Mountain pastures and livestock farming facing uncertainty: environmental, technical and socio-economic challenges

19th Meeting of the FAO-CIHEAM Mountain Pastures sub-network
14-16 June 2016 – Zaragoza, Spain

Mid-Congress tour
Mountain pastures and associated livestock production systems in the Pyrenees

Wednesday 15 June

Departure: Zaragoza city - Hotel Reino de Aragón 7:30
Congress Venue - IAMZ 8:00
Arrival: Evening

10:00 - Mountain cheese farm (http://www.flordelaspe.com/)

coffee

12:00 - Mountain pastures in Aisa Valley (IPE, http://www.ipe.csic.es/)

picnic lunch

16:00 - Research Farm La Garcipollera (CITA, http://www.cita-aragon.es/)

coffee

Don’t forget to bring comfortable trekking shoes, sun protection and a cap!
Suckler cattle and sheep farm with an artisan cheese factory located in Esposa, a small village in Aisa Valley. The visit will be conducted in the farm surroundings, although animals use pastures in different areas.

**The pastures**

Natural grassland close to the farm (40 ha natural meadows), shrub and forest pastures (5 to 50 km away), and high mountain ranges (15 km).

**The sheep flock**

Flock of 500 adult Rasa Aragonesa sheep, an autochthonous breed commonly used for producing light lambs (22-24 kg LW, <3 months). The reproductive objective is 3 lambings per 2 years, and thus there are 3 lambing seasons each year (January, May and September). Ewes are generally bred by natural mating with rams, but occasionally heat synchronization and artificial insemination are conducted within the genetic improvement scheme of the breed.

Throughout the suckling period ewes are fed with meadow silage and concentrates, and they graze the rest of the year. Lambs are weaned at 1.5 months of age, and then they are fattened with concentrates on-farm until they reach 16-18 kg and area moved to a cooperative feedlot. Productivity is 0.85-0.90 lambs sold per ewe and year.

In the near future the flock will be transformed into a 350-head Lacaune and Latxa flock, two dairy breeds which will guarantee self-supply of milk for the cheese factory. A milking parlour is under construction, and the production system will change accordingly: lamblings are expected at the end of the year, the offspring will be weaned and sold as suckling lambs (10-12 kg LW), and the flock will be milked throughout the spring and early summer.

**The cattle herd**

Beef cattle herd of 40 Pirenaica adult cows and 35 heifers (increasing census). Extensive management: grazing throughout the year on natural grassland close to the farm, high mountain ranges in the neighbor valley and transhumance to shrub and forest pastures.

Cows calve during most of the year, although the summer months are avoided. Cows in the different physiological states use different grazable resources, decisions are made upon pregnancy diagnosis twice a year. The trend is to concentrate calvings in the early autumn, in order to simplify animal management. Calves are sold from 5 months of age or 200 kg LW to a
cooperative feedlot (if born late in the spring, they are early weaned and raised on concentrates until they reach these thresholds).

The cheese farm

Since it started in 2007, the farm produces artisan cheese mostly from sheep’s milk. They elaborate cheese throughout the year (about 2000 l milk per week), but sales are higher in the summer tourist season, and therefore production doubles in the spring (4000 l milk per week March to June). Ewe’s milk comes from a Lacaune farm in Zaragoza and cow milk from a Brown Swiss farm in Borce (France). They elaborate pure sheep, pure cow and sheep/cow cheese, with raw milk, and in different sizes (500 g, 800 g and 3 kg).

Cheese is distributed in short food supply chains within the area, and through food dealers in markets and gourmet shops in the province. They also manufacture under different tourist labels (“San Juan de la Peña” or “Valle de Ordesa”, associated to neighbouring Protected Natural Areas). New types of cheese in project (blue, creamy, ...)

Premises and production line

1. Two 1100 L cooling reception tanks
2. Steam boiler for quick temperature-raising to 25°C
3. Pasteurizer, although it is not in use, as they work with raw milk
4. 1000 L tank for curdling (calf rennet, ferments)
5. Laboratory for milk and cheese analysis: milk analysis once a month (AILA association), detection of inhibitors (incubator, colour)
6. Draining table
7. Press with moulds of various sizes (the moulds are turned over after 45 minutes, pressure parameters depending on cheese pH).
8. Whey draining and salting (24 hours for large cheeses, 16 hours for small cheeses)
9. Cooler at 5°C (1 week)
10. Airing-maturing chamber at 12°C and at least 85% humidity (humidity is increased when the output rate is slow, so that the cheese does not get too dry). Ripening on a beech table and turning over of cheese (daily in the first week, twice a week in the second and third weeks, and less often afterwards). Ripening period: 1.5 months for 500 g cheeses, 2-3 months for 800g cheeses, 3-4 months for 3 Kg cheeses.
11. Chamber for brushing off mould and packaging
12. Cool storage
13. Cheese yield (to ewe’s milk) 5:1 fresh and 6:1 cured.
Grazing Ecology Research in “Puerto De Aisa”

