland formations) as well as many other included in Groups 1 (Coastal and halophytic habitats), 2 (Coastal sand dunes and inland dunes), 3 (Freshwater habitats), 4 (Temperate heath and scrub), 5 (Sclerophyllous scrub) and 6 (Forests), which are also used for livestock rearing through grazing and browsing.

Extensive livestock rearing has been an essential tool in modelling Spanish cultural landscapes and in creating and preserving most of its rich environmental and cultural heritage (Montserrat, 2008). As a result, the preservation of much of the terrestrial Mediterranean flora, fauna and habitats protected under European Directives depends upon extensive livestock management models (Caballero et al., 2011; San Miguel, 2016). Indeed, transhumant sheep herds have strongly contributed to increase and preserve a strikingly high level of diversity in Spanish grasslands. Manzano et al. (2005) and Manzano and Malo (2006), report figures of over 150,000 seeds being transported by each transhumant sheep every year through both endozoochory and epizoochory. In addition, pastoralism plays an essential role in fire prevention (Ruiz-Mirazo et al., 2009; Ruiz-Mirazo and Robles, 2012) and supports major cultural, social and economic aspects that are essential for Sustained Rural Development in Spain.

3.7. Agro-ecological zones

Many classifications have been made of the Spanish agro-ecological zones. Almost all of them consider three essential

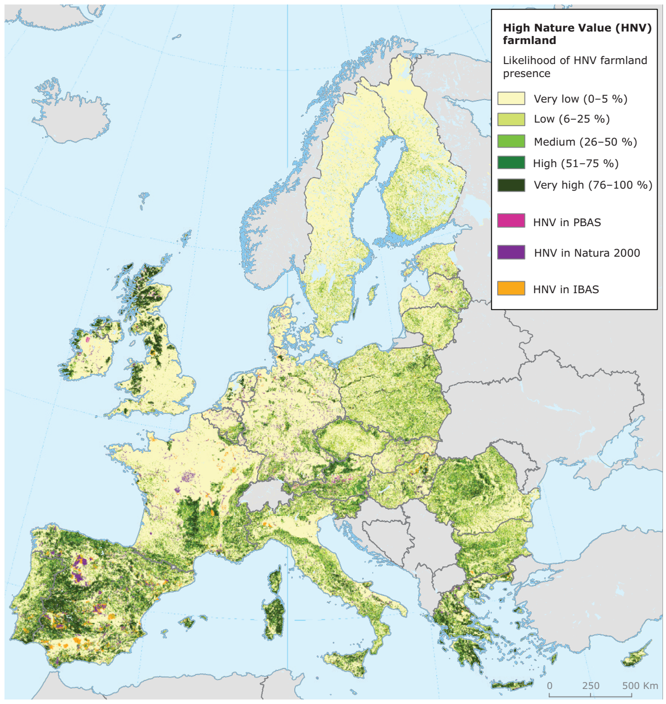

FIGURE 3.12. Distribution of High Nature Value Farmland in the European Union. Source: JRC: http://www.eea.europa.eu/data-and-maps/

factors: climate (temperate, Mediterranean continental, Mediterranean oceanic or Mediterranean xeric), soil fertility (fertile soils or acidic nutrient-poor soils) and topography. As a result, a broad classification could be summarized as follows:

- ***Temperate: North-Northwest***
  Temperate climate, without or almost without dry season. Natural forests (usually deciduous) and scrub (heath, gorse, broom) prevail on mountainous areas, while cropland (sometimes sustaining forage crops), permanent grasslands and forest plantations dominate on low, flat territories. The most important livestock species is cattle and, to a much lesser extent, horses and sheep.

- ***Mediterranean continental: central Spain***

Mediterranean continental climate. The land-use pattern depends on soil fertility. There are two broad possible situations:

Fertile soils: cropland dominates on plains and gently sloping lands. Permanent Mediterranean semi-natural pastures, scrublands and forests (perennial sclerophyllous, semi-deciduous or coniferous) thrive on steep slopes or rocky areas, unsuitable for agriculture, usually interspersed with croplands. Dairy sheep (goats to a much lesser degree), usually feeding on agricultural products and byproducts as well as on nearby rangelands, are the most important livestock. Extensive beef cattle rearing is important on mountain areas, while intensive cattle feedlots are usually located on well communicated flatlands.

Acidic, poor-nutrient soils: cropping is usually possible only on long (2-4 years) rotations. Pastoral landscapes, usually with scattered trees (extensive cattle or sheep *dehesas*) occupy gently sloping lands and sometimes plains. Mountains are covered by forests, scrub or, most frequently, patchworks. Big game (red deer, wild boar and other wild ungulates) is an important objective of large estates. Extensive beef-cattle rearing is the most important livestock farming type on mountain areas. Dairy goat farms may use scrubland pasture resources. Extensive Iberian swine farms are important on less continental (oceanic) areas of western and southwestern Spain, where acorn yields are higher.

- ***Mediterranean coastal border***

Mediterranean maritime mild climate, with low-medium rainfall. Eastern Spain and Balearic Islands. Irrigated crops dominate there where irrigation is possible, usually low river basins. Extensive rain-fed croplands occupy those flatlands where irrigation is not possible. Mosaics of scrub, Mediterranean grasslands, woodlands and forests thrive on steep slopes and rocky areas, unsuitable for agriculture, usually interspersed with croplands. The most important livestock systems are extensive sheep and goat farms on rangelands and intensive feedlots in agricultural, well-communicated areas. Byproducts from intensively managed cropland may be important for livestock feeding. Extensive livestock has declined dramatically in recent decades.

- ***Warm (subtropical) areas (southeastern Mediterranean coastal provinces and Canary Islands)***

Mediterranean subtropical climate, usually semiarid. Southeastern Iberian Peninsula and Canary Islands. Intensively managed cropland (sometimes cultivation under plastic) is a major form of land use on plains. Dairy goat (sheep to a much lesser degree) farms may use scrubland pasture resources as well as agricultural byproducts. Intensive feedlots are sometimes present on agricultural, well-communicated areas. Extensive livestock has declined dramatically in recent decades.

4. THE PASTURE RESOURCE

4.1. Breakdown of the Spanish territory by land uses

The Spanish territory can be separated into three broad classes (Figure 4.1): urban areas and water bodies (purple), cropland (orange) and natural or semi-natural areas (*monte = terreno forestal*) (different shades of green). The area covered by urban areas and water bodies amounts to 9% and shows a significant increase over the last decades due to urbanization processes, especially in coastal areas and on the outskirts of large cities.

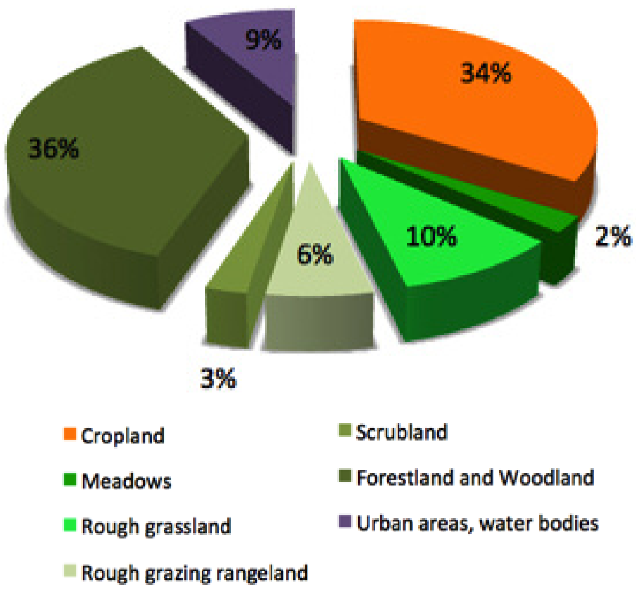

FIGURE 4.1. Breakdown of the Spanish territory by land uses. Source: MAGRAMA (2015a).

Cropland covers, approximately, 34 % of the territory and shows a slight, although continuous, decrease. It comprises both cultivated and fallow land. Fallow land can be defined as land under a system of rotation, whether worked or otherwise, not giving any harvest during the whole accounting year. Land set aside and not cultivated is also included in this category as well as set-aside lands with green cover (pastureland). The use of fallow land and arable stubbles for grazing is a widespread practice in Spain.

Natural and semi-natural land has been classified into five types:

- **Natural meadow (*prado*):** natural or semi-natural grassland often associated with the conservation of hay or silage. It grows under humid climate and/or on moist soils (without or almost without dry period) and may be harvested both by mowing or grazing. The extent of this grassland category is slightly, although continuously, decreasing.

- **Rough grassland (*pastizal*):** natural or semi-natural grassland growing under sub-humid, dry, semiarid or arid climates and dominated by annual or summer withering perennial grasses. They cannot be harvested by mowing. Its area is slightly, although continuously, decreasing.
- **Rough grazing rangeland (*erial a pastos*):** uncultivated land covered by sparse rough grass and scrub vegetation as a consequence of natural succession, following the abandonment of agricultural use, and absence, or near absence, of grazing activity (stocking rate under 10 kg of live weight per hectare). Its area is also slightly, although continuously, decreasing.
- **Scrubland:** land dominated by multi stemmed woody plants usually non exceeding 5 m in height. Its area has increased significantly over the past decades.
- **Forestland and Woodland:** land covered by trees with a canopy cover over 10%. Its area has increased significantly over the past decades.

4.2. Pasture classification

Pastureland has been defined as land (and the vegetation growing on it) devoted to the production of introduced or indigenous forage for harvest by grazing, cutting, or both (Allen et al., 2011). Since Spain is a largely Mediterranean country where green grass is scarce in summer, due to drought, and in winter, as a result of cold temperatures, there are other significant sources of food (apart from grass), both for livestock and for wild ungulates, such as browse, mast and even flowers (Ferrer et al., 2001). Indeed, browse and mast are essential sources of food for both wild ungulates and extensive livestock farming in summer and winter all over Mediterranean (and also non-Mediterranean) Spain. As a consequence, a classification of the Spanish pasture is presented in Figure 4.2.

4.2.1. Natural and semi-natural grasslands

Natural grasslands (pasturelands might provide grass and/or browse) have been defined as ecosystems dominated by indigenous or naturally occurring grasses and other herbaceous species used mainly for grazing by livestock and wildlife (Allen *et al*., 2011). Semi-natural grasslands are managed ecosystems dominated by indigenous or naturally occurring grasses and other herbaceous species (Allen *et al*., 2011). The difference between natural and semi-natural grasslands lies, therefore, on the management regime and may be quite subtle. Consequently, they will be considered together in this section.

Herbaceous grasslands (meadows, rough grassland and rough grazing rangeland) cover an area of 10.02 Mha (20% of the Spanish territory). They are dominated by herbaceous species but they usually include a significant woody component. Spain, accounting for 33.3% of the total European Union permanent grasslands, is indeed the most important contributor (Huyghe et al., 2014). Most of it is used, to a greater or lesser degree, for grazing by livestock and/or wild ungulates. However, it also provides other highly valuable regulation and cultural ecosystem services. Furthermore, a significant part of the Spanish scrubland (9.34 Mha) and forestland and woodland area (18.37 Mha) provide browse for livestock and wild ungulates, especially in summer and winter.

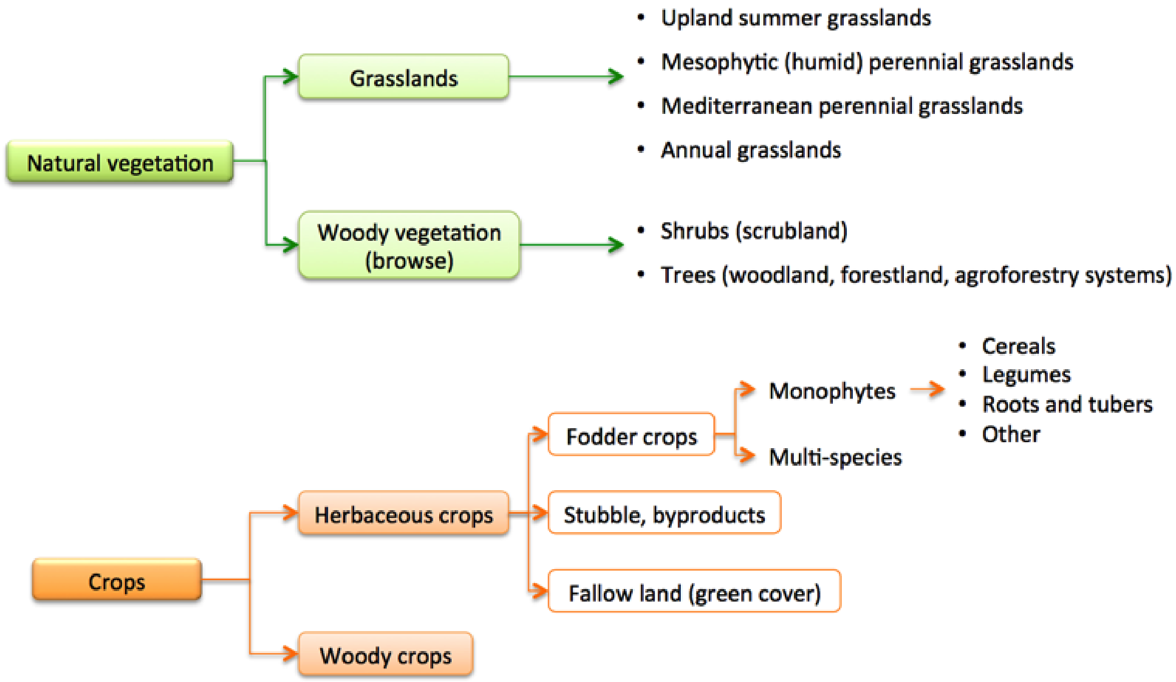

FIGURE 4.2. Classification of Spanish pastures.

The area of natural and semi-natural grasslands in Spain shows a slight, albeit continuous, annual decline of about 1-2% since the beginning of the millennium. The decrease is slightly higher in meadows and rough grazing rangelands (*erial a pastos*) (2%) than in rough grasslands (approximately 1%) (MAGRAMA, 2015a).

San Miguel (2001, 2016) describes four main types of herbaceous natural and semi-natural grasslands in Spain (Figure 4.2).

■ Natural upland summer grasslands

Natural upland summer grasslands (*pastos de puerto*) (Figures 4.3 and 4.4) usually grow over the timber line (1800 - 2200 masl in the Iberian Peninsula) on high mountain summits and slopes where neither sowing nor cultivating is possible. However, primary timber lines have been frequently brought down to lower altitudes as a consequence of the combined effects of grazing by wild ungulates and livestock and felling and burning by humans. Thus, natural upland summer grasslands may even be found at relatively low elevations (e.g. 1000-1500 masl). Cold temperatures throughout most of the year restrict vegetative growth to summer, and consequently forage is harvested only by summer grazing. The upper limit for cattle grazing is usually defined by the limit between oro- and cryo-oro- thermotypes: around 2000 masl in northern and central Spain and 2700 in Sierra Nevada, south eastern Spain. Therefore, sheep grazing is almost the only possibility under cryoro-thermotypes, and is rapidly decreasing due to the disappearance of traditional shepherds. However upland grasslands are not mere productive systems. They also sustain high levels of biodiversity and endemisms and provide highly valuable regulation and cultural ecosystem services, especially recreation, outdoor sports and tourism (Fillat et al., 2008; Montes, 2012). As a consequence, most natural upland summer pastures are considered habitat types of Community interest, and therefore protected by the European Union (EU) Habitats Directive (92/43/EEC).

