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Pasture improvement in *montado* extensive farming systems[1]

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SUMMARY – In general the persistence and better productivity in pastures is related to the use of mixtures of species and cultivars well adapted to the environmental conditions. Our experimental scheme was developed to determine to which extent it is important to integrate perennial grasses and, for our environmental conditions, what are the species yielding better results under rotational and extensive systems of pasture exploitation. Near Elvas, Portugal, trials were established to compare biodiverse sown pastures (CMIX) with natural ones (NS). The results show that, in terms of biomass yield, it is possible to detect, on the first year of the trial, a small positive response corresponding to CMIX. On the second year, the results show an important increase of CMIX in relation to NS. A finer analysis of the benefits of the sowing state reveals that on the second year there were very important increases in legume and grass proportion in the biomass. The grasses introduced that had more persistence are *Dactylis glomerata* followed by *Lolium perene* and *Phalaris aquatica*. The other perennial grass introduced in the mixture, *Festuca arundinacea*, had great difficulties to persist.

Keywords: Mediterranean pastures, *montado*, biodiverse sown pastures, grasses, legumes, yielding.

RESUME – *"Amélioration des pâturages dans les systèmes d'exploitation extensive du* montado*". En général la persistance et l'amélioration de la productivité des pâturages sont liées à l'utilisation de mélanges d'espèces et de cultivars bien adaptés aux conditions environnementales. Notre système expérimental est destiné à déterminer dans quelle mesure il est important d'intégrer des graminées pérennes et quelles sont les espèces ayant de meilleurs résultats sur le système rotationnel et d'exploitation extensive des pâturages. Près de Elvas, au Portugal, on a mis au point des expériences afin de comparer des pâturages semés biodivers (CMIX) avec des pâturages naturels (NS). Les résultats montrent qu'en termes de disponibilité de biomasse il est possible de détecter, sur la première année d'essai, une légère réponse positive correspondant à CMIX. À la deuxième année, les résultats montrent une importante augmentation de CMIX par rapport à NS. Une analyse comparative plus fine des avantages du semis a révélé que dans la deuxième année, il y a une très importante augmentation de la proportion de légumineuses et graminées dans la matière sèche. Les graminées ayant plus de persistance sont* Dactylis glomerata *et ensuite* Lolium perene *et* Phalaris aquatica*. L'autre graminée pérenne introduite dans le mélange,* Festuca arundinacea*, a de grandes difficultés de persistance*.

Mots-clés : *Pâturages méditerranéens,* montado*, pâturages biodivers semés, graminées, légumineuses, productivité.*

Introduction

An European project of research, PERMED, with a net for diverse Mediterranean conditions, has the aim of study the effect in terms of soil parameters and feed production using rich biodiverse mixtures for long-term pastures. To develop this project in Portugal were chosen the conditions of *montado*. In terms of land use, the *montado* system dominates the South Region of the country and it is possible to find tendencies of it enlargement. The richness of the system is based on the traditional way of extensive land exploitation, with good sustainability and products characterized by high quality.

Potes and Babo (2003) characterized *montado* as an ecosystem extremely well adapted to the Mediterranean climate that is mainly based on three types of plant components:

(i) Trees, mainly *Quercus* spp. (*Q. suber* L. – cork tree and Q. ilex L. – oak tree).

(ii) Shrubs, mainly consisting of *Cistus* spp. (*C. ladanifer* L., *C. crispus* and *C. salvifolius* L.).

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(iii) Herbaceous annual plants with natural resowing like *Trifolium* spp., *Medicago* spp., *Ornithopus* spp., *Lupinus* spp. *Vicia* spp., *Biserrula pelecinus* L. Other annual legumes and grasses.

The density of the trees is not homogeneous and sometimes scarce, the distribution is random and can appears others species like *Pinus* sp., *Olea* sp., *Castanea* sp., *Quercus coccifera* L., *Quercus faginea* Lam. In some conditions of fertile soils, due to high intensity of plough and grazing, the shrubs are not present. The composition relative to the shrubs is in high dependence of edaphoclimatic conditions and appears other species like *Genista tridens*, (Cav.) DC, *Stauracanthus boivinii* (Webb) Samp., *Cytisus* sp. and *Ulex* sp. The species composition in terms of herbaceous is frequently with high biodiversity and too many heterogeneous in dependence of the nature and fertility of the soil, effect of management and grazing, amount of rainfall and other environmental conditions.