Livestock husbandry in Aisa Valley

The first reliable data about stock numbers in the valley are from 1864 when 464 heads of cattle, 388 goats and 4918 sheep were recorded. A peak in sheep numbers occurred in 1930 with approximately 6000 heads. After the Spanish Civil War (1936-1939) numbers dropped dramatically coinciding also with the end of the transhumance to the Ebro Valley. From then, sheep numbers have been maintained between 1500-2500 heads. In the last years subsidies coming from the European Community and housing market bubble have produced some recuperation of the sector (see fig. below).

During the summer livestock graze in the summer pastures (Puerto de Aisa) in the North part of the Aisa Valley. In spring and autumn livestock use transit or intermediate zones (pastures, abandoned fields and cleared forests) below 1600 m. In the winter cattle remain in stables, but sheep continue using pastures in the surroundings of the villages during light-hours and when weather conditions permit.

For centuries the main human activity in the valley has been agriculture and livestock husbandry. Nowadays, only 5% of the municipal surface (8154 ha) is used for crops (including irrigated meadows). Three quarters of the surface are occupied by forests and pastures. The rest of the acreage is composed of shrubs (pure or with sparse trees) and unproductive areas (rocks, peaks, water and marsh zones).

Aisa summer pastureland (“puerto”, alpage, estive)

Puerto de Aisa is a summer pastureland (communal grazing land) situated near the France border in the Spanish western Pyrenees. The supraforestal pastures occupy an area of 1200 ha from 1600 to 2650 m altitude on the hillsides of Aspe peak, predominantly south-
facing. The lowest part of this summer range consists of flat areas and gradual slopes with deep soils in the bottom parts. Above 2000 m, however, rocky fields, screes, ledges and extremely steep slopes with mobile substratum predominate, making plant rooting difficult or even impossible and confining herbivores to small areas when looking for food. Low winter temperatures and snowfall reduce the growing period, above 2000 m, to less than four months. Annual mean temperature in the study area is 7.1°C and rainfall, excluding snowfall, is 1100 mm per year (average data at 1600 and 1800 m in study area). The number of plant species found in the area is over 500 taxa whereas above 2000 m the number diminishes to 250. Mesobromion erecti, Nardion strictae, Festucion gautieri and Primulion intricatae are the most widely represented phytosociological alliances in these pastures (see vegetation map below). From 1980s whole grazing area was used by 1500-3000 sheep from 3 to 6 owners and herded by 1 or 2 shepherds, 100-400 cows belonging to several owners and a few goat heads (30-50) in free ranging conditions. There are also 400 chamois (Rupicapra pyrenaica) which occupy the highest areas in summer. Stocking pressure in used surface is 1.0 AU/ha [AU = (Kg body weight/500)0.75]

**Objectives**

Our main objectives have been:

a) to study the factors which determine the grassland structure and its variation over specific ecological gradients;

b) to study the patterns of the herbivore use of pastoral resources;

c) to formulate hypotheses about the evolution of pastoral ecosystems caused by global change (livestock management changes) and climatic variation.

With the gathered information, we developed an eco-pastoral index (a mathematical combination of ecological and productive variables of grasslands), which would be able to provide a functional assessment of pasture communities for both conservation and livestock husbandry purposes.

**Procedures**

The study of the interactions between pastures and herbivores in the Aisa summer pastureland has involved the following steps:

- Typification, classification and mapping of supraforestal pastures (see figure below).

- Determination of biomass, production and nutrient composition of the main types of pastures and species, and their temporal evolution.

- Establishment of the patterns of spatial, temporal and trophic utilization of summer pasturelands by livestock and wild animals (see figure below).

**Some results and conclusions**

- The grazing behaviour of herbivores, their daily activity and the movement of herds are the main factors in the use of the different plant communities. In general, the of use by herbivores is low in all cases and does not reach 50% in any plant community. This fact reflects the reduction of herbivore pressure and, perhaps, can explain the present invasion of certain species, such as Juniperus communis, Pinus sylvestris or Calluna vulgaris, especially in the bottom parts.
- The use of vegetation maps combined or overlapped with the pastoral utilization maps is a useful tool when studying the stocking rate, habitat selection and grazing behaviour, and therefore is interesting for pastoral management purposes.

- Studies concerning grazing on summer pasturelands have shown a close relationship between feeding habits and phenological condition of the plants. On the whole, un-improved or wild herbivores (goats and chamois) adapt very well to the variations in trophic resource availability. The consequence for vegetation is that impact of herbivores may be temporarily variable according to changes in plant fodder values.