The most important natural upland summer grasslands in Spain are represented by the following vegetation types (phytosociological classes) (see Rivas-Martínez, 2011):

- ***Caricetea curvulae***: acidophile grasslands (they also thrive on calcareous rock materials when snow cover, and hence soil leaching, is rather intense: e.g. leeward slopes), with Eurosiberian (Alpine) flora. Pyrenees, over 1800 masl. The most conspicuous species are *Festuca eskia, Festuca airoides* and *Carex curvula*. Included in the 6140 Habitat Type of Community Interest by the EU Habitats Directive (92/43/EEC).
- ***Festucetea indigestae***: acidophile grasslands rich in dwarf chamaephytes, with Mediterranean flora: southern, central and northern (Cantabrian) Spanish mountain ranges. The most conspicuous species is *Festuca indigesta* (also *F. summilusitana* in central mountain ranges and *F. clementei* and *F. pseudoeskia* in Sierra Nevada). Included in the 6160 Habitat Type of Community Interest by the EU Habitats Directive (92/43/EEC).
- ***Festuco hystricis-Ononidetea striatae***: short and rough basophile grasslands rich in dwarf chamaephytes, growing on soils with ephemeral snow cover, often with cryoturbation phenomena. However, their nutritional quality is rather high since legumes are usually abundant. Elevation may vary between 1000 and more than 2400 masl. Eurosiberian (*Festucion gautieri*) or Mediterranean (*Festuco hystricis-Poetalia ligulatae*) flora. *Festuca gautieri, F. hystrix* and *Poa ligulata* are amongst the most conspicuous species. Included in the 6170 Habitat Type of Community Interest by the EU Habitats Directive (92/43/EEC).

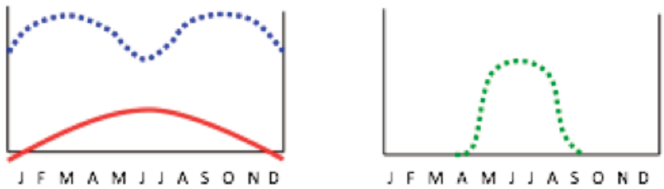

FIGURE 4.3. Climate diagram (left) and yearly distribution of vegetative growth (right) in natural upland summer pastures. Red line: mean monthly temperature; blue line: mean monthly precipitation in a two-fold scale (30ºC - 60 mm); green line: vegetative growth.

FIGURE 4.4. Natural upland summer pastures from the Pyrenees, northern Spain, oro-temperate thermotype 2000 masl (top), and Sierra Nevada, southeastern Spain, oro-Mediterranean thermotype 2,200 - 2,700 masl (bottom).

- ***Kobresio myosuroidis-Seslerietea caeruleae***: basophile dense grasslands, sometimes enriched by dwarf chamaephytes, growing on slopes with medium or long-lasting long snow cover. Pyrenees and Cantabrian mountains. *Lotus alpinus, Myosotis alpestris* and *Leontopodium alpinum* are amongst their characteristic species. Included in the 6170 Habitat Type of Community Interest by the EU Habitats Directive (92/43/EEC).
- ***Carici rupestris-Kobresietea myosuroidis***: basophile graminoid and grass communities with dwarf cushion-shaped chamaephytes growing on summits exposed to high mountain winds exposed summits. Pyrenees and Cantabrian mountains. *Kobresia myosuroides, Carex rupestris* and *Dryas octopetala* are amongst their most conspicuous species. Included in the 6170 Habitat Type of Community Interest by the EU Habitats Directive (92/43/EEC).
- ***Nardetea strictae***: dense grasslands thriving on long-lasting snow areas with strongly acidic organic mineral or peaty mineral soils that are damp in summer. Eurosiberian or Mediterranean flora. Northern, central and southern Spanish mountain ranges. *Nardus stricta* is the most conspicuous and usually dominant species. Included in the 6230 Habitat Type of Community Interest (* priority habitat) by the EU Habitats Directive (92/43/EEC).

■ Mesophytic (humid) perennial grasslands

Mesophytic (humid) perennial grasslands grow under temperate bioclimates and over moist soils (Figures 4.5 and 4.6). Potential vegetation is usually deciduous or mountain conifer forests. They are considered semi-natural grasslands since their presence requires grazing and/or mowing. Since there is not a summer dry period, vegetative growth is limited by winter cold. However, summer temperatures over 20ºC might result in a decrease of vegetative growth (dotted line in Figure 4.5). Harvest can be carried out by grazing, mowing or both. The usual livestock type is cattle. Production is usually high or very high. The highest yield is achieved in thermo-temperate well-managed meadows.

The most important mesophytic perennial grasslands in Spain are represented by the following vegetation types (phytosociological classes) (see Rivas-Martínez, 2011):

- ***Nardetea strictae (Violion caninae* and *Campanulo herminii-Nardion strictae)***: dense grasslands thriving on strongly acidic (sometimes organic mineral or peaty mineral) soils: *Agrostis-Festuca (Violion)* and *Nardus* rough grazing types. Eurosiberian or Mediterranean flora. *Nardus stricta* is the most conspicuous species in *Nardus* grasslands. *Agrostis capillaris, Festuca* gr. *rubra, Danthonia decumbens* are usually abundant in *Agrostis-Festuca* rough grazing types. Included in the 6230 Habitat Type of Community Interest (* priority habitat) by the EU Habitats Directive (92/43/EEC).

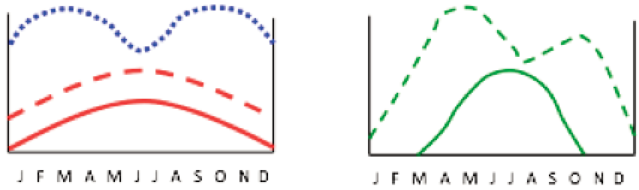

FIGURE 4.5. Climate diagram (left) and yearly distribution of vegetative growth (right) in mesophytic semi-natural perennial grasslands. Red line: mean monthly temperature; blue line: mean monthly precipitation in a two-fold scale (30ºC - 60 mm); green line: vegetative growth. The dotted line describes the pattern of variation for the thermo-temperate thermo-climate; the solid one shows that pattern for the supra-temperate thermo-climate (colder).

FIGURE 4.6. Two typical aspects of mesophytic (humid) semi-natural perennial Spanish grasslands: meadows.

- ***Festuco-Brometea (Brometalia erecti)***: highly diverse, basophile and humid grasslands, not deeply transformed by grazing. Intense grazing and/or mowing would transform them in *Molinio-Arrhenatheretea* communities. The most conspicuous species are *Bromus erectus, Festuca nigrescens, Brachypodium pinnatum* and *Trifolium montanum.* Included in the 6210 Habitat Type of Community Interest (* priority habitat) by the EU Habitats Directive (92/43/EEC), as important orchid sites.
- ***Molinio-Arrhenatheretea***: meadows and humid grasslands growing on deep and moist soils, widely transformed and spread by grazing and/or mowing all over the world, but with Eurasiatic optimum and origin: typical meadows (*Arrhenatheretalia*), wet

meadows (*Molinietalia caeruleae*), nitrophile, trampled meadows (*Plantaginietalia majoris*) and Mediterranean summer green rush communities and grasslands (*Holoschoenetalia*). Some types have been included in the 6410, 6420, 6510 and 6520 Habitat Types of Community Interest by the EU Habitats Directive (92/43/EEC).

■ Mediterranean perennial grasslands

Mediterranean perennial grasslands thrive under different types of Mediterranean climate: from thermo- to supra-Mediterranean thermotypes. Annual rainfall may be higher or lower, but there is always a rather long (usually over 3 months) summer drought period (Figure 4.7). The sward is dominated by perennial grasses whose vegetative growth period is concentrated mainly in spring and secondarily in autumn (Figure 4.7). As a consequence of the summer dry period perennial grasses dry out, but remain alive, until the arrival of autumn rains. The forage is rough and shows a high cellulose content for most of the year, so harvest is only possible by grazing (Figure 4.8). The usual livestock types are sheep, goats and beef cattle.

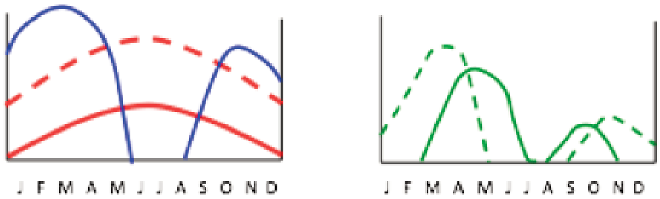

FIGURE 4.7. Climate diagram (left) and yearly distribution of vegetative growth (right) in Mediterranean perennial grasslands. Red line: mean monthly temperature; blue line: mean monthly precipitation in a two-fold scale (20ºC - 40 mm); green line: vegetative growth. The dotted line describes the pattern of variation for the thermo-Mediterranean thermo-climate; the solid one shows the pattern for the supra-Mediterranean thermo-climate (colder).

FIGURE 4.8. Two types of Mediterranean perennial grasslands: *Stipa* (= Celtica) *gigantea* with subMediterranean semi-deciduous oak (*Quercus pyrenaica*) woodlands in Central Spain (top) and *Stipa* (= Macrochloa) *tenacissima* with dispersed *Pinus halepensis* individuals, in Eastern Spain (bottom).

The most important Mediterranean perennial grasslands in Spain are represented by the following vegetation types (phytosociological classes) (see Rivas-Martínez, 2011):

- ***Stipo giganteae-Agrostietea castellanae***: acidophile Mediterranean tall perennial grasslands growing on deep cambisols, with or without gleyic properties. *Agrostis castellana, Stipa gigantea* and *Festuca merinoi* are the most conspicuous species.
- ***Festucetea indigestae (Jasiono sessiliflorae-Koeleretalia crassipedis)***: acidophile rough Mediterranean grasslands rich in woody chamaephytes often interspersed with scrub patches. The most conspicuous species are *Festuca indigesta, F. summilusitana, Koeleria crassipes* and *Plantago radicata*.
- ***Festuco hystricis-Ononidetea striatae (Festuco hystricis-Poetalia ligulatae)***: short and rough basophile grasslands rich in dwarf chamaephytes, growing on soils with ephemeral snow cover, often with cryoturbation phenomena. Their nutritional quality is rather high since legumes are usually abundant. *F. hystrix* and *Poa ligulata* are the most conspicuous species.
- ***Festuco-Brometea (Brachypodietalia phoenicoidis)***: basophile Mediterranean, but not xerophile, perennial grasslands. They usually grow on sub-Mediterranean environments or on deep clayey soils, which allow a longer growing season, drying out in late summer. The most conspicuous species is *Brachypodium phoenicoides*.
- ***Lygeo sparti-Stipetea tenacissimae***: basophile and xerophile Mediterranean perennial grasslands: pseudo-steppes. *Stipa tenaccissima, Lygeum spartum, Festuca scariosa, Brachypodium retusum* and *Hyparrhenia hirta* are amongst the dominant species. *Brachypodium retusum* communities have been included in the 6220 Habitat Type of Community Interest (* priority habitat) by the EU Habitats Directive (92/43/EEC).
- ***Poetea bulbosae***: Dense, short and nutritive Mediterranean perennial grasslands created by intense and continuous grazing, that dry out in summer. They include dwarf perennial grasses, but also annuals. Legumes (genera *Trifolium, Astragalus*, *Medicago*) are usually abundant. Included in the 6220 Habitat Type of Community Interest (* priority habitat) by the EU Habitats Directive (92/43/EEC).

■ Annual grasslands

Annual grasslands thrive mostly under Mediterranean climate where cropping or other human or natural perturbations prevent the development of perennial communities. Rainfall may be higher or lower, but there is always a summer dry period (Figure 4.9). As a consequence of the long summer drought, grasses disperse their seeds and die in late spring or summer. Subsequently, with the start of the rainy season in September-October, seeds germinate and begin their vegetative growth, which is soon inhibited by winter cold. The sward is dominated by annual grasses whose vegetative growth period is concentrated mainly in spring (60-70% of the annual DM yield) and secondarily in autumn (10-25% of the annual yield, according to the variable starting date of the rainy season) (Figure 4.10). The forage quality is very low after flowering if the legume abundance is not high, which is the usual situation. Even though the annual DM yield may be rather high (1,500-2,500 kg/ha) the most important management problem is its strongly unbalanced distribution throughout the year. The usual livestock types are sheep, goats and native breeds of beef cattle.

The most important annual grasslands in Spain are represented by the following vegetation types (phytosociological classes) (see Rivas-Martínez, 2011):

- ***Tuberarietea guttatae***: Pioneer plant communities dominated by non-nitrophilous annual short herbs and grasses, usually interspersed with shrub patches. They may thrive on acidic, basic or sandy soils. Basophile annual communities (*Trachynietalia distachyae*) have been included in the 6220 Habitat Type of Community Interest (* priority habitat) by the EU Habitats Directive (92/43/EEC).
- ***Stellarietea mediae***: annual ephemeral weed, ruderal, nitrophilous and semi-nitrophilous communities. The most important grassland types are those growing on fallow land: barbecho, posío.

4.2.2. Scrublands, woodlands and forests

Browsable biomass is an important source of forage both for livestock and wildlife in times of lack or shortage of green grass. This is the case in summer (as a result of drought) in Mediterranean Spain and winter (as a consequence of low temperatures) almost everywhere. Furthermore, in arid and semiarid territories woody plants are much more important for livestock and wildlife feeding than grasses. Therefore, scrublands, woodlands, open forests and agroforestry systems play an essential role for extensively managed livestock and wild ungulate rearing systems in Spain. These land uses cover extensive areas (53%) of our territory and most of them are managed through grazing and/or browsing.

In most cases, the edible parts of the plant are its leaves and twigs. However, in other cases, only its flowers are edible (Figure 4.11).

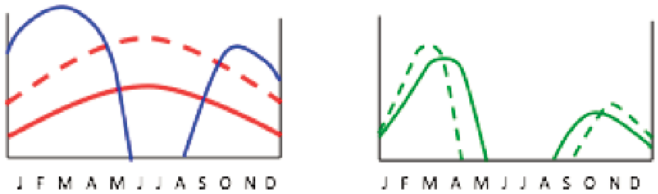

FIGURE 4.9. Climate diagram (left) and yearly distribution of vegetative growth (right) in Mediterranean annual grasslands. Red line: mean monthly temperature; blue line: mean monthly precipitation in a two-fold scale (20ºC - 40 mm); green line: vegetative growth. The dotted line describes the pattern of variation for the thermo-Mediterranean thermo-climate; the solid one shows the pattern for the supra-Mediterranean thermo-climate (colder).

FIGURE 4.10. Two types of Mediterranean annual grasslands: under scattered holm oak (*Quercus rotundifolia*) trees (typical Spanish dehesa) (top) and without tree cover (bottom).

Although browsable biomass is usually taken directly by browsing, branch pruning is sometimes necessary to make browsable biomass accessible to livestock, as in the dehesa system (Figure 4.12).

Some types of shrub communities (temperate heath and scrub, sclerophyllous scrub (matorral) and some other) are considered habitats types of Community interest, and are therefore protected by the EU Habitats Directive (92/43/EEC). Fire and browsing are usually necessary for their conservation.

Overabundance of wild ungulate populations has been described as an important problem for woody plant communities


FIGURE 4.11. Goat browsing on a wild olive tree (*Olea europaea var. sylvestris*), on the left, and "segureña" sheep nibbling *Genista versicolor* flowers in Sierra Nevada, southeastern Spain (2,700 masl), on the right.



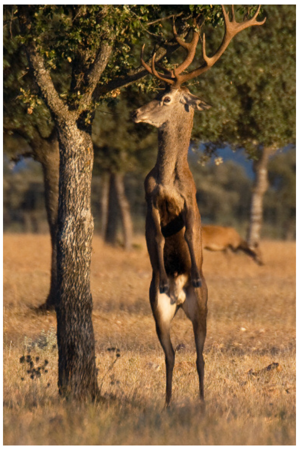

FIGURE 4.12. "Avileña negra iberica" cattle browsing on previously pruned holm oak (*Quercus rotundifolia*) branches in a typical Spanish dehesa (left). Iberian ibex (*Capra pyrenaica*) browsing directly on a holm oak tree (center), and red deer stag standing on its hind legs with the aim of reaching the lower branches of a *Quercus faginea* tree with its antlers and, subsequently, eating their leaves and twigs.

all over Spain, but especially in natural protected areas and for some highly preferred and threatened shrub and tree species (San Miguel et al., 1999, 2010; Perea et al., 2014, 2015). The lack or scarcity of green grass in summer and winter and the opportunistic (mixed-feeder) feeding behavior of most wild ungulates, combined with high stocking rates, lead to unsustainable browsing intensities on highly preferred woody species, especially when they are not abundant.

