ranean clover *(Trifolium subterraneum)* with orchardgrass *(Dactylis glomerata)* or perennial rye *(Lolium perenne)* have successfully replaced the degraded non-palatable shrub communities. The maintenance of a partial oak cover is beneficial for soil fertility and pasture establishment and is being retained where possible. In the North, establishment of pastures of perennial grasses and legumes, primarily white clover *(Trifolium repens)*, is being attempted with limited success. Infertile soils and inexperience with pasture utilization are problems to be overcome.

Portugal is a small country with a long history of agriculture, pastoralism, reforestation, and fire. These factors have all influenced the present vegetation. Portugal's rangelands have been a focus of conflicting interests throughout its history. Their used as a source of livestock forage has never been officially accepted as a bonafide land use. However, these lands have been used by pastoralists for a millennium, and grazing continues to be important on communal lands today. At the present time Portugal is attempting to increase wood production through reforestation. This often is in direct conflict with livestock use of the area. Consequently, natural resource managers are looking for ways to more fully utilize the resource base, as well as resolve conflicts associated with livestock and wood fiber production.

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Agro-Sylvo-Pastoral Systems in the Iberian Peninsula: *Dehesas and Montados*

Teodoro Marañón

The Iberian Peninsula is located in the west of the Mediterranean Basin, receiving the influence of the Atlantic Ocean with a mild mediterranean climate characterized by cold, wet winters and warm, dry summers. Long-time eroded Paleozoic rocks (schists, granites, and quartzites) are predominant in the western half of the Peninsula, offering a landscape of plains and rolling hills, where soils are shallow, acidic, and nutrient deficient. The physical constraints of the shallow soils and the seasonal droughts make most of these lands unsuitable for intensive farming. Instead a peculiar agro-sylvo-pastoral system, called locally *dehesa* in Spain and *montado* in Portugal, has been historically developed. This system, composed of cleared oak woodlands with an annual grassland understory, covers more than 5,500,000 hectares (Campos 1984, Ruiz 1986).

Oak trees *(Quercus rotundifolia* and *Q. suber)* are pruned periodically to increase the production of acorns and cork, while providing fuelwood, charcoal, and browse. An important rural economy is based on the fattening of *Iberian* pigs with sweet acorns (600–700 kg/ha) (Parsons 1962). The cork oak *(Q. suber)* bark is stripped off every 7 to 9 years. This