- The existence of different species of domestic livestock facilitates the exploitation of mountain pastures without excluding the presence of wild ungulates (mixed grazing). Herbivores present particular morphophysiological characteristics that allow them to benefit from food resources differentially, reducing animal competition.

- The complementary use of marginal zones by livestock seems to be a system of mountain exploitation compatible with the maintenance of biodiversity (if appropriate stocking rates are used). It is important to find out the features of this agro-ecosystem, the underlying ecological processes and the interactions between the elements (grass and herbivores). This would enable a plan for new forms of future sustainable development in the mountains, based on systems that have proved efficient in the past.

(Full results have been given in several reports and publications, some of which can be found at http://digital.csic.es/handle/10261/318#).
Ecological services and benefits of Pyrenean mountain pastures

- Biodiversity reserve. Soil protection. Carbon capture and storage
- Production: Pyrenean supraforestal pastures extend over 8500 km². They can produce 1.1 Tera ton of grass each year. Theoretically they can feed 1.5 million sheep.
- Aesthetic values that are increasingly valued by society

Main threats of mountain grasslands (global change)

- Climatic change -> mountain plant community alterations
- Grazing abandon or stocking rate decline -> shrub encroachment, wild boar impacts, biodiversity loss
- Local overgrazing by heavy or non-mountain adapted cattle breeds -> eutrophication, plant changes, erosion
- Urban building, infrastructures, ski resorts -> habitat alteration and destruction
- Tourism overuse -> trampling, faunal disturbance
Experimental farm for the study of mountain agriculture and livestock production systems

Agriculture and livestock production have traditionally been the main economic activities in mountain areas, and even though new activities such as tourism are increasingly important, they are still important both in economic terms and for their role on environmental preservation.

Mountain production systems and their technical management deserve particular attention in the European context, where it has to deal with specific challenges. To address these challenges, La Garcipollera Research Station started its activities in 1985, with the aim of providing technical information which can help farmers develop profitable and sustainable systems, with a rational use of the available animal and natural resources.

Since then, research concerning mountain livestock systems and their technical improvement has in La Garcipollera Research Station a milestone in Southern Europe, where scientists from CITA carry out their projects in close collaboration with both national and international teams. Its situation provides close contact between scientists, advisors, students, farmers and society, involving different public and private institutions and collectives.

THE FARM

The site

La Garcipollera Research Station is located in the mountain area of Central Pyrenees (Spain, 42o37’N, 0o30’W). The experimental site ranges in altitude from 950 to 2200 m above sea level. The average annual rainfall is 1000 mm, bimodally distributed with peaks in the spring and autumn, with dry summers and some precipitations in the form of snow in the winter; the mean annual temperature was 10.9oC. Soils on the study site are mainly Flysch (a sequence of sediments comprising sandstones, conglomerates, marls, shales and clays), in contact with a karstic land of limestones in the Northern part of the area.

The animals

Pirenaica and Brown Swiss are two of the breeds more widespread in the Spanish Pyrenees, both managed as suckler cattle. Mature weight is very similar in both breeds, around 575 kg at calving. The main differences between them have been found in aspects related to milk production, Brown Swiss cows having higher yields and their calves growing faster until
weaning. Besides, Brown Swiss heifers reach puberty at similar weight but younger age than Pirenaica heifers, due to a faster maturing rate.

According to reproductive management, the herd is divided into two groups, half calving in late winter and half calving in the autumn, with different management throughout the annual cycle. Spring-calving cows are housed in December, turned out to valley meadows or high mountain ranges in June, and graze on forest pastures from weaning in September until housing. Autumn-calvers are housed in October, weaned and turned out in April to forest pastures, and graze during the summer on high mountain ranges until housing.

Churra Tensina sheep is an endangered local coarsewooled breed (45 kg adult weight), commonly reared under very extensive production systems. It is now used only for lamb production, although it has been milked for years. There is a main lambing season in spring and a smaller flock lambing in the autumn, and the lambs are raised by their dams on pasture.

**The pastures**

Both cattle and sheep use throughout the grazing season different surfaces: valley meadows, forest pastures and high mountain ranges.

The natural valley meadows extend over 15 ha, and they are mainly composed by Graminaceae (80%), Leguminosae (4%) and other families (16%), the most abundant pasture species being *Dactylis glomerata*, *Festuca arundinacea*, *Trifolium repens*, *Poa pratensis* and *Lolium perenne*. Pasture availability and quality changes throughout the grazing season, ranges are 1000-2000 kg DM/ha, 17-23%CP, 50-60% NDF.