4.3. Cultivated pastures

Cultivated, or sown, pastures provide food for both extensively and intensively managed livestock as well as, sometimes, for wild ungulates (Muslera and Ratera, 1991). Cultivated pastures may be aimed at producing forage as a direct and valuable product. However, stubble and other by-products are also important for extensively managed livestock in Spain. The green cover of fallow land is also considered as an agricultural pasture even though it is the result of germination of the soil seed bank, mostly composed by spontaneous species.

Fodder crops cover a small part of the Spanish territory: 1.08 Mha, 2% of the total area and slightly over 6% of the agricultural land (MAGRAMA, 2015a) (Figure 4.13). Legumes are the most important group, with 36% of the area, with lucerne (*Medicago sativa*) (Figure 4.14) being by far the most important species, both for irrigated and rain-fed systems, with 260,531 ha. Cultivated grasses contributed to 33% of the area, being winter cereals (192,456 ha) and maize (*Zea mays*, 96,444 ha) (Figure 4.15) the most important species. Roots, tubers and other monophyte crops cover only less than 6% of the fodder crop area, while multi-species forage crops (*praderas*) (Figure 4.16) cover, approximately, 26%: 279,178 ha.

Only 19% of the fodder crop area is harvested for fresh consumption. The rest is conserved as hay (27%), silage (24%) (Martínez-Fernández et al., 2014) or through dehydration (30%) (MAGRAMA, 2015a).

Grain cereal croplands (approximately 6 Mha, or 35% of the agricultural land) provide stubble for grazing of extensively managed livestock and/or straw, a resource of increasing importance for livestock feeding.

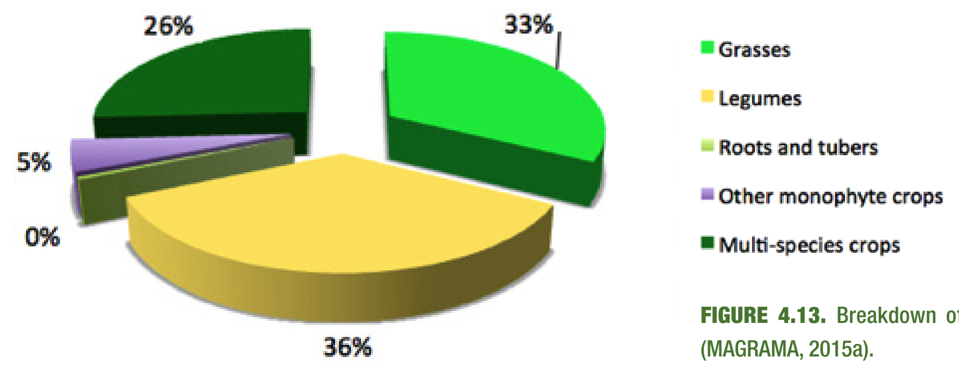

FIGURE 4.13. Breakdown of the Spanish forage cropland area in 2012 (MAGRAMA, 2015a).

FIGURE 4.14. Lucerne (*Medicago sativa*) is the most important fodder crop legume in Spain, both in irrigated and rain-fed systems. It requires calcareous soils and is usually conserved as hay or through dehydration.

FIGURE 4.15. Maize (*Zea mays*) (left) and Italian ryegrass (*Lolium multiflorum*) (right) are the most important fodder crop grasses in Spain.

FIGURE 4.16. Multi-species fodder crops (praderas) have become an interesting alternative for increasing both DM yields and forage nutritional quality in Spain. The one shown in the picture is protected from grazing by a solar-powered electric fence.

Fallow land covers 3.55 Mha, 20% of the Spanish agricultural land. Its green cover (barbecho) contributes substantially to extensively managed livestock rearing.

The extent of cultivated pastures in Spain seems to have remained steady or to have increased slightly since the beginning of the millennium.

5. UNGULATE REARING SYSTEMS

5.1. Brief history and current situation

From the beginning of the Neolithic period until the 1960s, livestock activity increased both in range and intensity. In contrast, wild ungulate populations decreased dramatically, since some species have been extirpated by humans through intensive hunting and land transformation, while the rest of their populations have been reduced to minimal densities consigned to marginal upland territories.

Extensive livestock rearing has been an essential activity in the Iberian Peninsula for, at least, 4-5 millennia. It has been both an engine for economic and social development and an essential tool for landscape modeling. Sheep have been the most important species due to their short gestation period and grazing behaviour that best fits the strong seasonality of Mediterranean grasslands. The arrival of the merino sheep breed in the Middle Ages, with the finest wool known all over the world, substantially contributed to the welfare of the Spanish Kingdom and resulted in a huge increase of sheep numbers. Indeed, the Mesta, a powerful association of transhumant herders, was created in 1273 and protected by Spanish Kings until 1836. It was given the privilege of herding throughout the Spanish territory with some exceptions, such as cultivated fields, meadows, vineyards and deffesas (later known as *dehesas*, areas devoted to the sustenance of draught and pack animals of the villagers).

Until the beginning of the second half of the 20th Century, extensive livestock rearing was, by far, the usual management model (Montserrat and Fillat, 1990). Sheep management systems were divided into two types: one associated with arable land (sometimes oriented towards milk and cheese production) and the other one consisting of transhumant herds associated to *dehesas*, rough grasslands and summer upland grasslands, aimed at wool and meat production. Goat herds were also distributed throughout Spain with the aim of taking advantage of scrubland, rough grasslands and rough grazing rangeland for milk and meat production (the goat was considered “the poor man´s cow”). Due to their long gestation and lactation periods, which poorly fitted the strong seasonality of Mediterranean grasslands, cows were mostly used as draught animals, with a few exceptions in northern Spain and mountain areas. Finally, some indigenous pig breeds, such as the Iberian pig, were also managed through extensive herding, mostly to take advantage of the abundant and valuable mast (forest fruits) such as acorns, chestnuts and beechnuts.

The second half of the 20th Century was a period of strong economic and social improvement in Spain. Supplementary feeding with concentrates became a widespread alternative for livestock feeding, thus allowing an increase in cattle rearing for meat and milk production and the introduction of new livestock breeds with the aim of increasing meat and milk yields. Meat and milk demand increased considerably as a consequence of social and economic progress, while the price of wool also dropped dramatically. On the other hand, shepherds became increasingly scarce and transhumance was gradually abandoned. Moreover, Spain´s integration in the European Union from 1986, and hence in the Common Agricultural Policy (CAP), resulted in deep changes in livestock management models. Nowadays, extensive livestock management is decreasing due to social and economic reasons and lack of shepherds, while intensive management aimed at meat production has increased substantially. Intensive management is also widespread for milk production even though the numbers of dairy cattle farms have decreased considerably while their individual size and production have actually increased.

The reduction of extensive livestock farming in Spain is resulting in severe conservation problems. These include shrub encroachment, increase risk of wildfire, reduction of biodiversity levels, degradation or disappearance of protected grassland habitat types, homogenization of landscapes (the so-called green desert), conservation issues for endangered flora and fauna, lack of food for insectivorous birds and carrion-eating animals, loss of cultural heritage and difficulties for achieving Sustained Rural Development. As a consequence, many LIFE-Nature Projects have been carried out with the aim of recovering these habitat types through the preservation or recovery of traditional extensive livestock management. Table 5.1 and Figure 5.1 summarize the evolution of livestock numbers in Spain since 1750.

Unlike extensive livestock farming, wild ungulate populations have vastly increased over the last five decades as a result of three major causes: an outstanding growth of big game demand (wild ungulates have become a major economic resource), rural abandonment and a parallel increase of protected areas (Figure 5.2).

5.2. Livestock

5.2.1 Sheep

As a consequence of the dominant Mediterranean climate and the resulting strong seasonality of green grass availability in Spain, small livestock (with short periods of high nutrient requirements in the lactation and late gestation phases) has prevailed over cattle and horse for centuries. According to their foraging preferences, sheep have been used for grazing, either through transhumance or by being associated to agricultural landscapes, products and byproducts, while goats have been aimed at scrubland browsing.

Sheep have been reared as a multipurpose species. For centuries, and especially after the selection of the Merino breed, the most important product was wool. Indeed, wool from Merino sheep was a major pillar of the powerful Spanish empire of the 15th -17th centuries (Phillips and Phillips, 1997). Lamb has been another major product, especially for transhumant or transterminant (shorter seasonal movements) grazing systems, while milk, usually for cheese making, was important mostly for breeds associated with cultivated landscapes and products. However, since the 1990s wool prices suffered a dramatic drop, which resulted in revenues that did not cover shearing costs (current prices are beginning to reverse the trend). The lack of shepherds resulted in substantial changes in sheep herding: partial substitution of shepherds by fences, shifting to semi-intensification and a dramatic decrease of sheep grazing on large areas of rough grassland, rough grazing rangelands and upland summer pastures, especially over 2,000 m above

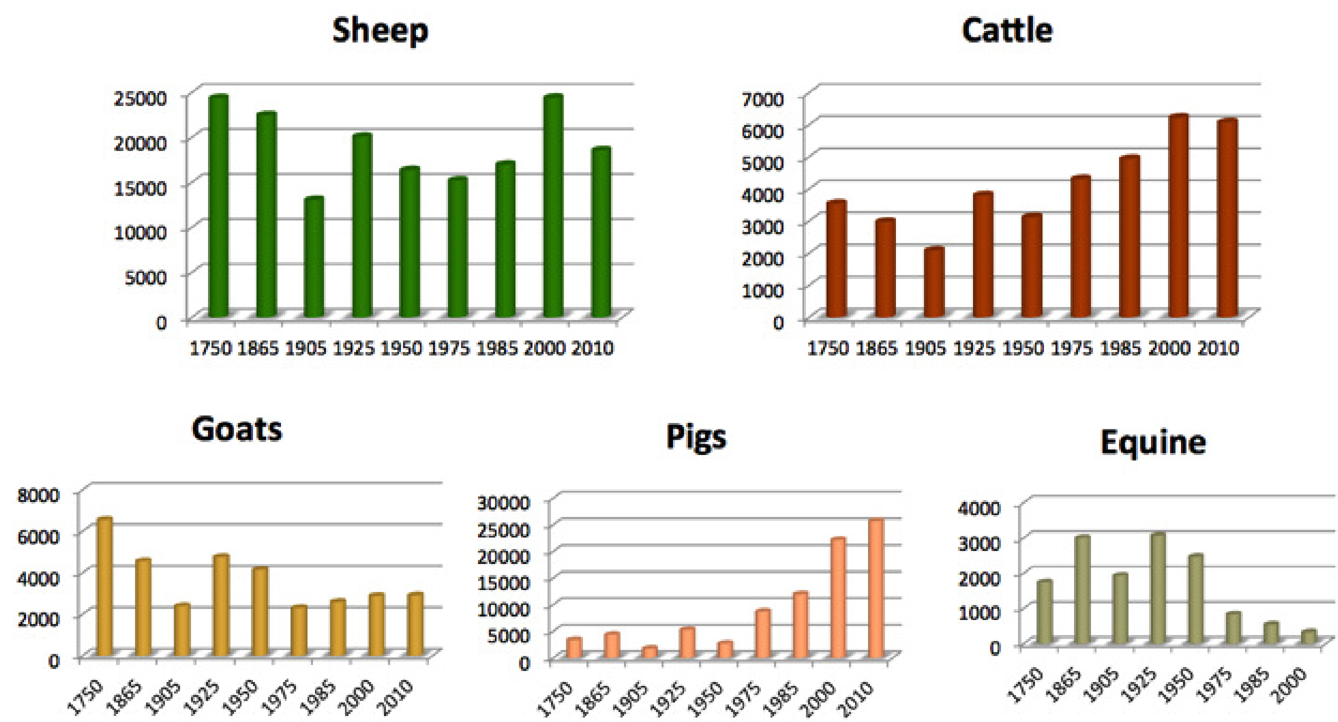

FIGURE 5.1. Evolution of livestock numbers (in thousands) in Spain since 1750. Source: MAGRAMA (2015a).

TABLE 5.1. Evolution of livestock numbers (in thousands) in Spain since 1750. Source: MAGRAMA (2015a).

Year	1750	1865	1905	1925	1950	1975	1985	2000	2010
Sheep	24350	22469	13026	20067	16344	15200	16954	24400	18552
Cattle	3535	2967	2075	3794	3112	4300	4930	6216	6075
Goats	6543	4552	2386	4750	4135	2293	2584	2876	2904
Pigs	3350	4352	1744	5267	2688	8700	11960	22149	25704
Equine	1738	2997	1928	3061	2463	831	540	321	318

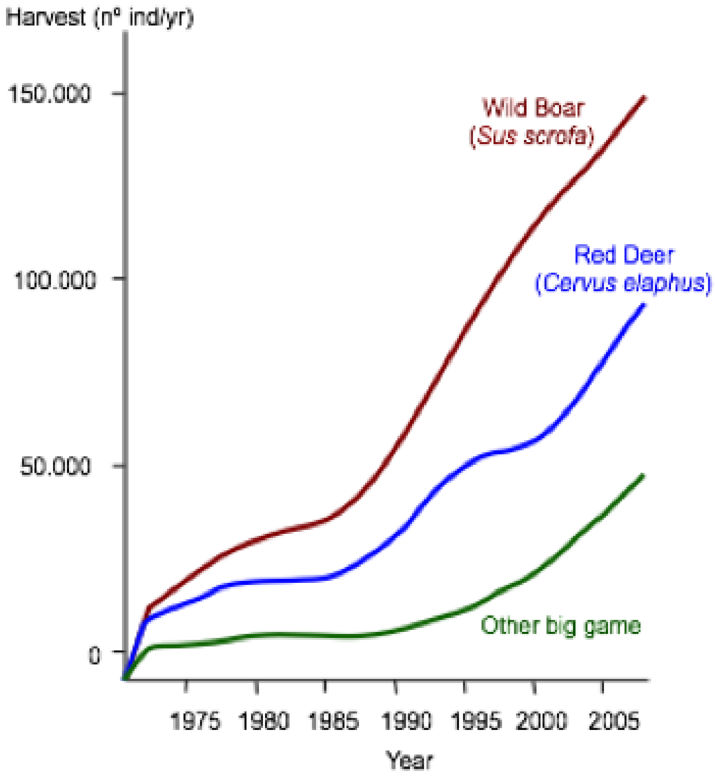

FIGURE 5.2. Trend in the number of wild boar, red deer and other big game harvests between 1972 and 2007 in Spain. Adapted from Herruzo and Martínez-Jauregui (2013).

sea level. On the other hand, as a consequence of the dwindling of lamb demand and prices, some sheep farming systems are now shifting more towards milk and cheese production, which seems to have a more promising future, especially when they are supported by quality labels and/or denominations of origin or geographic indications.

The current number of sheep is almost 20 million head, with a slightly decreasing trend in the past decade (Table 5.1; Figure 5.1). The number of dairy ewes is fairly stable or increasing while the number of flocks for meat is declining. The distribution of sheep numbers throughout Spain is shown in Figure 5.3. A major part of sheep farms depends on *dehesa* systems, rough grasslands (marginal areas) and crop byproducts and products, mostly in areas where cattle farming is not possible or not profitable. Figure 5.4 summarizes sheep farming types, according to the main final product, in Spain.