The traditional management of the ecosystem typically consists on the control of shrubs, using biological (animals) or mechanical (machinery) means, and the integration of this operation into a crop rotation system. Forage crop has a very important role in animal feeding due to the large heterogeneity, during the year, of the amount of natural feed available. To carry this system two factors are determinative of the success, such as the supplying of phosphorus and the proper use of stocking rates (Potes *et al*., 2005).

Traditionally occurs a hard integration of activities with large rotational schemes of cereals and annual forages, turning with fallow used for grazing. The last implements on Common Agricultural Policy occur on 1992 and after that, the use of cereals is reduced, although is possible to detect a high variation of the areas involved, in dependence of the market price of the product, and the lands are frequently used as permanent pastures.

Appropriate management of the overall system is of utmost importance. In these systems the animals are all the year in the fields using the feed available and the forage, and rarely concentrates, are used to complement the pasture.

Material and methods

For the research scheme of the project PERMED, two situations of private farms with natural pastures and extensive grazing of cattle were chosen. They are 10 and 20 km North from Elvas. The geographic coordinates are: farm 1 – 38°56'17''N, 7°13'3''W; farm 2 – 39°58'12''N, 7°16'41''W. At these farms, like so many others in the region, a sparse forest of *Quercus ilex* L. covers lands with various kinds of limitations: poor drainage, low cation exchange capacity (CEC) and other characteristics of low fertility. The soils are shallow, eroded and poor in organic matter. At farm 1 the soil derives from calcareous rocks and has loam sandy texture. At farm 2 it derives from granite and has sandy loam texture. Both soils are characteristic of the most frequent situations in the region. At farm 1 the soil is more fertile than at farm 2. Local breeds of cattle and crosses with *charolais* and *limousine* are reared. The animals are permanently in the fields and grazed it rotationally. Only for fattening, before they are sacrificed, some of them are closed in more restrict areas. The system of production is extensive in both farms, with low percentage of inputs and based on natural resources at the fields. The most important components of cattle diet are the pasture, straw of cereals, hay of cereals or mixture of cereals with legumes, acorns and leaves of trees and shrubs. Sometimes are used concentrates and products of food and feed industries. The most important products are fat animals or calves. The lands for the trial are plate and in the previous two years were used as natural pasture or fallow.

The experimental design consists of two surfaces, with 3 hectares each, in each farm in correspondence of the two treatments: natural sward (NS); sown sward with a complex commercial mixture (CMIX**)**. Fertiprado (Seed Company) chosen the mixtures composition according to the main climatic features of the region and the soil characteristics such as pH and CEC. The seeding rate was 30 kg per hectare with diverse components such as: *Trifolium subterraneum* L. (6 varieties – 9 to 10 kg), annual medics (2 varieties in farm 1– 2 kg), *Ornithopus sativus* Brot. (2 or 3 varieties – 2 to 6 kg), *O. compressus* L. (1 variety on farm 2 – 3 kg), *Bisserrula pelecinus* L. (1 variety on farm1 – 1 kg) and perennial grasses which belongs to four species; 1 kg of *Lolium perene* L.; 2 kg of *Dactylis glomerata* L.; 1 or 2 kg of *Phalaris aquatica* L. and 1 kg of *Festuca arundinacea* Schreb. For the farm 1, with best soils than farm 2, the mixture includes also 2 *Lotus species* (2 kg) and *Medicago sativa* L. (1 variety – 1 kg). Seedbed was prepared with spike harrow. Fertilization just before sowing is with 22 kg of N, 44

kg of P_2O_5 and 44 kg of K_2O. Fields were sown on the 20 and 22 of October 2005 in farm 1 and farm 2, respectively, with the machinery available on each farm – spreader of the fertilizers – and the seeds covered with role. Cows grazed the pastures in similar conditions as the whole farm system, on periods chosen according to dry matter availability. To determinate values of the dry matter production, on several dates during growing season, mechanical defoliation was done, using scissors at 6 fixed points per paddock. At that points exclusion cages were installed to protect the plants against grazing. The green mass collected was dried in a forced-air oven at 65ºC, just to a constant weight. The species composition was registered and the carrying capacity was recorded.

Results and discussion

In terms of carry capacity for grazing, the figures mean a high potential of production by sowing pastures. On equivalent Cattle Unit Grazing Days ha^{-1} $year^{-1}$ the data for 2005/06 are: (i) farm 1 and NS – 0.40; (ii) farm 1 and CMIX – 0.48; (iii) farm 2 and NS – 0.16; (iv) farm 2 and CMIX – 0.32.

