

Livestock grazing systems and land use: the case of northern Portugal before the EU agrarian policy

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Summary

Ruminant grazing systems of northern Portugal are part of the whole farming systems, traditionally highly connected with other agricultural and/or forestry systems. At present, the agrarian traditional systems are becoming more simple, with less connectivity between its components, leading to a poor genetic and ecological landscape. This paper aims to present the relationships between ruminants and landscape at the beginning of the 1980s (before Portugal's accession to EU). Linear correlation, multiple regression and canonical correlation analysis (CCA) were performed on the number of sheep, goats, beef and dairy cows, and the area of sixteen land use types (from annual crops to older forest stands) of 752 municipalities, to elucidate the main land use types determining livestock distribution. Two factors emerge as important to understand that dynamic: the climate gradient and the topographic situation. The first factor explains a transition between sheep and beef cattle based in a more or less productive environmental climate. The second factor takes physiography as determinant in the choice between goats in steep, stony and rocky situations (heathland) or dairy cattle at the bottom of large valleys (alluvium with wet annual crops).

Keywords: ruminants, land use, and canonical correlation analysis, Portugal.

Introduction

Tras-os-Montes e Alto Douro (13 300 km²), in the Northeast of Portugal, is a region of high environmental diversity (Castro, 1996), preserved from influences of modern agricultural development of other regions by distance, rural exodus, mountainous relief, etc. (Ribeiro, 1987). Their traditional farming systems, as in many other regions of the Mediterranean Basin, are characterised by low inputs of mechanisation and chemical fertilisation, and high diversity and connectivity of vegetal and animal productions (Gomez Sal, 1997). The grazing systems of ruminants are based on autochthonous animals, supported by a complex land use pattern of the territory of each village ("aldeia") (Castro *et al.*, *in press*; Barbosa, 1993).

In the present century, as a consequence of agriculture modernisation and the issues of agrarian policy, the agricultural traditional systems are becoming more simplified, with less connectivity between their components, leading to a poor genetic and ecological landscape (Gomez Sal, 1997). The association between number of ruminant heads and area of land use types may be an indicator of that relationships, as well as interdependence, maturity and adequacy of that production systems.

The evaluation of present state of affairs needs a reference, to make it possible to interpret the effects of the various European Common Agrarian Policies, over the last decade. Thus, the first results about these relationships at the beginning of the 1980s (the first systematic statistics and land use maps are already available), would leave us in a good position to assess the effects of the most recent developments over the last ten years.

Materials and methods

The number of sheep, goats, beef and dairy cows (Institute National de Estadística, 1981) of 752 constituencies ("freguesias") was associated with a land use map in a spatial database, using a geographical information system. Sixteen land use types were used (given in hectares): low intensity dry farming - cereals & fallow (Cs), high intensity dry farming - cereals & summer crops (Ch), high intensity irrigated crops (Cr), olives (Po), vineyards (Pv), almonds (Pd), fruit trees (Pf), chestnuts (Pc), permanently wet natural pasture (Lh), not permanently wet natural pasture (Ls), high altitude natural pasture (La), annual and permanent crops around dwellings (Ei), pine forests (Mp), deciduous oak forests (Mq), evergreen oak and juniper forests (Mz), uncultivated land with shrubs and occasional trees (Im) (Agroconsultores & COBA, 1991).

Linear correlation, multiple regression and canonical correlation analysis (CCA) (ter Braak, 1986) were performed on the number of sheep, goats, beef and dairy cows, and the area of sixteen land use types (from annual crops to older forest stands) of 752 municipalities, to elucidate the main land use types determining livestock distribution.

Results

There was highly significant correlation between land use and beef cattle, negative with perennial crops and positive with the other land use types (except chestnuts). Goats and dairy cows had low significant correlation with land use. Vineyards (negatively) and natural wet pastures (positively) were highly correlated with all species considered (Table 1).

Table 1. Significant correlation between ruminant groups and land use types (blank - positive, dashed - negative).

	Cs	Ch	Cr	Po	Pv	Pd	Pf	Pc	Lh	Ls	La	Ei	Mp	Mq	Mz	Im
Sheep	***	***	n. s.	***	***	***	n. s.	***	***	***	n. s.	***	n. s.	**	*	***
Goats	***	n. s.	n. s.	n. s.	**	n. s.	n. s.	n. s.	***	n. s.	***	***	***	***	n. s.	***
Beef cattle	**	***	***	***	***	**	*	*	***	***	***	***	***	***	***	***
Dairy cattle	***	***	***	**	***	n. s.	n. s.	n. s.	***	***	n. s.	n. s.	***	n. s.	n. s.	n. s.