Most sheep flocks aimed at lamb production use extensive management systems. They usually belong to one of two types of lambing strategies (Figure 5.5). The first one (one lambing per year) is aimed at reducing supplementary feeding to a minimum. Autumn lambing is usually preferred, since lamb prices are much higher in winter (Christmas) than in spring, the natural lambing season. The second one (three lambing periods within two years) is aimed at maximizing lamb yield even at the expense of increasing supplementary feeding (one lambing period occurs in summer, the worst

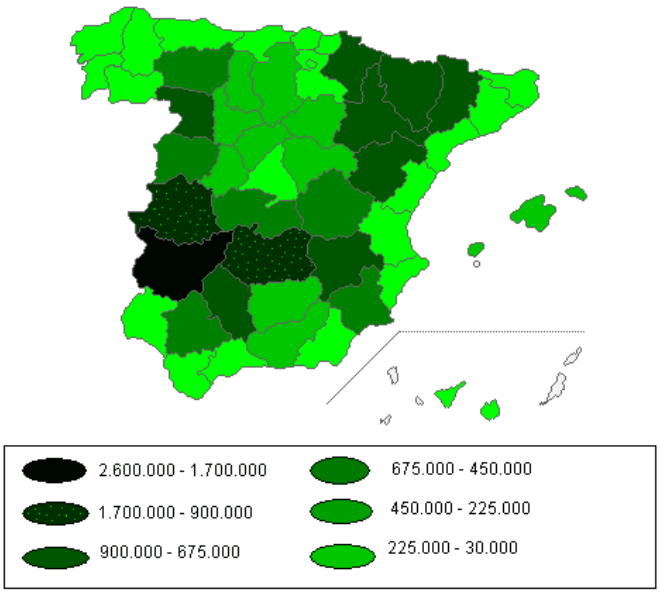

FIGURE 5.3. Distribution of sheep numbers throughout Spain. Figures in head numbers. Source: MAGRAMA (2015a).

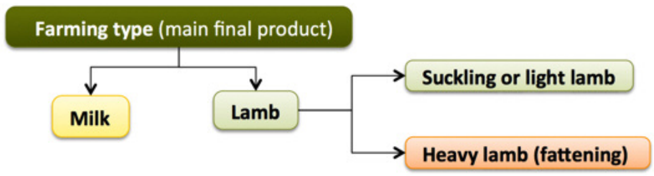

FIGURE 5.4. Mayor sheep farming types in Spain.

season regarding available forage quality and thus requiring more supplementary feeding).

While beef and pork consumption has increased for the last decades and now remains more or less stable, sheep meat has suffered a sharp drop, of about 50%, since 2000. Per capita consumption of sheep and goat meat is usually between 2 and 3 kg per year, around 4% of the total meat consumption (MAGRAMA, 2015a). Lambs may be sold approximately 45 days after lambing, weighing less than 8 kg (suckling lambs), or at around 4 months of age, weighing 11-16 kg (light lamb, the most consumed type in Spain). Some of them are also intended for fattening up to 6-12 months of age, when they weigh over 16 kg.

The most important native sheep breeds for meat production are Merino, Castellana, Churra, Segureña, Rasa, Ojalada, and Mallorquina (Figure 5.6).

Sheep milk amounts to 8% of the Spanish milk annual yield (MAGRAMA, 2015a). Most dairy sheep farms are aimed at cheese production, usually under quality labels and/or Protected Denominations of Origin (PDO) or geographic indications. Some

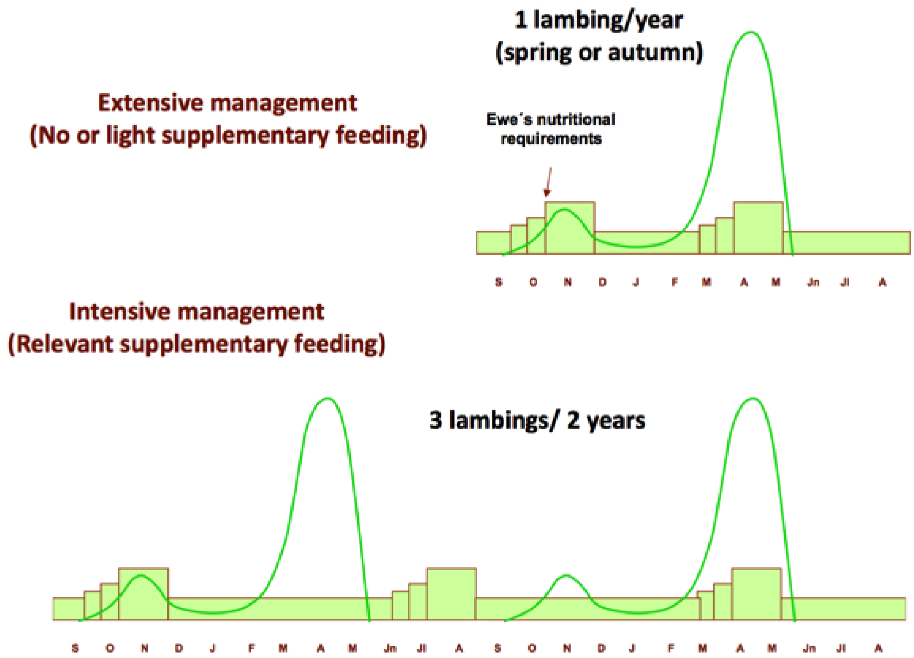

FIGURE 5.5. Major calving strategies of sheep farms aimed at lamb production in Spain. Solid lines indicate the availability of green grass throughout the year and bars show the ewe's nutritional requirements.

of them are associated with arable landscapes and products, like the Manchego cheese, while others depend upon grazing on meadows, forage crops or even rough grasslands, like the Idiazabal or Ronkal cheeses from northern Spain. Others might be classified as intermediate types, like the Torta del Casar cheese from Extremadura.

Although there are significant variations between breeds and management systems, dairy ewes usually produce between 150 and 200 kg of milk in 150-180-days lactation periods.

The most important sheep breeds for milk production are Manchega, Latxa, Carranzana, Castellana (native breeds, Figure 5.7), Assaf and Lacaune (foreign breeds).

5.2.2. Cattle

Due to their long gestation and lactation periods, which poorly fit the strong seasonality of Mediterranean grasslands, cattle in the past were mostly used as draught animals, with few exceptions in northern Spain and mountain areas, where meadows are available. In those areas cows were also aimed at milk and beef production. However, since the beginning of the second half of the 20th Century, the use of supplementary feeding and the introduction of foreign breeds selected for beef production changed dramatically the management of cattle in Spain.

Dairy cow breeds behave as grazers. However, most Spanish beef cattle breeds behave as mixed feeders: they graze whenever green nutritive grass is available, but might browse, even intensively, when green grass is scarce or show a low nutritional value. They may even bring down small trees (up to some 20 cm in diameter at breast height) with the aim of browsing their leaves and twigs.

The number of cows has increased greatly since the 1950s, and now remains around 6 million head showing a rather stable trend (Table 5.1; Figure 5.1). The number of dairy cows has decreased since Spain joined the European Union. Over a period of a few decades, the number of farms dropped dramatically while those that remain are much bigger in head numbers and milk production. The average milk production per cow has also increased by many folds, through genetic selection and improvement of infrastructures and feeding management. On the other hand, the number of beef cattle has increased substantially over the same period (Figure 5.8), presumably because they are supported by CAP subsidies and because, unlike sheep and goat farms, shepherds are not needed in beef cattle farms.

The distribution of cow numbers throughout Spain is shown in Figure 5.9. A major part of beef cattle farms depends on meadows (northern Spain and mountain areas), but also on the *dehesa* system (sparsely wooded pastures of western and southwestern Spain), rough grasslands (marginal areas) and upland summer pastures.

There are many Spanish native breeds of beef cattle, each one adapted to the particular ecological conditions of their home range through centuries of careful selection. However, since they were not aimed at beef production until the 1960s, today they are usually crossed with Charolais and Limousin (French) breeds in order to increase the live weight and growth of beef suckler calves and thus maximize meat production. Most

FIGURE 5.6. Some of the most important Spanish sheep breeds for meat production: Merino (top left), Churra (top right), Segureña (bottom left) and Castellana (bottom right).

FIGURE 5.7. Two of the most important Spanish sheep breeds for milk production: Manchega (left), from central Spain, and Latxa (right), from northern Spain.

farms are located in rural areas and specialize in rearing suckler calves which are sold at 5-6 months of age and later fattened to an optimum slaughter weight with concentrate feeds in specialist fattening farms. Fattening farms are usually located in well communicated agricultural areas, often far from beef cattle farms. Beef cows are usually fed through extensive management low-cost systems on natural and semi-natural grasslands. In northern Spain they usually require a limited winter housing and feeding on hay or silage. However, their dependence on supplementary feeding has increased over the last decades, especially in Mediterranean Spain, where winter housing is not needed. Most beef cattle farmers depend for their income on a combination of livestock sales and support payments, CAP subsidies from the European Union.

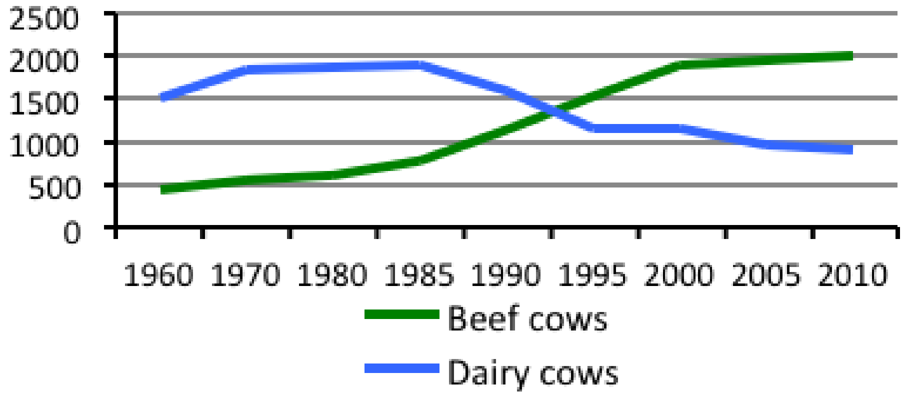

FIGURE 5.8. Evolution of beef cows and dairy cows, in thousands of head, since 1960. Source: MAGRAMA (2015a).

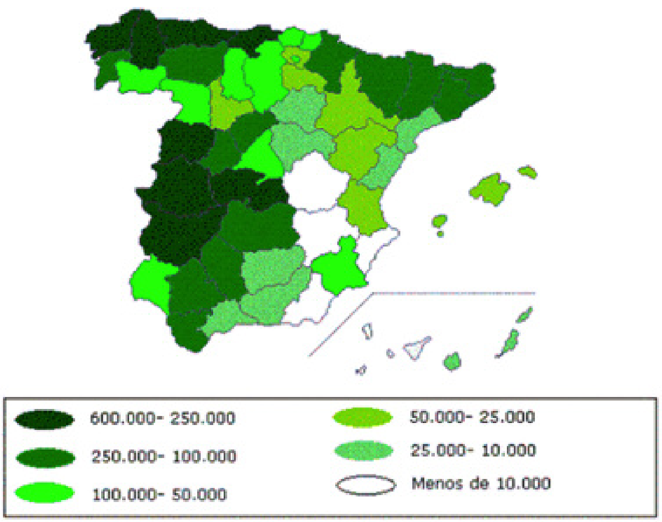

FIGURE 5.9. Distribution of cattle (beef and dairy cows) throughout Spain. Figures in head numbers per province. Source: MAGRAMA (2015a).

Some of the principal breeds of beef cattle in Spain are Rubia gallega, Asturiana de los valles, Tudanca, Pirenaica and Parda de montaña in northern Spain; Morucha and Avileña negra ibérica in central Spain and Retinta, Lidia and Berrenda in southern Spain (Figure 5.10). However, some traditional breeds are currently managed for new desired traits, often linked to market demands. Cattle feeding is mainly based upon grazing during the season of vegetation growth: (April) May - October (November) in northern Spain and October - May in Mediterranean Spain.

Cow milk amounts to 86% of the Spanish annual milk yield. Dairy cows are now mainly located in northern Spain (one third in Galicia, NW Spain), where the largest dairy industries are located (MAGRAMA, 2014). Their individual size is rather variable: from 14 cows/farm in Extremadura, W Spain, to 202 in Valencia, E Spain, with a mean of 37 cows/farm, everywhere showing a clear increasing trend for the past decades (MAGRAMA, 2015a). Dairy cattle facilities often show high levels of technology to ensure welfare for animals as well as efficiency and a suitable environment to improve health and prevent diseases. The usual breed is Holstein-Friesian. The number of dairy cows was around 855,000 in 2014, showing a negative trend (MAGRAMA, 2015a). Feeding is mainly based on annual forage crops (often silage in northern Spain) and concentrates. Genetic improvement of cattle for milk production has been practised for many years. The average milk yield per cow has shown a steady growth for the last decades and now is 8,000 kg for a lactation period of approximately 280 days (MAGRAMA, 2015a).

5.2.3. Goats

Goats have been reared almost everywhere in Spain, as a multipurpose species, since the beginning of the Neolithic period. They are among the most efficient domestic animals in their use of water. In addition, their short period of high nutritional requirements (late gestation and usually a 45-day lactation) fits perfectly the seasonal offer of green forage of Mediterranean ecosystems. They are also opportunistic feeders, with a large spectrum of food sources, usually including browse as a major component of their diet. Finally, as their milk yield per unit of live weight is higher than that of cows and sheep, they were considered the poor man´s cow. As a consequence, herded goats have been widespread all over Spain for millennia.

The number of goats was over 6 M head in the 18th century. Its lowest level was reached in the 1980s, with some 2 M head, probably due to the lack of shepherds and the strong competition of other livestock species: cattle and sheep. Over the past decades it has increased slightly to reach, today, 2.7 M head (MAGRAMA, 2015a).

The distribution of goat numbers throughout Spain is shown in Figure 5.11. Most goat farms are located in Mediterranean scrublands, rough grazing rangelands and rough grasslands (marginal areas). Figure 5.12 summarizes goat farming types, according to the main final product, in Spain.

FIGURE 5.10. Some of the most important Spanish breeds for beef production: Asturiana de los valles (top left) and Tudanca (top right), from Northern Spain, and Retinta (bottom left) and Avileña-negra ibérica (bottom right), from Mediterranean Spain.

Per capita consumption of goat meat has dropped for the last decades and nowadays is slightly under 2 kg/year. Suckling kids represent 82% of the goat meat consumption in Spain (MAGRAMA, 2015a). On the other hand, goat cheese is rather highly appreciated and priced, mostly under Protected Denominations of Origin (PDO). Therefore, goat farms primarily aimed at meat production have almost disappeared and today most goats are reared for milk production, with kids becoming something similar to a by-product. Goat milk currently accounts for 6% of the Spanish milk annual production (MAGRAMA, 2015a).

Some dairy goat farms are associated with agricultural landscapes and purchased feed (intensive management), but most depend, to a greater or lesser degree, upon scrubland and rough grassland browsing and grazing (semi-intensive management). Semi-intensive management results in milk yields of 150-300 kg/goat for lactation periods of about 200 days, while intensive management usually results in milk yields of 400-800 kg/goat for the same period (Daza et al., 2004; MAGRAMA, 2015a).

The most important goat breeds for milk production are Murciano-Granadina, Malagueña, Payoya, Majorera, Tinerfeña and Palmera. The most important goat breeds for mixed meat/milk production are Pirenaica, Verata, Blanca andaluza, Blanca celtiberica and Guadarrama (Figure 5.13).

5.2.4. Iberian pig

Although most Spanish natural pastures are devoted to ruminant rearing systems, some pig breeds have also been used to take advantage of forest fruits, such as oaks (*Quercus* spp.) and beech (*Fagus sylvatica*) masts, and grass, through extensive herding. The most important one is the Iberian pig, a traditional breed resulting from wild boar (*Sus scrofa*) domestication and selection in southwestern Europe. It is closely linked to the *dehesa* (Spain) - *montado* (Portugal) system: a traditional agro-silvo-pastoral extensive and efficient management system that links production and biodiversity conservation (Montero et al., 1998; Olea and San Miguel, 2006). Their link is so close that the outbreak of the African swine disease in the first half of the 20th century resulted in the uprooting of vast areas of Spanish *dehesas*.