On the first year the defoliation was done twice on each place. The results for the cut of May are higher for CMIX than NS at farm 1, but quite similar one to other at farm 2 (Tables 1 and 2). The results of farm 1 show that the sown treatment was too much affected at the first phase, by the establishment process, because the figure of dry matter relative to this treatment is 1/8 than the one relative to NS. The second cut, on CMIX, compensates the poverty of the first one but the sum of the two cuts for both treatments is similar. Farm 2 gave results different than the farm 1, because with both defoliation actions there are not significant differences between the treatments.

Table 1. Means of total annual aboveground biomass sampled in the cages on the first year (t ha^{-1}) on farm1

Treatment	1st cut (January 23)	2nd cut (May 24)	Total
NS	2.476±1.153 a	3.050±0.694 b	4.700±1.861
CMIX	0.310±0.056 b	6.022±0.431 a	4.324±3.476

Values in the same column followed by the same letter are not significantly different by the Student Newman Keuls Test.

Table 2. Means of total annual aboveground biomass sampled in the cages on the first year (t ha^{-1}) on farm 2

Treatment	1st cut (March 16)	2nd cut (May 10)	Total
NS	3.218±2.583	2.976±1.352	6.193±3.936
CMIX	3.277±1.437	2.668±0.576	5.945±2.012

Values in the same column followed by the same letter are not significantly different by the Student Newman Keuls Test.

In relation to the second year the sampling occurs four times on each farm. The data show that for the first and second cuts the CMIX produces almost the double or even more biomass than NS (Tables 3 and 4). For the other defoliations, except for farm 2 and 4th cut, CMIX presents more biomass than NS. Concerning total data of the four cuts CMIX has in relation to NS rising in terms of biomass availability: 73% on farm 1 and 35% on farm 2.

In terms of dry matter production relative to the two family plants more interesting in the pastures, grasses and legumes, the results of the 3rd cut, on March 21 and April 12, respectively on farm1 and farm 2, are illustrative of the benefits of sowing (Table 5). The percentage of increase was as high as more than 15 times in farm 1 for grasses and as high as more than 14 in farm 2 for legumes.

Data obtained on the third year of establishment relative to a demonstrative project developed on the same environmental condition of farm 1 demonstrate that CMIX means an increase, of 3.418 t

ha^{-1} year^{-1} of dry matter up than the 4.952 t ha^{-1} year^{-1}, of dry matter produced with NS (Barradas *et al.*, 2006). On that trial, in terms of average of the second and third years after establishment, the improvement action implies an increase of the percentage of legumes from 34.4 to 46.1 and an increase of the in vitro digestibility from 64.4 to 67.0%.

Table 3. Means of total annual aboveground biomass sampled in the cages (t ha^{-1}) on the 2nd year on farm 1

Treatment	1st cut (Nov 13)	2nd cut (Jan 10)	3rd cut (March 21)	4th cut (July 4)	Total
NS	Nd	0.628±0.142 b	1.362±0.471 b	1.706±0.585 b	3.847±0.812 b
CMIX	0.340±0.171	1.543±0.594 a	3.176±1.615 a	2.587±0.514 a	6.664±2.876 a

Nd: not done.
Values in the same column followed by the same letter are not significantly different by the Student Newman Keuls Test.

Table 4. Means of total annual aboveground biomass sampled in the cages (t ha^{-1}) on the 2nd year on farm 2

Treatment	1st cut (Nov 13)	2nd cut (Jan 10)	3rd cut (March 21)	4th cut (July 4)	Total
NS	0.228±0.141 b	1.301±0.510	2.534±0.575	2.115±0.337	5.825±0.896
CMIX	0.645±0.319 a	2.105±0.881	3.419±1.476	1.702±0.371	7.871±2.267

Values in the same column followed by the same letter are not significantly different by the Student Newman Keuls Test.

Table 5. Variation of the production (t ha^{-1}) of the main botanical pasture component in relation to treatment

Farm	Family of plants	NS	CMIX	Variation in percentage of dry matter
1	Grasses	0.109	1.660	+ 1 426
	Legumes	0.118	0.722	+ 510
	Others	1.132	0.798	- 30
2	Grasses	0.509	1.433	+ 182
	Legumes	0.073	1.094	+ 1 391
	Others	1.948	0.893	- 54

Relatively to the perennials with better persistence were found mainly the three species that more frequently occurs in the natural vegetation: *Dactylis glomerata*, *Lolium perene* and *Phalaris aquatica*.

Conclusions

Compared with natural pastures, sowing the most appropriate mixtures of grasses and legumes in Mediterranean rainfed conditions means a significative increase of total dry matter productivity with a more favourable botanical composition in terms of pastoral species for grazing and bromatological composition. Sown pastures improved the distribution of seasonal forage production especially in autumn and winter seasons.

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