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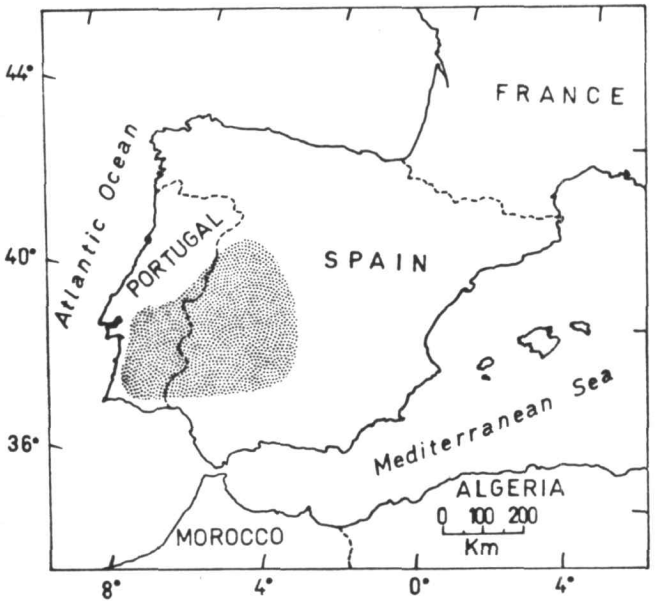
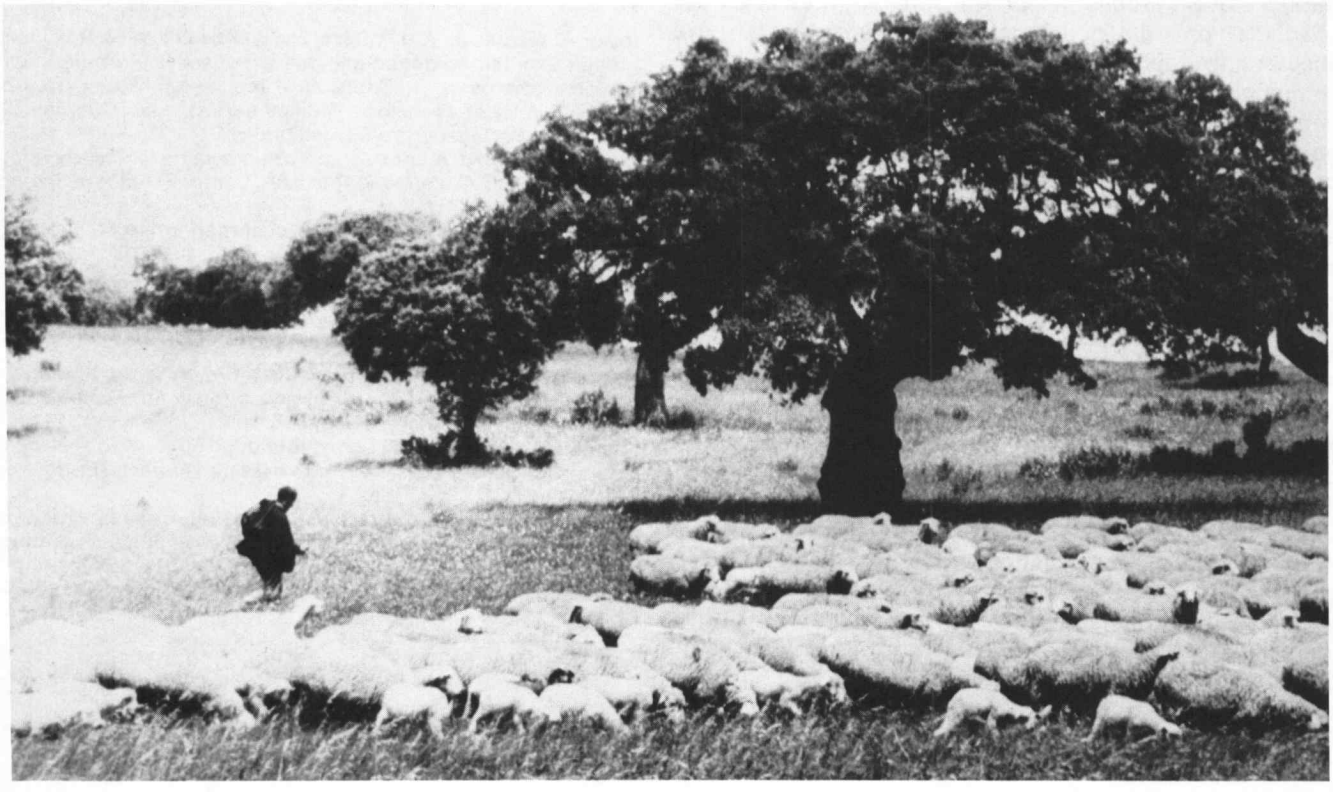


Area of dehesas *and* montados *in the Iberian Peninsula.*



Shepherd leading a flock of Merino sheep in front of an old holm oak tree.

region supplies almost 3/4 of the world's commercial cork production. Besides producing food, energy, and cork, oak trees modify the micro-environment for the herbaceous understory and serve as shelter for livestock.

Annual grasses and legumes are abundant in a highly diverse grassland (130 species/0.1 ha, Marañón 1985). The annual herb production (900–2300 kg/ha) is concentrated in April–May, providing abundant spring forage. However, supplements (hay, alfalfa, cereals) are needed in summer and autumn. Under the oak trees the drought stress is less severe and the soil has a higher organic matter content favouring the perennial grasses, orchardgrass *(Dactylis glomerata)* and ryegrass *(Lolium perenne)* (Escudero et al. 1985, Marañón 1986).