Its colour may be black or dark red, with little or no hair and black hooves; that is why it is called *pata negra* (Figure 5.14). Iberian pigs show a striking capacity to accumulate intramuscular and epidermal fat. This retards meat oxidization processes and makes their taste so special. The Iberian pig is a good example of a high quality, highly prized meat product which can also contribute to the conservation of traditional and endangered cultural landscapes such as the Spanish *dehesa* and the Portuguese *montado*, especially under quality designations of Protected Denominations of Origin (PDO). Indeed, some Iberian pig dehesas have been certified under the FSC Forest Certification System.

Some traditional Iberian pig breeds were on the verge of extinction in the 1960s as a result of cross breeding with Duroc breeds. Indeed, some of them disappeared. However, the Spanish Institute for Agrarian Research (INIA) succeeded in

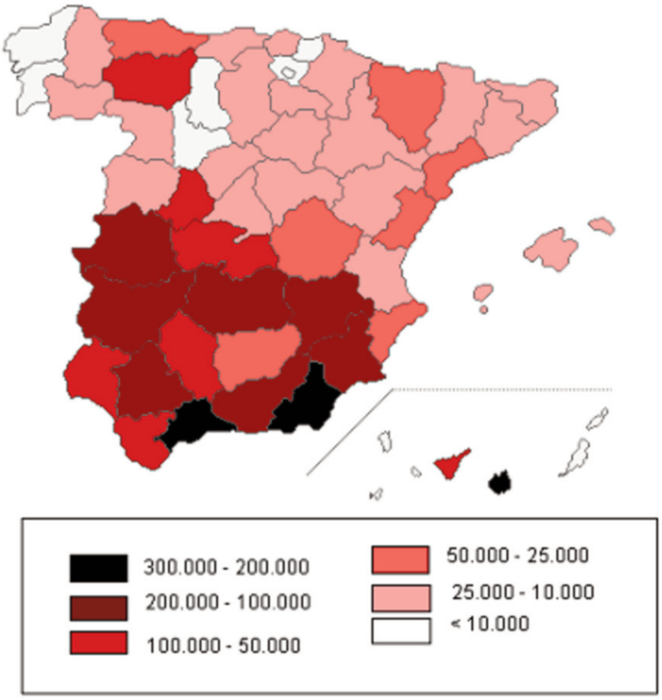

FIGURE 5.11. Distribution of goat numbers throughout Spain. Figures in head numbers. Source: MAGRAMA (2015a).

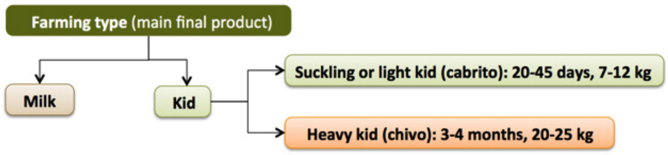

FIGURE 5.12. Major goat farming types in Spain.

FIGURE 5.13. Some of the most important Spanish goat breeds: Murciano-Granadina (top left), Palmera (top right), Blanca andaluza (bottom left) and Verata (bottom right).

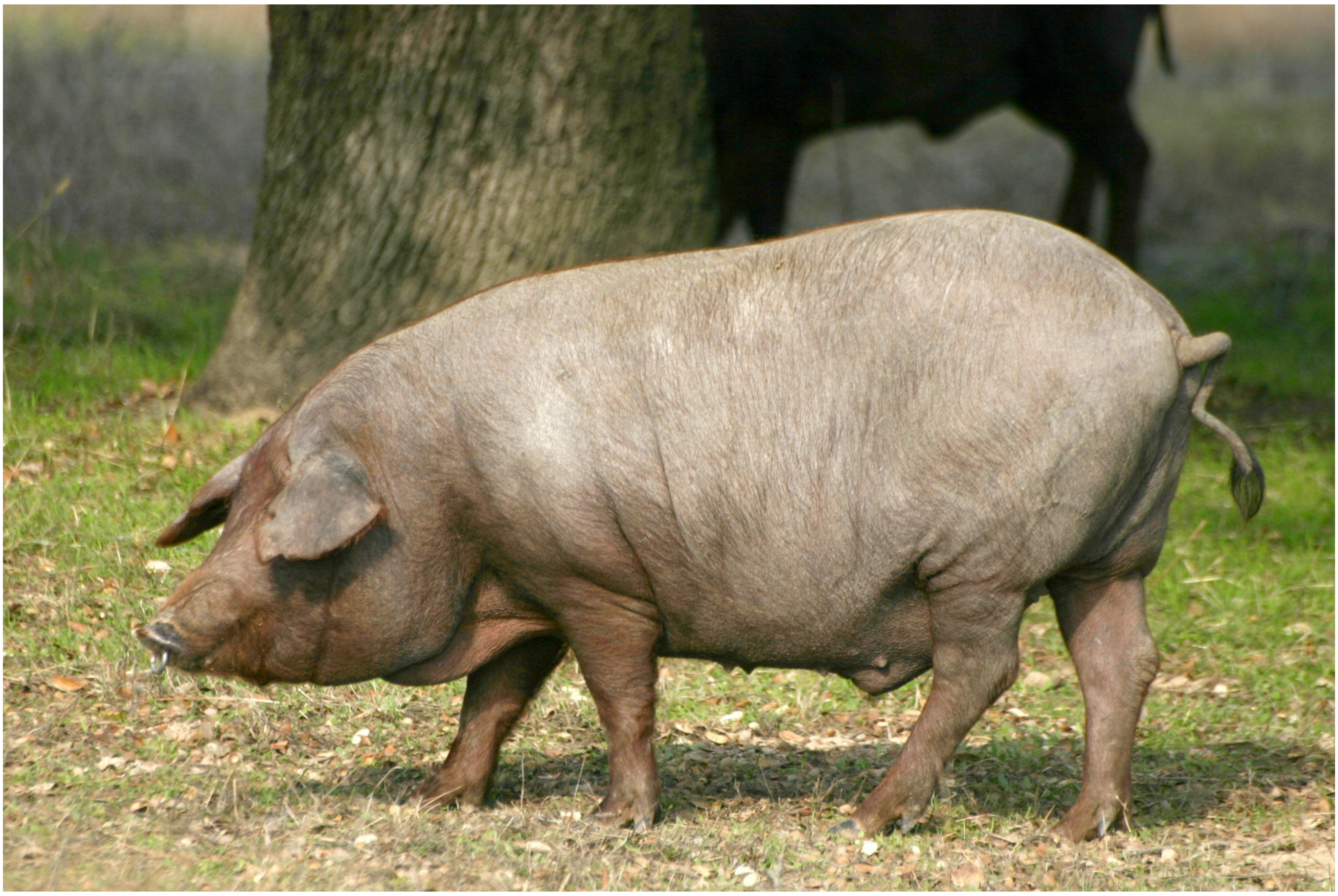

FIGURE 5.14. Detail of an Iberian pig shearling feeding on acorns and grass in a typical Spanish holm oak dehesa.

the conservation of some pure-bred lineages. Today, the Spanish regulation requires different labelling for products from pure-bred (100%) Iberian pig and cross-bred Iberian pig (50-75%).

Iberian pigs may be fattened in enclosures through concentrate feeding (intensive management). Indeed, most Iberian pigs are fattened with concentrates until they reach the age of one year. However, some of them are managed through extensive herding in *dehesas* for the last 3-4 months of their life: October-January, when acorns are easily available on the ground under the trees. This last phase is called *montanera*. Over the *montanera* period Iberian pig herds move freely throughout the dehesa system and feed on acorns (rich in carbohydrates and fats) and green grass (rich in protein and saturated acids: oleic, linoleic and some others). During that period they may gain 60-70 kg of live weight while producing a highly valuable and appreciated meat. To do so, animals should reach the age of one year and a live weight of 70-100 kg. Not less, but also not more, because they would not be able to gain more weight in such a short period of time (Figures 5.15 and 5.16). These animals are called shearlings. They are also castrated and nose-ringed, with the aim of avoiding damages to grassland by rooting. Acorn consumption per animal is related to its weight, with an average of 6-10 kg of acorns per animal and day, with an additional intake of, at least, 3 kg of grass. It is usually necessary to consume 10-15 kg of acorns for each 1 kg gain in live weight, and the daily weight gain is typically 0.5-1 kg/day (Benito et al., 2006). The usual acorn consumption over the *montanera* phase is 500-800 kg. Therefore, stocking rates usually vary between 0.5 and 1 shearlings/ha. The final product of this extensive highest quality system is labelled as *bellota* (acorn) Iberian pig. However, the amount of acorns available is, in many cases, insufficient to obtain commercial weights in the herd of pigs. In these cases an alternative method, known as "*recebo*", is used. This consists of giving the pig a supply of an additional specific feed (Benito et al., 2006). In 2012, the number of Iberian pigs in Spain was 4.17 Million (M): 0.52 M were pure Iberian breed and 3.65 M cross-breed (with Duroc). Around 0.96 M head were fed on the *dehesa* system: *bellota* and *recebo* (MAGRAMA, 2015a).

Best quality acorns are provided by holm oak (*Quercus rotundifolia*, or *Quercus ilex* subsp. *ballota*). However, other Mediterranean *Quercus* species, which may form mixed woodland with holm oak, also provide acorns (Gea et al., 2006). The earliest acorn yield comes from *Quercus faginea* while the widest seasonal distribution of acorn yield is provided by cork oak (*Quercus suber*). *Quercus pyrenaica*, a sub-Mediterranean oak, may also contribute to the acorn yield in somewhat cold *dehesas*.

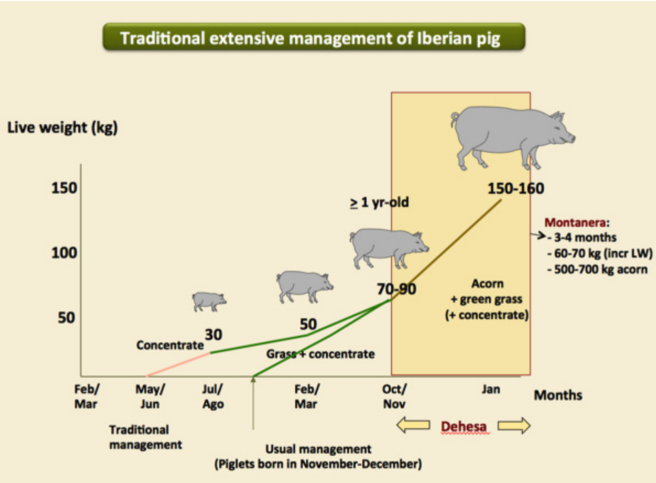

FIGURE 5.15. Iberian pig traditional extensive management in the dehesa system.

The distribution of Iberian pig numbers is concentrated in southwestern Spain: 60% in Extremadura, 30% in Andalusia and 10% in other Autonomous Communities (MAGRAMA, 2015a).

The increase of concentrate prices has resulted in a more expensive fattening transition from piglet to shearling, and that situation, together with the recent economic crisis, has led the Iberian pig sector to a steady decline over recent years.

5.2.5. Equids

Equids include horses, donkeys and mules. *Equus hydruntinus*, also known as zebro, was an Iberian wild horse that might have become extinct as late as the 16th Century. Equids are not ruminants. They are monogastric animals: have a single stomach and small intestine layout, and a ruminant-like fibre fermenting, large volume hindgut for microbial digestion. That is why they may feed on low-nutrient fibre-rich roughages and show different feeding preferences than ruminants: they behave as grazers and might be considered as grassland improvers since they may feed on rough grass rejected by other livestock species. They are also extremely resistant to severe climatic conditions and are probably the only livestock species able to survive by itself throughout the year in upland pastures of Spain (Figure 5.17). That is also why they are the livestock type with the highest percentage of wolf attacks in northwestern Spain.

In Spain, equids have been used for millennia as draught animals. However, horse meat is not generally eaten in Spain. Their use for meat production is only marginal: 11,096 t (carcass weight) and 46,400 slaughtered animals with a decreasing trend (MAGRAMA, 2015b). This is why their numbers have dropped so dramatically (some 90%) over the last century (Table 5.1., Figure 5.1). However, Spain exports meat horses (both live animals and slaughtered meat) for other European markets, mostly from its northern provinces.

5.3. Wild ungulates

Many studies have documented the extinction of several Mediterranean wild ungulate species and the intense population decrease of the remnants due to human causes along the Holocene, and especially during certain periods (Blondel and Aronson, 1999; Tsahar et al., 2009). However, that trend changed dramatically in Spain during the last decades of the 20th century. Since then, the numbers of most wild ungulate species increased significantly as a result of both increase in density and range expansion (Gordon et al., 2004; Milner et al., 2006; San Miguel et al., 2010; Herruzo and Martínez-Jauregui, 2013; Perea et al., 2014). The most important causes for this shift are related to social and economic changes. One of them was the abandonment of traditional landscape management models and the sudden decrease of human density in rural areas. That situation promoted natural succession, shrub encroachment, expansion of forest land and, hence, a higher availability of shelter and food for wild ungulates. The result was both the recovery of native populations and the

FIGURE 5.16. Iberian pig herd roaming freely and feeding on acorns and grass in November in a typical Spanish dehesa.

FIGURE 5.17. Horse herds grazing freely on summer upland pastures in the Cantabrian mountains (northern Spain).

spontaneous re-colonization of long lost ranges. Another major cause was an exponential increase in the demand for wild ungulate hunting and watching throughout most European countries (Milner et al., 2006). Thus, wild ungulates suddenly became a major economic resource for many European regions, and in particular for Spain (Gordon et al., 2004; Herruzo and Martínez-Jauregui, 2013). As a result, many landowners contributed to the increase of their numbers both through re-introduction and through habitat and population management (sometimes quite sophisticated and intensive), with the main goal of increasing both animal density and trophy quality.

We lack sufficient knowledge about regional censuses for every wild ungulate species in the Mediterranean region. However, wild boar (*Sus scrofa*) (Figure 5.18) is probably the species showing the highest increase both in numbers and in range; and both at a European and at a Mediterranean scale. Its common Spanish name is *jabalí* (derived from the Arabic language خنزير جبلي - (ḫinzîr) (ğabalî), which means mountain pig. It is an omnivore and is well adapted to an extremely wide range of ecological conditions. In addition, wild boars may breed twice a year, producing litters of 4-6 piglets, so their populations may grow very quickly. In Spain the annual harvest of wild boar has increased tenfold during the last 35 years (Figure 5.2), and the species is now found in nearly all environments: from the high Pyrenees, on alpine pastures over 2,400 m asl, to Europe's most arid environments located in SE Spain, where the species thrives in esparto (*Stipa tenacissima*) grasslands. As a consequence, wild boar overpopulation is a growing problem, causing many different conflicts: severe damages to agricultural crops, natural grasslands (Bueno et al., 2009), biodiversity, parasites and diseases, traffic collisions and many other aspects. Indeed, severe concerns have been raised about wild boar sanitary status within the One Health Initiative (http://www.onehealthinitiative.com/) since it is considered a major reservoir and agent of transmission of infectious diseases (tuberculosis, brucellosis, Aujeszky, foot and mouth disease, anthrax and some others) that also affect livestock (epizootic diseases) and, even, humans (zoonoses). Prevalence of tuberculosis in wild boar populations in south-central Spain has increased over the last decade and is currently affecting over 63% of individuals (Gortázar et al., 2006; Vicente et al., 2013; Barasona et al., 2014).