Levels of significance: *** $P < 0.001$, ** $0.01 > P > 0.001$, * $0.05 > P > 0.01$, n.s. $P > 0.05$

Multiple regressions of the number of heads on the area of land use types revealed highly significant values (Table 2). It can be observed that a higher number of land use types than in the case of sheep, goats and dairy cows was used to determine the number of beef cows in each municipality. The equation for sheep has the higher regression coefficient, followed by beef cattle, goats and dairy cows. The values of errors are inversely proportional to the size of the animal.

Table 2. Multiple regressions of ruminant groups against land use types.

Group	Multiple regression equation	R	Error	F
Sheep	$16.343 + 0.351PO + 0.291CH + 0.28LH + 0.204CS + 0.184MQ + 0.173PD + 0.121IM - 0.133PV$	0.739	179.2	111.5 ***
Goats	$6.478 + 0.624LA + 0.446LH + 0.105IM + 0.067PO + 0.044MP + 0.039CS - 0.061CH - 0.091PD$	0.653	136.0	69.0 ***
Beef cattle	$-5.82 + 0.286LH + 0.192CR + 0.173EI + 0.161LA + 0.14LS + 0.068CH + 0.068MQ + 0.031MP + 0.029IM - 0.05PD - 0.06MZ$	0.703	66.9	65.8 ***
Dairy cattle	$4.87 + 0.241CR + 0.088LS + 0.078LH + 0.035CH + 0.019CS + 0.013MP - 0.006IM$	0.517	42.0	38.7 ***

For the first and second axis of canonical correlation analysis between number of animal heads and land use areas, the values of 0.621 and 0.502 respectively, were found. Transitions between sheep and beef cows are explained by the variation of land use types from olives, extensive dry annual crops and evergreen oaks and junipers, to chestnuts and permanent - not permanent natural pasture and pine forests. Transitions between goats and dairy cows are explained by the variation of land use types from uncultivated land with shrubs, deciduous oak forests and chestnuts, to high intensity dry farming and high intensity irrigated crops (Figure 1).

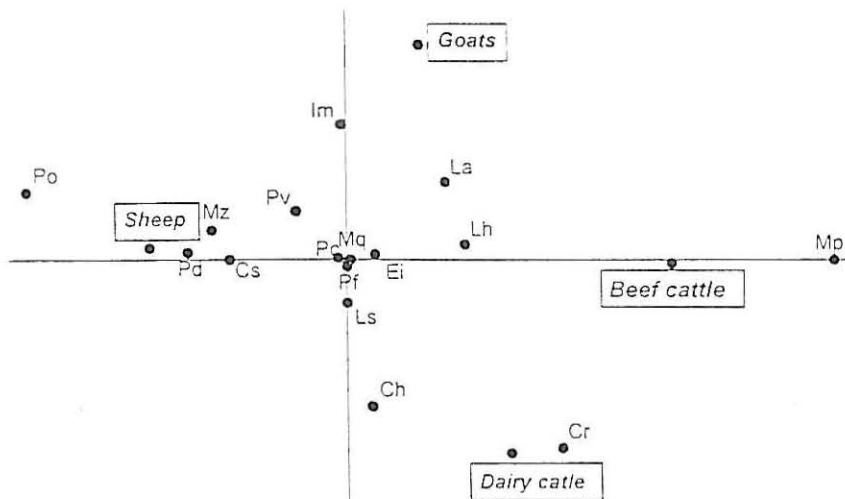


Figure 1. Graphical representation of canonical correlation analysis.

Discussion and conclusions

A very interesting relationship between animals and land use was revealed. A high diversity of land resources is associated with sheep and beef cows, and a low diversity associated with goats (predominating in highland pasture and natural wet pastures) and dairy cows (predominating in alluvium irrigate annual crops).

Two factors emerge as important to understand that dynamic: a climate gradient and topographic situation. The first factor explains a transition between sheep and beef cattle

based in a more or less productive environment (from olives and vineyards to permanent and not permanent wet pastures). The second factor takes the physiographic situation as determinant in the choice between goats on heathland (over stony and rocky summits) or dairy cattle on alluvium with irrigated annual crops (on the bottom of large valleys).

The spatial representation of results displays homogeneous surface tendencies defined by their characteristic breeds of sheep, goats and cows. In fact, for an effective and complete genetic and landscape resources conservation, it seems important to investigate the recent evolution of species-land use relationships, as well as the characteristic landscape resources used by each breed.

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