Native *Retinto* cattle (50%), *Merino* sheep (42%), goats (6%) and Iberian pigs (2%) graze freely in *dehesa* (Campos 1984). The traditional management of open range livestock in this region migrated to America, where it influenced the early cowboy or "vaqueros" culture (Young & McKell 1976). Game animals (deer, wild boar, hare, rabbit, wood pigeon, red partridge) are also consumers of the *dehesa* primary production. The combination of different types of domestic and game animals would optimize the resource exploitation (Ruiz 1986).

On moderately fertile soils, dry farming of cereals (wheat, barley, oat, triticale) that produce 900–1,200 kg/ha is practiced at 4–6-year intervals (Campos 1984). This itinerant plowing also allows the control of undesirable shrubs.

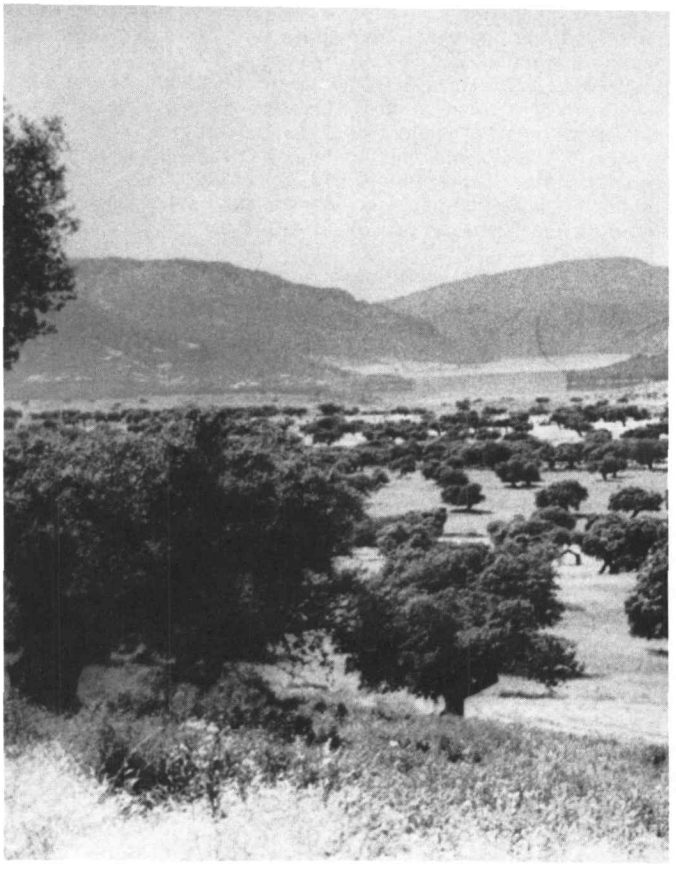
This agro-ecosystem maintains a high biological diversity. It is also an important reserve of plant genetic resources tolerant to seasonal drought, poor soils and heavy grazing. Many of these plant species have been successfully dispersed (accidentally or intentionally) to mediterranean and semiarid areas in North and South America and Australia. The *dehesa* is one of the last breeding habitats of rare and endangered birds like the imperial eagle, black vulture or black stork, and winter habitat for European cranes.