Red deer (*Cervus elaphus*) is also a very important big game species in Spain (Figure 5.19). Its common Spanish name is *ciervo*. Its populations reached a minimum in the early 20th century, when it was only present in south-central Spain with very low densities: under 1 ind/km^2. However, the species has recovered long lost ranges over the last decades and red deer numbers have also increased dramatically (Figure 5.2). Its annual harvest has increased by eightfold during the last 35 years (Herruzo and Martínez-Jauregui, 2013). In much of Mediterranean Spain deer populations have become overabundant and ecologically unsustainable due to their impact on flora and vegetation (San Miguel et al., 1999; Perea et al., 2014) and its condition of wild host of parasites,

FIGURE 5.18. Wild boar (*Sus scrofa*): the most abundant and important big game species in Spain.

FIGURE 5.19. Red deer (*Cervus elaphus*) stag in the rutting season in central Spain.

causing major epizootic and zoonotic diseases (Gortázar et al., 2006). Red deer behave as opportunistic feeders: they graze when green nutritive grass is available but may browse heavily during hunger periods: summer and winter. Due to the lack of natural predators, deer populations usually grow some 20% each year. Usual densities are around 30-50 ind/km^2 (sometimes even more) in south-central Spain, where big game estates are frequently fenced, and 4-10 in northern Spain, where they are not fenced (Acevedo et al., 2008). Red deer population management is becoming more and more artificial (e.g.: supplementary feeding and watering, genetic selection and improvement, habitat management and sanitary practices) each year with the aim of achieving ever better trophies, especially in Mediterranean Spain. Indeed, there is concern about the loss of genetic purity of the Spanish red deer: *Cervus elaphus* subsp. *hispanicus*, so analyses of mitochondrial DNA are being carried out with the aim of certifying hunting trophies.

FIGURE 5.20. Roe deer (*Capreolus capreolus*) young male.

Roe deer (*Capreolus capreolus*) is a small forest ungulate native to Spain (Figure 5.20). The species is known as *corzo* in Spanish. Its range and population densities have also increased over the last decades as a consequence of the abandonment of rural areas and the reduction in hunting pressure. Maximum densities, over 20 ind/km^2, have been recorded in the Cantabrian Mountains (Fandos and Burón 2013). However, they have dropped dramatically over the last five years, probably due to a mortality increase related to a fly parasite (*Cephenemyia stimulator*). Roe deer females may give birth to 1-3 offspring each year. However, as a result of its territorial behaviour, small size, competition with red deer and presence of natural predators, there seems to be no problem of overabundance. Roe deer mostly behave as generalistic browsers, although they may consume substantial quantities of grasses in open landscapes (Abbas et al. 2013). In fact, roe deer have recently colonized agricultural lands, particularly in the Spanish plateaus, where densities are increasing significantly (Fandos and Burón 2013).

Fallow deer (*Dama dama*) are also wild ruminants belonging to the family Cervidae (Figure 5.21). Its common Spanish name is *gamo*. They were present in the Iberian Peninsula until the last Ice Age. However, the species disappeared and was re-introduced in ancient and recent times. Today, its populations are widespread all over Spain, from the Pyrenees to southwestern Spain (i.e. Doñana National Park). However, their densities are seldom very high. Fallow deer mostly behave as grazers, even though it may compete with red deer for limited feeding resources, such as acorns.

FIGURE 5.21. Fallow deer (*Dama dama*) male (buck).

The **Iberian ibex (*Capra pyrenaica*)** is the most important big game species belonging to the Family Bovidae in Spain (Figure 5.22). Its common Spanish name is *cabra montés*. It is indeed the most highly valued big game trophy in Spain. The species is endemic of the Iberian Peninsula, with four subspecies. Two of them (*C. p. lusitanica* and *C. p. pyrenaica*) became extinct in recent times, the latter very recently, in the year 2000. The other two subspecies (*C. p. victoriae* and *C. p. hispanica*) were also on the verge of extinction but currently have healthy populations in mountain ecosystems all over the Iberian Peninsula: *C. p. victoriae* usually thrives on acidic lithologic substrates and *C. p. hispanica* on basic soils. Indeed, *C. p. victoriae* was also introduced in the French Pyrenees in 2014. The Iberian Ibex is an opportunistic feeder that may browse heavily during hunger periods. That is why high densities (over 20 ind/km^2) may result in serious impacts on threatened flora and woody vegetation (Perea et al., 2015). Adult females usually give birth to one kid in late May or June, so annual population growth is usually around 20%.

FIGURE 5.22. Spanish Ibex (*Capra pyrenaica victoriae*): male herd (top) and female with young kid (bottom).

Chamois (*Rupicapra pyrenaica*) is another small wild bovid species native to high mountains of northern Spain (Figure 5.23). There are two subspecies: *R. p. parva* in the Cantabrian Mountains and *R. p. pyrenaica* in the Pyrenees. Their common Spanish names are *rebeco* in the Cantabrian Mountains and *sarrio* in the Pyrenees. Both subspecies behave as grazers and contribute to the conservation of natural upland grasslands (Aldezábal et al., 2002). Females give birth to 1(2) kids in late May or June. However, annual population growth is uncertain, and usually low, as a consequence of high natural mortality due to accidents and predation on youngsters. Population densities usually vary between (2) 5 - 10 (20) ind/km^2.

The **mouflon (*Ovis orientalis musimon*)** is a wild sheep native to Asia (Figure 5.24). It was introduced in Corsica, Sardinia and Cyprus in ancient times where it became a feral species. It was then introduced in Spain in the 20th century as a big game species. Its typical habitat is low mountains and open woodlands. The horns of mature rams are curved, sometimes in almost one full revolution. Adult females produce one to two offspring and may lamb twice a year, even though it is not frequent. Their annual population growth may be over 30%. However, natural mortality and predation on youngsters compensate for a significant part of that growth. The species mostly behaves as a grazer and population densities are rarely over 20 ind/km^2.

FIGURE 5.23. Spanish Chamoix (*Rupicapra pyrenaica*): *R. p. parva* (left) and *R. p. pyrenaica* (right).

FIGURE 5.24. Mouflon (*Ovis orientalis musimon*).

FIGURE 5.25. Aoudad (*Ammotragus lervia*): ram and ewe.

The **aoudad or Barbary sheep (*Ammotragus lervia*)** (Figure 5.25) is a wild caprine native to arid and semi-arid environments of northern Africa, where the species has been listed as Vulnerable in the IUCN Red List of Endangered Species. Adult males may weigh up to 160 kg. The aoudad was introduced in Murcia (southeastern Spain) in 1970 and later in La Palma, Canary Islands, with the aim of increasing the diversity of big game species. Today, it is considered an alien invasive species in Spain. It behaves mostly as a grazer, even though it may browse in times of green grass shortage (Fernández-Olalla et al. 2016). Ewes may produce one, two or even three offspring each year, so their annual population growth may be around 30%. Their current population density in Sierra Espuña, Murcia, is around 7 ind/km^2 (San Miguel, 2015).

6. CONCLUSIONS

As a consequence of its high ecological diversity and long history of human activity, pastures cover a high percentage of Spain´s land.

Natural meadows, different types of rough grasslands and rough grazing rangelands cover about 18% of the Spanish territory: 9 Mha. However, since Spain is a Mediterranean country where green grass is scarce in summer and winter, browse is also an important source of forage for both livestock and wildlife. Therefore, scrubland, woodland and forestland (20 Mha), are also widely used by livestock and wild ungulate rearing systems. Cultivated pastures (fodder crops, stubble, by-products and fallow land) provide food for both extensively and intensively managed livestock as well as, sometimes, for wild ungulates. Lucerne and other legumes are the most important fodder crop type followed by winter cereals and maize.

Extensive livestock rearing has been an essential activity in the Iberian Peninsula for, at least, 4-5 millennia. It has been both an engine for economic and social development and an essential tool for landscape modeling. Sheep have been the most important livestock species. Goat herds were also used particularly to take advantage of scrubland, rough grasslands and rough grazing rangeland for milk and meat production. Cows were mostly used as draught animals and some indigenous pig breeds, such as the Iberian pig, were also managed through extensive herding, mostly to take advantage of forest fruits.

Since the second half of the 20th century, supplementary feeding with concentrates became a widespread alternative for livestock feeding. This allowed an increase in cattle rearing for meat and milk production and favored the introduction of highly productive livestock breeds, increasing meat and milk yields. Moreover, Spain´s integration in the Common Agricultural Policy (CAP) resulted in deep changes in livestock management regimes. Nowadays, extensive livestock management is decreasing due to social and economic reasons and lack of shepherds, while intensive management aimed at meat production has increased substantially. Intensive management for milk production is now facing a difficult time because of market globalization.

The reduction of extensive livestock farming in Spain is causing severe conservation problems. These include shrub encroachment, risk of wildfire, reduction of biodiversity levels, degradation or disappearance of protected grassland habitat types, and homogenization of landscapes.

Unlike extensive livestock farming, wild ungulate populations have vastly increased over the last five decades as a result of three major causes: an outstanding growth of big game demand (wild ungulates have become a major economic resource), rural abandonment and a parallel increase of protected areas. Although they contribute to Sustainable Rural Development, wild ungulate populations are also raising conflicts related to overabundance and animal and human health (epizootics and zooneses) since ungulates may act as disease vectors and reservoirs.

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2

IN MEMORIAM

IN MEMORIAM

Pedro Montserrat

Todos los que conocimos a Pedro Montserrat y especialmente quienes lo hicieron a través de la SEEP, constataron su interés apasionado por los pastos y la ganadería. Esta predilección parecería natural y poco relevante porque, al fin y al cabo, ese era el tema central de la investigación promovida por la Sociedad de la que había sido inspirador y cofundador.

Pero Montserrat provenía de las disciplinas de Ciencias Naturales y su gran vocación y objeto de sus primeras investigaciones, allá por los años cincuenta del pasado siglo, era la botánica que podríamos considerar más clásica, es decir la florística, la corología, la autoecología y la taxonomía de las plantas. En aquella época, y aun después a lo largo de varias décadas, el "pastoreo" apenas era considerado en el entorno académico de la Biología, la Fitosociología y la Ecología vegetal de nuestro país más allá que como un "agente perturbador" de las comunidades vegetales, y el estudio de los herbívoros domésticos, desde cualquier perspectiva, se consideraba ajeno a la investigación en esos ámbitos.

Fue D. José María Albareda, destacado edafólogo, organizador y primer Secretario General del CSIC, quien en 1954 le solicitó con autoridad ineludible ***("era una súplica que consideré una orden")*** la dedicación al estudio de los pastos. Esa encomienda emanaba de la visión pragmática de Albareda que juzgaba prioritario el avance de la pascicultura en una época en que nuestro país, sumido en la autarquía económica de una larga posguerra, necesitaba con urgencia la mejora de su producción primaria. En esa tesitura, Montserrat, que de esa disciplina únicamente tenía experiencia en la cunicultura doméstica practicada en su juventud, hubo de empezar desde cero y tuvo que aplicar su conocimiento de la ecología de las plantas que iba a resultar innovador y de extraordinaria utilidad.

Durante su estancia en Inglaterra en 1954, alternó estudios de taxonomía botánica con la ecología y mejora de las comunidades pratenses y entró en contacto con destacados científicos que influyeron decisivamente en su formación. Cuando recordaba a sus compañeros fundadores de la SEEP siempre repetía la gran influencia y ayuda que recibieron de William Davies, el agrónomo posiblemente mejor conocedor del tema en el Reino Unido de aquellos años y también miembro fundador de la Brittish Grassland Society. Le entusiasmaba el esquema británico de reuniones en el que había un congreso con comunicaciones escritas y otro de verano (el **"summer-meeting"** que tantas veces mencionaba) en el que se priorizaban las visitas a las explotaciones. Otra zona que reconocía muy interesante era todo el valle del Poó, donde Giovanni Haussman había tenido mucho éxito con el trébol blanco ladino y estudiaba por aquellos años las muchas posibilidades de las alfalfas. Con David Crespo hablaba con entusiasmo del éxito del pastoreo continuo de ovejas en los "montados" portugueses y de las condiciones del suelo y su contenido en fósforo, se entendía muy bien con J. Katznelson de la Universidad Hebraica de Haifa. Otros recuerdos y personajes podrían ampliar este espectro de relaciones multifuncionales que ya empezó en los prados de la Seu d'Urgell y la Cooperativa del Cadí y cuya sistematización de los grupos funcionales ensayaron con éxito con Fernando González-Bernáldez. La mención de otros colegas investigadores con los que tuvo estrecho contacto resultaría aquí prolija y causaría un grave riesgo de olvidar a alguien importante.

Tras su regreso a España, Montserrat recorrió, entre 1955 y 1960, Madrid, Extremadura, Salamanca, Cantabria, Navarra y Aragón, trabajando para el Patrimonio Forestal del Estado en parcelas experimentales, a la búsqueda de especies bien adaptadas a siega y pastoreo en clima y suelo muy variado, con el fin de mejorar la producción vegetal y, por ende, la de leche y carne. En 1956 escribió "Los Pastizales aragoneses" que constituye el primer intento de análisis de la interacción pasto-herbívoro realizado en nuestro país. Además, durante estos viajes y en la exploración botánica del Valle del Ebro asistiendo a J. Braun-Blanquet y O. de Bolòs, conoció los modos de explotación y manejo del ganado y se interesó por la impronta humana en el paisaje y el modelado de la vegetación por los animales que quedó reflejado en numerosos artículos y sintetizado en el escrito de carácter divulgativo “La cultura que hace el paisaje”. La lectura de este librito quizás constituya el mejor atajo para acercarse a su obra.

Se ha destacado a menudo la introducción por Montserrat del vocablo “agrobiosistema” que añadía los sistemas humanizados a los que hasta entonces se estudiaban y consideraban prístinos e incluía la actividad humana en los “factores bióticos” que definen el entorno natural. Pero dejando a un lado el término, que se extendió con cierta fortuna en los ambientes nacionales de la ecología terrestre, la aportación de Montserrat fue la de “internalizar” la actividad agropecuaria en la interpretación de la estructura, la función y la dinámica de los ecosistemas. Y más en detalle, si hubiera que elegir un concepto para vincularlo a su visión de la ecología, sería el de la “explotación a través del consumo”, como eminente motor y escultor de los paisajes naturales y, por supuesto, de los humanizados: ***“La esencia de los ecosistemas terrestres es el consumo, materializado por unos consumidores organizados con eficacia a lo largo del tiempo”***. Este mismo principio, derivado de la ecología trófica, el del consumo y renuevo en la dinámica de los pastos, resulta primordial para interpretar y tratar de equilibrar explotación y conservación: ***“conservar exige renovar”***. Estas y otras ideas de Montserrat, maduradas de forma personal o exprimidas oportunamente de los destacados colegas que ya hemos mencionado con los que compartió su trabajo investigador, pueden parecer hoy banales para quienes conocen a fondo los entresijos de la ecología moderna, pero cabe reflexionar sobre lo mucho que, más allá de los conceptos insignes del ideario “montserratiano” queda por estudiar, experimentar y aplicar.

El legado científico de Montserrat ha sido ya reseñado de forma detallada y está disponible en distintas publicaciones y la mera mención de sus aportaciones a la pascicultura hubiera requerido varias páginas. En esta breve reseña hemos pretendido únicamente destacar algunas de las contribuciones de D. Pedro durante las seis largas décadas de su intensa dedicación investigadora. Pero, más allá de las vicisitudes y méritos profesionales, no queremos terminar sin resaltar, por inhabituales en el mundillo de los científicos, dos aspectos del personaje: El primero su inquietud y compromiso permanente, hasta el final de sus días, con los “problemas ambientales y socioeconómicos” en general y, sobre todo, con los de los habitantes de las montañas (***“siempre intenté “aplicar” los conocimientos botánicos y ecológicos”***) como queda patente en sus artículos divulgativos en prensa que escribió hasta bien cumplidos los 97 años y en los que sugirió muchas propuestas cargadas de ilusión (***“me gustaría ser joven para verlo”***). El segundo, que sin duda suscitará el recuerdo y el acuerdo unánime de los colegas de la SEEP, la bondad en su carácter y comportamiento que sedujo a sus numerosos discípulos, colaboradores y amigos y le procuró longevidad y una vejez sosegada, activa, productiva y plena de emociones.