The forest pastures consist of 1500 ha (900 to 1500 m altitude), reafforested with *Pinus nigra*, with bushes of *Buxus sempervirens*, *Juniperus communis* and *Genista scorpius*. Herbaceous cover on these pastures was 38% on average, ranging from 15.9% to 89.9% in the different botanical communities. *Brachypodium spp.*, *Bromus erectus*, *Festuca rubra*, *Carex spp.* and *Aphylloanthus monspeliensis* were the predominant grass species. Average herbage availability on these pastures over several years was 741 kg DM/ha (8.2% CP, 75.3% NDF), with peak production and higher quality at the end of the spring. These pastures are used during the spring and autumn at a low stocking rate of 0.2 LU/ha on the area effectively grazed.

The upper supraforestal pastures (1500 to 2200 m) consist of a 800-ha range, mostly grasslands of *Festuca rubra*, *Festuca skia*, *Bromus erectus*, *Nardus stricta* and *Trifolium alpinum*. Although herbage mass is higher in these pastures (from 1900 to 4100 kg DM/ha in the different areas) quality is also low (7.4% CP, 65.3% NDF). Pasture size is 800 ha, and slopes
ranged from 15 to 55%. These pastures are used during the summer (June to October) at a moderate stocking rate (0.5 LU/ha).

**The facilities**

The animals are kept during the housing season in different types of barns, mostly in similar conditions as in commercial farms, but some especially equipped for research (digestibility experiments, milking equipment, forage and concentrate individual intake recording, etc.)

There are laboratories for processing before analyses different types of biological animal samples and forages. The farm is run by 5 technicians and field staff.

**THE SCIENTIFIC OBJECTIVES**

The research work conducted in the farm in the last 30 years, in the framework of 100 projects funded by the EU, national or regional government or private contracts, has been focused the following main guidelines:

- Characterisation, preservation and improvement of autochthonous livestock breeds
- Study of genes of interest in ruminants related to quality and food safety and the efficiency of production
- Nutrigenetics and nutrigenomics studies in animal metabolism and product quality.
- Relationships between animal management, environment and physiology in mountain conditions, optimization of reproductive performance
- Nutritional management of livestock: feeding resources (nutritional assessment, intake, digestibility and metabolism), supply patterns and effects on animal performance and the environment.
- Alternatives for beef and lamb meat production and effects on product quality, traceability of feeding systems and technical basis for organic farming
- Animal health in mountain conditions
- Interactions between livestock and the environment: technical basis for optimal pasture management
- Development of simulation-optimization tools for farm technical-economic management and evaluation of alternative management and agricultural policies.
- Analysis of sustainability of livestock systems: evaluation of carbon footprint and mitigation strategies, valuation of ecosystem services

**THE RESULTS: Science and Knowledge Transfer**

The research work has yielded very valuable technical information concerning the characterisation of production traits of the breeds more commonly used in the Pyrenees. The relative importance of environmental and management factors has also been determined.
From this information specific guidelines for management directly transferable to farmers have been established:

- Ruminant management systems based on an optimum pasture use, reducing housing periods and guaranteeing environmental sustainability
- Feeding and management plans for heifer replacement for optimal first calving performance and lifetime productivity
- Reduction of winter feeding costs while optimizing reproductive performance of dams and growth performance of the offspring.
- Improvement of herd reproductive management, by combination of health control, management and adequate assisted reproduction techniques and protocols
- Health management in mountain conditions, minimizing pharmacological treatments
- High quality beef and lamb meat production in conventional and organic systems, design of adequate management strategies depending on available resources and target market.
- Design of multifunctional animal production systems combining economic performance in marketable products and the delivery of public goods or ecosystem services

Scientific results from this research work have been published in 25 PhD thesis, 100 peer-reviewed papers and over 300 papers in other scientific journals and conference proceedings. Technical information is transferred to extensionists and farmers by means of extension articles, training courses and technical support provided to breeders associations.

**Current research projects**

- Effect of pea inclusion as alternative protein and energy level of the diet on the efficiency of ruminant fattening diets. INIA RTA2014-00038-C02-00
- Strategies to mitigate the impact of changing from a forage diet to others rich in concentrate for intensive rearing of beef cattle. AGL2013-46820-P
- Effects of maternal nutrition on embryo growth and offspring: implications for beef productive efficiency. INIA RTA2013-00059-C02-00.
- Effect of phenolic compounds of the diet on animal performance, reproductive traits and on carcass and meat quality in sheep. INIA RTA2012-00080.
- Evaluation of carbon footprint and ecosystem services to design sustainable strategies in sheep production. INIA RTA2011-00133-C02-00
- Consequences of growth patterns on subsequent productivity of beef cattle. INIA RTA2010-00057-C03

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