Crisis in the Traditional System

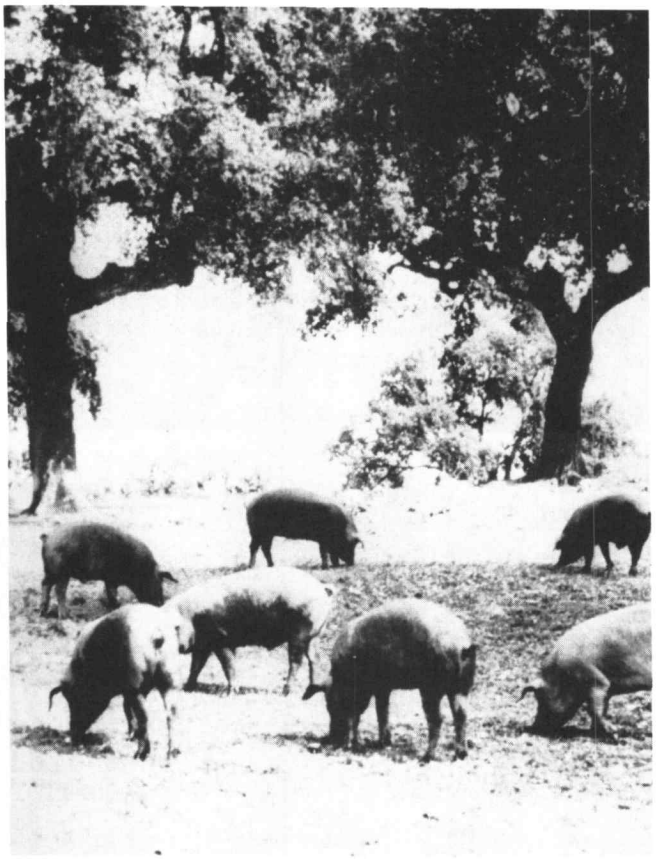
This multi-purpose system fits exceptionally well to the semiarid landscape and contrasts with the stereotyped deforested Mediterranean land. However, this fragile man-environment equilibrium is nowdays in crisis. It has been affected by the socio-economic changes, by the African swine fever (that in the 60s caused the loss of 85% of the swine population) and by the world reduction in the price of wool (Campos 1984, Ruiz 1986). After the emigration of the rural area population, many abandoned *dehesas* became less productive, fire hazard shrublands.

In some cases, oak trees were cut down transforming *dehesas* into cereal cropland areas with intensive, subsidized farming. After a few years the fragility of soils and high priced fertilizers and fossil fuel made farming unprofitable. Left were eroded soils, sparse grasslands, with slow recovery and the destruction of the equilibrium of forest-grassland-livestock-soils built up over centuries. In other cases, extensive tracts of *dehesas* were bulldozed and planted with eucalyptus to produce low quality wood and pulp.

However, many *dehesa* managers are still trying to keep the traditional system profitable, through improvement of



General view of a dehesa *in the Extremadura region.*



Iberian pigs feeding on acorns of cork oak during the autumn.

pastures (Australian cultivars of *Trifolium subterraneum* have been widely planted), fertilizing, fencing, crossbreeding native livestock with production-selected breeds, and better animal husbandry methods. A regional legislation supports these attempts at "combining the conservation of the *dehesa* ecosystem with its rational exploitation and transformation" (Comunidad Autónoma de Extremadura 1986).

In January 1986, Spain and Portugal became members of the European Economic Community and new expectations and fears are felt by *dehesa* managers about meat prices, the "fuel" that keeps this agro-ecosystem working.

The 1987 Man and Biosphere Seminar

Prompted by this critical situation, over 100 experts (range ecologists, foresters, and economists) mainly from Spain and Portugal, with participants from other western Mediterranean countries (France, Italy, Morocco, Algeria, and Tunisia), attended in April 1987 the "Seminar on the *dehesas* and other similar agro-sylvo-pastoral systems" under the auspices of the UNESCO-Man and Biosphere program. The conclusions of the Seminar were[1]:

"— The *dehesas* and similar agro-sylvo-pastoral systems have historically proved, over extended land surfaces, to be a model for the management of renewable natural resources, flexible and adapted to the Mediterranean climate in unfavourable environments".

"— These land use systems are still valid and productive over relatively large areas in the Iberian Peninsula, offering possibilities for their extension and adaptation to other regions".

"— The ecological relevance of these systems is remarkable, specially for the maintenance of a high biological diversity, the stability and the conservation of the natural and cultural heritage".

"— The lasting benefits obtained by mankind from this land use are nowdays threatened by the socio-economic changes and by the use of production techniques, without adequate evaluation of their compatibility with the maintenance of the system".

"— These threats are sharpened in the Iberian Peninsula because of the presumable effects of the Agrarian Policy in the European Economic Community".