Daniel Gómez y Federico Fillat

PASTOS

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RESEÑAS DE TESIS DOCTORALES

■ **Autor:** Santiago Lledó Gómez.
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Director: Dr. Óscar Santamaría Becerril.
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Resumen

La dehesa es un ecosistema muy importante en el suroeste de la Península Ibérica tanto por la gran extensión que ocupa, alrededor de 1,3 millones de hectáreas en Extremadura, como desde un punto de vista social, ecológico y económico. Los tres componentes esenciales de la biocenosis de este ecosistema, y sobre los que más se ha estudiado, son el ganado (doméstico y silvestre), el estrato arbóreo y al estrato herbáceo. Sin embargo, existe un cuarto componente, la micoflora endofítica que, aunque no se le haya prestado especial atención, tiene gran importancia en muchos aspectos de la producción vegetal y animal de la dehesa, e influye en gran medida sobre los otros tres componentes. Los hongos endofíticos, que aparecen en el interior de la mayor parte de los vegetales, durante todo o parte de su ciclo vital, en numerosas ocasiones provocan un efecto beneficioso sobre las plantas hospedantes, aumentando su valor adaptativo, particularmente en condiciones de estrés y protegiéndolas frente a enfermedades y/o patógenos. Esto hace que en muchos casos tengan una gran influencia sobre las producciones de la biomasa herbácea y la calidad de éstas, alterando las características bromatológicas y nutritivas o produciendo sustancias tóxicas para el ganado.

Por tanto, viendo la importancia del ecosistema dehesa en el suroeste peninsular y la gran influencia de los endófitos sobre las producciones herbáceas y las calidades de éstas, los principales objetivos del presente trabajo fueron: (1) Identificar y caracterizar la micobiota endofítica de dos especies de leguminosas características de los pastos de la Dehesa Extremeña y determinar cómo influyen los factores edafoclimáticos y la especie hospedante sobre su abundancia y diversidad específica; (2) Determinar la influencia de las especies endofíticas más abundantes sobre la producción y determinados parámetros de calidad del pasto (proteína, fibra, lignina, digestibilidad, nutrientes, etc.); (3) Evaluar el efecto antagonista de hongos endofíticos sobre algunos patógenos fúngicos y analizar la influencia de la asociación endófito-patógeno en su patogenicidad en planta (Lolium rigidum), producción de materia seca y calidad del forraje.

Para ello se procedió a la recolección de muestras de *Trifolium subterraneum* y *Ornithopus compressus* de cinco deheses de Badajoz y cinco dehesas de Cáceres, con condiciones ambientales diversas. Estas muestras se esterilizaron y se sembraron en placas Petri, de donde se aislaron los endófitos. Se identificaron molecularmente y morfológicamente. De todos estos endófitos se seleccionaron los más característicos y se inocularon sobre *Trifolium subterraneum*, *Ornithopus compressus* y *Poa pratensis* en condiciones de invernadero, y además sobre *T. subterraneum* en condiciones de campo. Justo antes de la floración se procedió a su recolección, para determinar el contenido en biomasa radicular y aérea, parámetros de calidad, contenido en cenizas y minerales. Por último para ver el efecto antagonista del endófito sobre dos patógenos (*Biscogniauxia mediterranea* y *Fusarium moniliforme*) se realizó un ensayo en el que se vio el efecto del filtrado de los hongos endófitos sobre el crecimiento de los patógenos considerados y la germinacion de esporas de Fusarium moniliforme. Posteriormente se realizó un ensayo en condiciones de invernadero sobre *Lolium rigidum* para ver el efecto de la asociación endófito-patógeno y cómo influye en la calidad del forraje.

Disponible en:
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■ **Autora:** Maite Gartzia Arregi.
Título: Evaluación de cambios en los pastos del Pirineo central y su relación con los componentes agropastorales.
Universidad/Departamento/Programa: Universidad de Zaragoza. Geografía y ordenación del territorio. Ordenación del Territorio y Medio Ambiente.
Directores: Dr. Fernando Pérez Cabello y Dra. Concepción López Alados.
Fecha de Lectura: 01/07/2016.

Resumen

Tanto los pastos naturales, determinados por las condiciones ambientales y la fauna herbívora silvestre, como los seminaturales, asociados a la actividad ganadera (Hejcman et al. 2013), proporcionan valiosos servicios ecosistémicos para el bienestar humano (Bernués et al. 2014). Sin embargo, su extensión y estructura están cambiando con gran rapidez (Millennium Ecosystem Assessment 2005). Los motores de cambio -usos del suelo y climáticos- que están alterando las propiedades de los pastos, parecen no tener freno en las actuales circunstancias socioeconómicas y ambientales (Vicente-Serrano et al. 2005, Wehn et al. 2011, Mariotte et al. 2013).

Con el fin de proporcionar información a los actores del territorio para una correcta gestión de los pastos, se han cartografiado y cuantificado los cambios ocurridos en el espacio y tiempo. Se han estudiado la matorralización, las variaciones en la biomasa y el verdor, y la pérdida de conectividad de los pastos del Pirineo Central Aragonés entre las décadas de 1980 y 2000. Para ello se ha partido de la información obtenida de las imágenes Landsat-5 Thematic Mapper y mediante la clasificación supervisada (Gartzia et al. 2013) y vectores multitemporales, se han detectado dichos cambios (Gartzia et al. 2016b). Posteriormente, se han identificado los factores y componentes de carácter socioeconómico, ecológico y ambiental responsables de ellos.

Una alta precisión en la clasificación supervisada de las comunidades vegetales de montaña, nos permitió identificar por un lado, cómo por debajo de los 2100 m se había matorralizado la cuarta parte de pastos ralos y casi una cuarta parte de pastos densos, siendo la cercanía a las comunidades leñosas el factor limitante (Gartzia et al. 2014). Además, en los pastos densos, este proceso viene condicionado por factores antrópicos, mientras que en los pastos ralos por los topográficos. Por otro lado, una tercera parte del matorral ya existente, se había poblado de árboles. También se detectó un incremento de la biomasa y el verdor en el 60 % de los pastos densos, debido a factores ambientales relacionados con el calentamiento global y exacerbado por la reducción de la presión ganadera, sobre todo en zonas altas y de difícil acceso (Gartzia et al. 2016b). Opuestamente, el descenso tuvo lugar en menos del 5 %, en áreas localizadas relacionándose con factores antrópicos: cargas ganaderas altas o construcción de infraestructuras. Los componentes ambiental y de pasto del sistema agropastoral se relacionaron con la pérdida de conectividad de los pastos debido a la matorralización y el incremento en biomasa y verdor, mientras que los componentes económico y geolocalización se relacionaron con la pérdida de conectividad debida a la disminución de la biomasa y el verdor (Gartzia et al. 2016a). El actual escenario socioeconómico de las zonas rurales ha dado pie al sobrepastoreo de unos pastos (Paudel and Andersen 2010, Xu et al. 2014) y al abandono de otros (Sitko and Troll 2008, Brandt et al. 2013). Por lo que estos pastos, protegidos por la Directiva Hábitats de la Unión Europea, sin una buena gestión y planificación a medio y largo plazo por parte de todos los actores del sistema agropastoral, pueden verse reducidos o llegar a desaparecer (Antrop 2005).

■ **Autora:** Beatriz Arias Sánchez.
Título: Pastos y rebaños en los dominios de las órdenes militares en La Mancha, siglos XIII al XV.
Universidad/Departamento/Programa: Universidad de Castilla-La Mancha. Historia. Análisis territorial y patrimonio histórico.
Director: Dr. Francisco Ruiz Gómez.
Fecha de Lectura: 03/02/2016.

Resumen

El objetivo de esta tesis es el estudio de la economía ganadera en territorio de Órdenes Militares en La Mancha en época bajomedieval, y en concreto en la llamada Mancha Baja y su prolongación a Sierra de Segura. Esta zona es un espacio ganadero por excelencia donde confluyeron los intereses de las Órdenes y del Honrado Concejo de la Mesta. El hilo conductor e hipótesis de dicha tesis es demostrar el cambio económico de las Órdenes que pasaron de ser “grandes propietarias de rebaños” a “grandes arrendatarias de pastos”. Este cambio se va a analizar a través de un análisis de las zonas de pastos, destacando la importancia de las dehesas: su origen, desarrollo, evolución, y las repercusiones socioeconómicas que su explotación y aprovechamiento tuvieron para las Órdenes Militares en sus dominios manchegos bajomedievales. Completando esta información con la elaboración de un extenso catálogo de las dehesas de los dominios de las Órdenes en La Mancha.

En la primera parte, se analiza el asentamiento de las Órdenes Militares, y como éstas se comportan como agentes transformadoras y colonizadoras del espacio, un espacio, donde la actividad ganadera era importante tanto para los propietarios de rebaños como para los arrendatarios de pastos. En esta primera parte, se fija el marco geográfico sobre el que girará el estudio de las zonas de pastos de las Órdenes en La Mancha Baja y su prolongación a Sierra de Segura. En esta parte, también se analiza el origen de las zonas de aprovechamiento agropecuario, centrándonos en las dehesas y en donde se realiza una clasificación de éstas.

En la segunda parte, se estudia la evolución de los espacios de aprovechamiento ganadero, centrándonos especialmente en las dehesas, desde el siglo XIII al siglo XV. Analizando sistemáticamente las dehesas, situándolas en las diferentes villas, aldeas, y encomiendas de los diferentes dominios de las Órdenes y su incorporación en los bienes de las Mesas Maestrales. Se ha determinado

el número aproximado, su concentración, y en los casos que se ha podido su extensión. Posteriormente, se ha elaborado un catálogo de más de 150 dehesas repartidas por los Campos de San Juan, Calatrava, Montiel y la Sierra de Segura. Toda esta información se ha complementado con un cuadro donde se describe con detalle las características de cada dehesa y un gran número de cartografías.

En la tercera parte, se ha analizado los derechos señoriales que las Órdenes percibían por el ejercicio de su señorío, diferenciando aquellos relacionados con el señorío jurisdiccional (portazgos, montazgos…), y las rentas relacionadas con el señorío territorial, destacando las rentas que proporcionaban los arrendamientos y acensamientos de las dehesas a las Órdenes Militares. También se realiza un estudio de los diezmos que percibían las Órdenes. Estos cuatro tipos de rentas, entre otros, son los que forman la parte más importante de los ingresos de las Órdenes.

Por último, se han comentado las relaciones derivadas del ejercicio de su señorío, centrándonos en las comunidades de pastos; en los conflictos entre las Órdenes y los concejos de sus dominios, otros que enfrentaban a las diferentes dignidades de las Órdenes; conflictos con otras jurisdicciones señoriales cercanas, como los que surgieron entre las propias Órdenes, con el Arzobispado de Toledo, con la Hermandad Vieja de Ciudad Real, y con otros concejos realengos de fuera de sus jurisdicciones. Para finalizar, hay que citar los enfrentamientos entre los dominios de las Órdenes y el Honrado Concejo de la Mesta, debido fundamentalmente a la usurpación de cañadas y dehesas, que es una de las causas más frecuentes; por las imposiciones injustas y otras extorsiones; y por las disputas por la posesión de algunas dehesas.

■ **Autor:** Francisco De la Vega Galán.
Título: Calidad de la canal y de la carne de cabritos de las razas autóctonas Payoya y Blanca Andaluza en sistemas de pastoreo.
Universidad/Departamento/Programa: Universidad de Sevilla. Ciencias agroforestales. Zootecnia y gestión sostenible: ovino y caprino.
Directores: Dr. José Luis Guzmán Guerrero, Dr. Manuel Delgado Pertíñez, Dr. Luis Ángel Zarazaga Garcés.
Fecha de Lectura: 02/02/2016.

Resumen

En España hay actualmente un interés creciente en la conservación de razas autóctonas, como es el caso de las razas caprinas Blanca Andaluza (aptitud cárnica) y Payoya (aptitud lechera), en sistemas de producción basados en el pastoreo. Además existen numerosas iniciativas en países del área Mediterránea que afirman la viabilidad de la producción caprina ecológica utilizando técnicas de producción y gestión sostenible. De acuerdo con los requerimientos de la producción ecológica, las explotaciones de estas razas pueden ser fácilmente transformadas en explotaciones ecológicas. El estudio de las posibilidades de transformación de las explotaciones convencionales en sistemas de producción ecológica necesita del análisis de la calidad de sus productos. El objetivo general de esta tesis doctoral es evaluar el efecto del sistema de producción (convencional vs. ecológico) y del sexo sobre diferentes atributos de calidad de la canal, de la carne y de la grasa de cabritos lechales de las razas Blanca Andaluza y Payoya y así poder evaluar las posibilidades de conversión de los sistemas de producción caprina convencionales de sierra (basados en pastoreo) a ganadería ecológica.

Veinticuatro cabritos de partos dobles (12 machos y 12 hembras) fueron seleccionados de cada sistema de producción (convencional y ecológico) y de cada raza (Blanca Andaluza y Payoya). Los cabritos de raza Blanca Andaluza procedían de dos explotaciones de la Sierra de Huelva y los de raza Payoya procedían de dos explotaciones de la Sierra de Cádiz; en ambos casos una con sistema de producción convencional y otra ecológica. Se estudiaron la calidad de la canal, de la carne y de la grasa, así como la calidad sensorial de la carne.

Se encontraron diferencias significativas solamente en algunos atributos de la calidad de la canal y de la carne, en algunas características sensoriales y en algunos porcentajes de ácidos grasos del músculo y tejido adiposo de los cabritos lactantes en los sistemas de producción ecológicos y convencionales en ambas razas, probablemente debido a que las madres fueron alimentadas en un sistema semi-extensivo similar, basado en el pastoreo. Además, el bajo contenido en grasas y el perfil de ácidos grasos, especialmente el contenido en PUFA y la proporción de n-6: n-3 PUFA, de la carne de los cabritos criados en ambos sistemas de producción, estuvieron dentro del rango considerado como beneficioso para la salud humana, lo cual puede ser útil para la promoción de estos productos regionales. Debido a estas razones, las explotaciones convencionales podrían fácilmente transformarse en sistemas de producción ecológica.

Disponible en:
https://www.educacion.gob.es/teseo/mostrarRef.do?ref=1189431

Autor: Alberto Luis Cantoral González.
Título: Valoración de la influencia del manejo agro-silvo-pastoral como elemento clave en el mantenimiento de la biodiversidad y repercusión de su abandono en la conservación del territorio de montaña comprendido entre los ríos Esla y Porma por debajo de los embalses de Riaño y Porma (León).
Universidad/Departamento/Programa: Universidad de León. Biodiversidad y gestión ambiental. Biología Animal y Vegetal.
Directores: Dra. Marta Eva García González y Dra. Raquel Alonso Redondo.
Fecha de Lectura: 17/12/2015.

Resumen

El estudio de divide en dos partes. La primera aborda la caracterización florística, fitosociológica y paisajística de la zona. La segunda estudia los cambios en la estructura y funcionalidad del paisaje en los últimos 50 años mediante técnicas de teledetección. Para la caracterización del paisaje hemos establecido unidades fisionómico-seriales basadas en la Fitosociología dinámico-catenal. La flora y vegetación es rica y diversa, con elevado número de táxones (1420) y sintáxones (124), algunos de valor científico reconocido y/o amparo legal vigente: *Fritillaria legionensis*, *Paeonia mascula subsp. mascula*, *Quercus pauciradiata*, *Eriophorum vaginatum*, *Lathraea squamaria*, *Orthilia secunda*, *Atropa belladonna*, etc.

El estudio del paisaje empleando los Tipos de Vegetación Fisionómicos y Seriales, agrupados en Complejos Teselares, permite caracterizar la estructura y funcionalidad del paisaje de acuerdo a los conocimientos que aporta la Fitosociología dinámico-catenal. El paisaje del territorio en 1957 estaba dominado por formaciones herbáceas, aunque con una representación elevada de fisionomías fruticosas y fanerofíticas. El paisaje vegetal actual muestra una relación equilibrada de formaciones herbáceas, fruticosas y forestales, que aparecen en proporción 1/1,1/1. Estos cambios en el paisaje responden a la transformación en la relación del hombre con el medio. La desaparición de los cultivos de secano, de la ganadería guiada por pastor, de ciertas prácticas de manejo (riego de prados, quema de aulagas), o la sustitución del ganado menor por el mayor; modificaciones más importantes en los factores de perturbación sobre el paisaje.

La modelización del cambio amplifica en el tiempo las tendencias observadas, augurando un paisaje dominado por masas forestales, con una baja proporción de perennigraminedas. Este marco predictivo presume un incremento en el estado de conservación basado en el índice de distancia a la potencialidad, pero una disminución en la diversidad del territorio. Esta tendencia representa una oportunidad para las especies vegetales esciófilas y las comunidades fanerofíticas, en detrimento de los táxones y sintáxones propios de espacios abiertos. El balance es negativo, ya que el cambio en la configuración del paisaje perjudica a un mayor número de especies y comunidades vegetales de las que pudieran verse favorecidas, proporción que se agrava al ponderar el grado de amenaza de las especies o el carácter prioritario de las comunidades implicadas.

La estructura del paisaje actual, equilibrada y diversa, proviene de un escenario variado dominado por pastos y tiende, a corto plazo, a un ambiente homogéneo imperado por formaciones boscosas. El mantenimiento de la configuración actual requiere la intervención sobre el medio a través de mecanismos que mantengan la proporción de comunidades subseriales, especialmente las menos estables: pastos y mosaicos de fruticeda con pasto. La ganadería diversificada y guiada por pastor lograba eficientemente conservar este paisaje frágil, en vías de desaparecer tal y como hoy lo conocemos.

La forestación de tierras agrícolas (prados y pastos) o la plantación de especies arbóreas en los puertos de montaña son prácticas impactantes e incoherentes con la dinámica natural. Se debería reinvertir los esfuerzos económicos y humanos en objetivos consecuentes con la conservación de los valores ambientales de la montaña cantábrica.

INSTRUCCIONES PARA AUTORES

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La revista PASTOS admite artículos originales sobre la producción y utilización de pastos y forrajes, dentro de las áreas de conocimiento siguientes: recursos naturales (suelo, agua, clima, etc.) en los que se basa la producción de pastos y forrajes; ecología, nutrición, protección, selección, mejora, manejo y conservación de especies forrajeras y pratenses; nutrición, alimentación y manejo de animales; sistemas de producción animal con base en pastos y forrajes; aprovechamiento de pastos; impacto ambiental de las explotaciones ganaderas; estudios económicos; etc. El envío de un trabajo a PASTOS implica que sus autores no han enviado simultáneamente el mismo original a otra revista para su publicación.

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Los textos originales se escribirán utilizando el programa Word de Microsoft Office. No se requiere ninguna especificación en cuanto a formato (fuente de letras, espacios, etc). La extensión máxima de los artículos científicos será de 70.000 caracteres (sin espacios). Para las revisiones científicas y ponencias de reuniones científicas no hay un límite prefijado de caracteres.

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Los editores principales enviarán los originales recibidos a uno de los editores asociados del área al que corresponda el trabajo. El editor asociado asignará la evaluación a un mínimo de dos revisores anónimos externos y expertos en la temática.

ORGANIZACIÓN DEL TEXTO

Los artículos científicos tendrán la siguiente disposición:

- Título principal en idioma original (máximo 25 palabras)
- Título en segundo idioma (inglés o español)
- Título abreviado (para cabecera de páginas; máximo 50 caracteres con espacios)
- Nombre autor/es
- Dirección autor/es
- Correo electrónico del autor de contacto
- Resumen en idioma original
- Resumen en segundo idioma (inglés o español)
- Palabras clave en idioma original
- Palabras clave en segundo idioma (inglés o español)
- Introducción
- Material y métodos
- Resultados
- Discusión (o junto a Resultados)
- Conclusiones
- Agradecimientos
- Referencias bibliográficas

NOMBRE DEL AUTOR O AUTORES

Nombre completo y dos apellidos. La dirección de los autores incluirá la dirección postal completa. Si los distintos autores tienen direcciones diferentes, debe indicarse con un superíndice numérico.

Se señalará el autor para la correspondencia con un asterisco y una nota con su correo electrónico a continuación de las direcciones.

Ejemplo: Juan Fernández García*1, Antonio Gómez Ferrán1 y Raúl Andrés Sarmiento2

1 Área de Producción Animal. Facultad de Veterinaria. Universidad de Cádiz. Plaza de la Ciencia s/n E-25371 Cádiz (España).
2 Área de Ecología. Facultad de Biología. Universidad de Toledo.
E-45071 Toledo (España).
* jfgarcia@tmail.com

RESUMEN

Debe ser informativo, no indicativo, para permitir al lector apreciar el contenido e interés del trabajo. Debe informar sobre objetivos, metodología, resultados y conclusiones. En su contenido no debe haber referencias ni al texto, ni a las figuras, ni a las tablas del artículo resumido. Máximo de 300 palabras para artículos científicos y notas de investigación, y 450 para las revisiones científicas.

PALABRAS CLAVE

El resumen irá seguido de un máximo de cinco palabras clave que no estén contenidas en el título.

SUBAPARTADOS

Para los apartados “Material y Métodos”, “Resultados” y “Discusión”, se podrá estructurar el texto en unidades menores como subapartados jerarquizados.

TABLAS

Las tablas deben estar concebidas y estructuradas de tal modo que puedan leerse y entenderse por sí mismas, con independencia del texto. Se recomienda hacerlas con el procesador de

textos y nunca insertadas como imagen desde otro programa. Se situarán al final del texto, después del apartado de referencias bibliográficas, aunque los autores podrán indicar su preferencia de ubicación en el trabajo. Los títulos irán encima de las tablas.
Se traducirá al segundo idioma inmediatamente debajo del título en idioma original.

FIGURAS

Las figuras deben estar concebidas y diseñadas de tal modo que puedan leerse y entenderse por sí mismas, con independencia del texto. Se enviarán en formato JPG o TIF a una resolución mínima de 300 ppp, o como fichero de excel. Se indicará en el texto del artículo su lugar de inserción. Se recomienda que las figuras sean originalmente en color, pero cuidando que sean comprensibles en la escala de grises. El pie (título de la figura) no formará parte de la figura. Se escribirá a continuación de las tablas con la correspondiente traducción al segundo idioma.

FOTOGRAFÍAS

Se recomienda incluir dos fotografías que ayuden a entender mejor aspectos importantes del trabajo. Estas deberán enviarse como archivos TIF, JPG o PSD, con una calidad mínima de 300 ppp. Se publicarán en color. El pie (texto de la fotografía) no formará parte de la fotografía. Se escribirá en el texto a continuación de los pies de figuras con la correspondiente traducción al segundo idioma. Se recomienda especificar el autor de la fotografía.

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Todas las citas que aparezcan en el texto deben figurar también en el apartado de referencias bibliográficas, situado al final del texto, y viceversa.

1. Si el nombre/s del autor/es no forma parte del texto se citarán solamente los apellidos, sin iniciales, entre paréntesis, en letra minúscula, seguidos del año de la publicación, separado por una coma, en el lugar que corresponda.
   Ejemplos: Caso de un autor "...(Garcés, 1995a)...", caso de dos autores "...(Pérez y Marqués, 2005)...", caso de más de dos autores "... (Navarro *et al.*, 2010)..."

2. Si el nombre/nombres del autor/es forma parte del texto se pone el año entre paréntesis.
   Ejemplos: "...según los trabajos de Garcés (1995a), Pérez y Marqués *et al.* (2005), Navarro *et al.* (2010), ...".

REFERENCIAS BIBLIOGRÁFICAS (al final del texto)

Las referencias bibliográficas se ordenarán por orden alfabético de apellidos del autor o primer autor, si son varios. Para distintos trabajos de un mismo autor, o autores, se seguirá el orden cronológico del año de publicación. Si en un mismo año hay más de una publicación de un autor, o autores, se distinguirán añadiendo una letra al año de publicación.
Ejemplo: 2013a, 2013b.

Forma de presentación de las referencias al final del texto:

• Caso de revistas:

Formato:
APELLIDO/S INICIAL/ES [del nombre],...,...,... Y APELLIDO/S INICIAL/ES [del nombre] [de los autores] (año) Título del artículo. *Nombre completo de la revista [en cursiva],* volumen (número), primera página-última página (del artículo).

Ejemplos:
PÉREZ A. Y MARQUÉS C. (2005) Caracterización de un sistema productivo forrajero basado en el uso de recursos endógenos. *Pastos,* 27(2), 124-145.
NAVARRO A.M., REQUÉS G. Y FERNÁNDEZ-RICO V. (2013) Factores asociados al crecimiento de *Dactylis glomerata* L. bajo distintos niveles de fertilización nitrogenada. *Pastos,* 41(2), 1-14.

• Caso de libros de un solo autor o grupo de autores para toda la obra:

Formato:
APELLIDO/S INICIAL/S [del nombre],...,... Y APELLIDO/S INICIAL/S [del nombre] [de los autores] (año) *Título del libro [en cursiva].* Ciudad de la Editorial, País: Nombre de la Editorial.

Ejemplos:
ALONSO MARTÍNEZ J. (2008) *Los recursos forrajeros de la baja Extremadura.* Badajoz, España: Ediciones Alday.
JONES J., INGLISH J.K. Y SMITH A.S. (2012) *British grasslands under siege.* Wallingford,UK: Commonwealth Agricultural Bureaux.

• Caso de libros colectivos, con capítulos escritos por distintos autores:

Formato:
APELLIDO/S INICIAL/S [del nombre],...,... Y APELLIDO/S INICIAL/S [del nombre] [de los autores] (año) Título del artículo o capítulo. En: Apellido/s Inicial/s [del nombre],...,... y Apellido/s Inicial/s [del nombre] [de los editores] (Ed, si es solamente un editor, o Eds, si son dos o más editores) *Título del libro (en cursiva),* pp. primera página-última página (del artículo o capítulo). Ciudad de la Editorial, País: Nombre de la Editorial.
En el caso de que haya más de dos editores se pondrá solamente el primero seguido de las palabras *et al.*

Ejemplos [con uno o dos editores]:
SMITH A. (2010) Measuring productivity. En: Taylor B.J.F. (Ed) *Measures of pasture systems,* pp. 25-40. Bristol, Australia: Ferguson and Liar Ltd.
MARTÍNEZ N. Y RUÍZ M.T. (2002) Fuegos prescritos. En: García P. y Bosque M. (Eds) *Usos y problemática del fuego,* pp. 115-147. Ciudad Real, España: Verdeamor.

Ejemplo [con tres o más editores]:
GARCÍA-NAVARRO R., ALVARENGA J. Y CALLEJA A. (2009) Efecto de la fertilización fosfórica sobre la presencia de especies en el forraje de prados de montaña. En: Reiné R. *et al.* (Eds) *La multifuncionalidad de los pastos: producción ganadera sostenible y gestión de los ecosistemas,* pp 197-203. Huesca, España: Sociedad Española para el Estudio de los Pastos.

• Caso de recursos en internet:

En el caso de que la referencia bibliográfica tenga un acceso URL a su contenido, se recomienda especificarlo al final de la referencia con la fecha de consulta.

Ejemplo:
ALONSO MARTÍNEZ J. (2008) *Los recursos forrajeros de la baja Extremadura.* Badajoz, España: Ediciones Alday.
Disponible en: http://pastosextremadura.org/librorecursos.pdf.
Consulta: 14 abril 2013.

UNIDADES DE MEDIDA

Para las unidades de medida se seguirá el SI (Sistema Internacional de Unidades). En general, los símbolos se escriben en minúsculas, salvo si se trata de la primera palabra de una frase o del nombre "grado Celsius", quedando invariables en plural. Nunca los símbolos van seguidos de punto, salvo si se encuentran al final de una frase. En este caso el punto corresponde a la ortografía habitual de la frase pero no forma parte del símbolo (es incorrecto escribir kg., ha., km.).

El símbolo de litro será L cuando vaya precedido por un número y l cuando lo sea por un prefijo de fracción (ejemplo, ml). Cuando las unidades no vayan precedidas por un número se expresarán por su nombre completo, sin utilizar su símbolo. Ejemplos de símbolos comunes: kilogramo = kg, hectárea = ha, metro = m, kilómetro = km. (en este último caso el punto no forma parte del símbolo, se pone porque es final de frase).

Expresión algebraica de los símbolos de las unidades SI

1. Multiplicación. Cuando una unidad derivada está formada multiplicando dos o varias unidades, los símbolos de las unidades se separarán por un espacio. *Ejemplo:* N m.

2. División. Cuando una unidad derivada está formada dividiendo una unidad por otra, se puede utilizar una barra inclinada (/), una barra horizontal o exponentes negativos.
   Ejemplo: m/s o m s-1. No debe utilizarse la barra inclinada y los exponentes negativos en un mismo artículo. Hay que optar por uno de los dos.

3. Nunca, en una misma línea, debe seguir a una barra inclinada un signo de multiplicación o de división, a no ser que se utilicen paréntesis para evitar toda ambigüedad.
   Ejemplo 1: m/s2 o m s-2, son expresiones correctas, pero m/s/s, es incorrecta.
   Ejemplo 2: m kg/(s3 A) o m kg s-3 A-1, son expresiones correctas, pero m kg/s3/A y m kg/s3 A, son incorrectas.

NOTACIÓN NUMÉRICA

1. En el texto se utilizarán palabras para los valores de cero a nueve y cifras para los valores superiores.

2. Debe dejarse un espacio entre grupos de tres dígitos, tanto a la izquierda como a la derecha de la coma (15 739,012 53). En números de cuatro dígitos puede omitirse dicho espacio. Los números de los años deben escribirse sin separar el primer dígito del segundo (es correcto escribir año 2011). Ni el punto, ni la coma deben usarse como separadores de los miles.
   Ejemplo: el número ciento veintitrés millones trescientos veinticinco mil ciento setenta se escribe 123 325 170 (123.325.170 o 123,325,170 son formas incorrectas).

3. Las operaciones matemáticas solo deben aplicarse a símbolos de unidades (kg/m3) y no a nombres de unidades (kilogramo/metro cúbico).

4. Debe estar perfectamente claro a qué símbolo de unidad pertenece el valor numérico y qué operación matemática se aplica al valor de la magnitud.
   Ejemplo: es correcto escribir 35 cm x 48 cm o 100 g ± 2 g (35 x 48 cm o 100 ± 2g son formas incorrectas).

CIFRAS DECIMALES

Dentro del texto en español:
Se separarán de la parte entera por una coma abajo (,).
Ejemplo: 10,17 (10.17 es forma incorrecta).

Dentro del texto en inglés (summary):
Se separarán de la parte entera por un punto.
Ejemplo: 10.17 es correcto.

ABREVIATURAS

Las abreviaturas deberán definirse la primera vez que se mencionen en el texto (*Ejemplo:* "política agraria común (PAC)") y de nuevo en todas las tablas y figuras donde aparezcan.

NOMBRES DE PLANTAS, CULTIVARES, ETC.

El nombre botánico de las plantas se escribirá en cursiva, en letra minúscula, con excepción de la primera del género, que será mayúscula.

El nombre de las variedades comerciales, o cultivares, se escribirá con letra normal y entre comillas simples o bien con letra normal precedido de cv (símbolo de cultivar) cuando sigan al nombre botánico de la especie.
Ejemplo: Lolium multiflorum Lam. "Tama" o *Lolium multiflorum* Lam. cv Tama.

En el caso de cultivos de microorganismos se indicará la procedencia y denominación cuando estén depositados en colecciones reconocidas. Los nombres vulgares de plantas deben ir seguidos del nombre botánico entre paréntesis la primera vez que aparezcan en el texto.