"The Seminar is aware of the existence of a wide body of scientific information on these systems[2], and proposes the continuation of basic research on the functioning (ecological, technical and socio-economical) of the Mediterranean agro-sylvo-pastoral systems, as well as the development of new methodologies for the planning, management and restoration of these systems".

"Considering the forementioned reasons, the Seminar makes the following propositions:"

[1]Translated from the original in Spanish.

[2]A bibliographical list of 997 references written by Spanish authors and dealing with the *dehesas* (ecology, economy, agronomy, law and history) was provided by the co-organizer of the Seminar (Servicio del Medio Natural, Comunidad de Madrid, 28020 Madrid, Spain).

1. "The planning and achievement of national pilot projects, capable of allowing the building of a network."
2. "The programs included in these projects should contribute to the improvement of knowledge on the functioning and rational use of the *dehesas* and similar agro-sylvopastoral systems, serving as a baseline for the activities of training, demonstration and information, and acting as the guideline to insure the sustainable development of the rural space considered, warranting the long-term preservation of the environment."
3. "The creation of a Panel that will elaborate an International Cooperation Project for the specification and achievement of the proposed Program."

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Rangeland Development in Dera Ghazi Khan, Pakistan

Javed Ahmed and Raja Atta Ullah Khan

Abstract

The first attempt at scientific management of rangelands in Dera Ghazi Khan, Pakistan, was made in 1960. However, the efforts failed to yield good results, and the area, being extremely arid, was declared unsuitable for range improvement (GOWP 1970). The senior author surveyed the area and prepared another range management project for the area in 1982. Range improvement techniques were designed keeping in view the local ecological conditions. The results obtained so far are very encouraging. The story of failure and success of range improvements in D. G. Khan is presented here for the benefit of the readers.

Pakistan (Figure 1) is situated between 24° and 37° N latitudes and 61° and 75° E longitudes. The Dera Ghazi Khan (D. G. Khan) district is situated between 28°-25′ and 31°-21′ N latitudes, and 69°-20′ and 70°-51′ east longitudes. Agricultural crops can only be cultivated with canal irrigation on 17% of the area. The remaining 83% is used for grazing by livestock. The summers are hot with temperatures soaring to 45° C, whereas, the winter temperatures are mild and pleasant.

Rangelands of D. G. Khan consist of piedmont plains and Suleman Hills. Total area of state-owed rangelands is 28,200 hectares, distributed in 13 blocks varying in size from 8,313 hectares to 242 hectares. The areas adjoining state rangelands are private or communal lands. A very small portion of the piedmont plains are cultivated by spreading rain water from the nearby Suleman Hills.

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Average annual rainfall is about 80 mm, most of which is received during the months of July and August. Rain is only effective if it falls in storms of more than 10–15 mm and is followed by similar storms at short intervals. The area is undulating in topography. Ridges consist of deep calcareous sandy loam; slopes are also calcareous; but the soil varies from sandy loam to loam. The slope sub-soil has more moisture than the ridges. The flat areas are made up of heavy clayey soils with little sub-soil moisture (Syal and Hameed 1984). Water penetration is more on the ridges and slopes compared to flat areas. The coarser soil structure of the ridges and slopes prevents upward capillary water movement. Therefore, more subsoil water is retained on ridges and slopes than on the flats.

The area has a long history of indiscriminate and promiscuous grazing. Livestock consists of sheep, goats, cattle, and camels. The area is grazed by animals of both the local people and migratory pastoralists from other parts of the country. It is estimated that the range areas are producing only 10–20% of their potential. There has been no scientific study of the vegetation of the area.

Past, Present, and Future Management

Past

Range management, as a scientific discipline, was introduced in Pakistan in 1954 with the establishment of a pilot research and demonstration project at Maslakh, near Quetta, with USAID assistance. The deteriorating vegetation quickly recovered as a result of fencing and controlled grazing. In turn, rate of lamb mortality among the sheep decreased, and rates of weight gains and wool production increased (Rafi 1965). After this successful experience, similar projects were initiated in different ecological regions of the country. One