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# Goat systems of Eastern Andalusia (Spain): Characterization and classification

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**Abstract.** Andalusia is the region with the largest goat population in Spain and Europe. In this region the most common goat breeding is based on the Murciano-Granadina race, located mainly in the Eastern mountainous areas. Different productive models and managerial schemes are found in the area, going from very extensive for meat production to the very technical and specialised system for intensive dairy production. The aim of this study is to perform a goat farming system typology of Eastern Andalusia. Based on data gathered from a survey of 151 farmers, a multivariate statistical analysis has been performed to identify different models of goat production in the area. As a result of a Principal Component (PC) analysis, 71.6% variance was explained. Three components have been estimated. The first component, "size", included total surface area and number of goats. The second, "land use and sheep", is formed by the proportion of cultivated area and presence of sheep. The third, "milk productivity", included milk sold per goat. After conducting a cluster analysis based on these three principal components, farms were classified into four groups. Group 1 is the largest group, with the smallest flocks and smallest area. Group 2 with smaller farms had a high proportion of crop surface area. Group 3 was made up of farms which had large surface areas and big flocks. Group 4 was made up of farms where the presence of sheep is important.

**Keywords.** Goat systems – Typology – Multivariate analysis – Eastern Andalusia.

## ***Le secteur caprin en Andalousie orientale (Espagne) : Caractérisation et classification***

**Résumé.** L'Andalousie est la région qui dispose de l'effectif le plus important de chèvres à l'échelle espagnole et européenne. La Murciano-Granadina est la race la plus commune située surtout dans les zones montagneuses de l'Est. Différents modèles de production et de systèmes de gestion sont trouvés dans la région, allant de la production de viande dans les systèmes très extensifs et traditionnels aux systèmes très modernes et spécialisés pour la production laitière. Le but de cette étude est de réaliser une typologie des modèles caprins de l'Andalousie orientale. Selon les données recueillies à partir d'une enquête portant sur 151 éleveurs, une analyse statistique multivariée a été menée permettant d'identifier les différents modèles de la production caprine dans la région. L'estimation de trois composantes principales a permis d'expliquer 71,6% de la variance. La première inclut la superficie totale et l'effectif de chèvres. La deuxième composante englobe la proportion de la superficie cultivée et l'effectif de brebis. La troisième constitue le lait vendu par chèvre. Après avoir effectué une typologie basée sur ces trois composantes principales, les fermes ont été classées en quatre groupes différents. Le Groupe 1 qui est le plus grand inclut des fermes ayant le plus petit nombre de troupeaux et la superficie la plus réduite. Le Groupe 2 inclut les petites exploitations possédant une forte proportion de superficie cultivée. Le Groupe 3 est composé par des fermes ayant de grandes surfaces et de grands troupeaux. Le Groupe 4 est formé par des fermes où la présence de brebis est importante.

**Mots-clés.** Systèmes caprins – Typologie – Analyse multivariée – Andalousie orientale.

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## **I – Introduction**

In economically depressed areas goat farming plays an important social role by fixing the population and maintaining traditions and furthermore contributes considerably to

multifunctionality and the sustainable development of these areas (Calatrava and Sayadi, 2006; Sayadi and Calatrava 2006a).

Andalusia is the second goat milk-producing region in Europe and the first in Spain. The importance of this sector is very high, accounting with 1,073,815 heads about 7,000 farms, and 228 million litres of milk (MARM, 2010). There are four dairy autochthonous breeds: Murciano-granadina, Malagueña, Florida and Payoya and two meat breeds: Blanca Serrana and Negra Andaluza. The types of systems are very heterogeneous: pastoral, intensive, milk specialized, cheese production (Ruiz *et al.*, 2008; Sánchez *et al.*, 2006; Castel *et al.*, 2010). There are numerous studies about goat systems in Andalusia (Castel *et al.*, 2003; Ruiz *et al.*; 2008, Sánchez *et al.*, 2006) but only a few performed in Eastern Andalusia (Sayadi and Calatrava, 2006b).

The construction of livestock farm typologies is a tool to improve livestock systems. It is possible provide more individualized solutions for each group of farms made. This type of analysis has been used by different authors to study goat systems (Ruiz *et al.*, 2008; Ruiz *et al.*, 2009; Usai *et al.*, 2009).

The objective of the present study was to establish a typology of goat farms in the Eastern Andalusia using multivariate analysis.

## II – Materials and methods

One hundred fifty five goat farms located in Eastern Andalusia were selected. The data were obtained through direct survey interviews with farmers in year 2007. The aim of the sampling was that surveyed farms were representative of the different production systems and herd size in the area rather than forming a strictly representative sample of the population in terms of herd sizes.

A total 16 indicators were chosen for the analysis. The indicators were selected out of a matrix with 151 records (farms) and 16 variables. From these, only the 11 indicators that had a variation coefficient (VC) higher than 50% were selected, since they explained the major diversity between breeders.

The 11 indicators were analysed in order to identify the groups of indicators correlated among them obtaining the intercorrelation matrix to avoid variables with high correlation. Once the correlations obtained were analysed, 7 indicators were finally selected as they were considered interesting in terms of classification and were also representative of other non-selected indicators (see Hair *et al.*, 2000 for more details).

First of all, a factorial data-reduction analysis was carried out with the 7 indicators, using the method of Principal Components and selecting the factors according to their associated eigenvalues when greater than 1. The indicators *Mortality* and *Replacement rate* were eliminated from the multivariate analysis because they created distortion. A second analysis with 5 indicators: total area, proportion of cultivated pasture area, goats number, milk sold per goat and sheep number was carried out applying the condition that eigenvalues be greater than 1, leading to the explanation of 71.6% of the variance and three principal components (PC). To proceed with this grouping a k-means cluster analysis was performed, using the three PC obtained as a classification criterion. The groups used showed perfectly distanced centroids and interesting common features within the systems of a given group.

Finally, in the form of confirmation analysis, the differentiating effect the grouping had on the original indicators was observed. For this a variance analysis (ANOVA) between categories was used. This methodology has been used by different authors to analyse small ruminant research systems (Usai *et al.*, 2006; Ruiz *et al.*, 2009).

For the statistical analysis SPSS v.14 (2005) software was used.

### III – Results and discussion

As a result of the cluster analysis, four groups were obtained which yield interesting and common features among farms from the same group. Group 1 is comprised of one hundred and nine farms. Group 2 is made up of sixteen farms; Group 3 is comprised of fifteen farms, Group 4 is made up of eleven farms. Table 1 shows descriptive statistics of the main indicators referring to each retained cluster.

**Table 1. Technical indicators (means and standard deviation) for each cluster.**

Indicators	Cluster 1	Cluster 2	Cluster 3	Cluster 4	P
Farms	109	16	15	11	
Farm age (years)	13.0 ( $\pm$ 1.1)	13.6 ( $\pm$ 3.0)	16.7 ( $\pm$ 4.0)	11.3 ( $\pm$ 2.8)	ns
Goats number	168 ( $\pm$ 10) b	192 ( $\pm$ 29) b	507 ( $\pm$ 68) a	202 ( $\pm$ 31) b	***
Replacement rate	26.8 ( $\pm$ 2.0)	37.6 ( $\pm$ 9.4)	29.9 ( $\pm$ 8.4)	20.6 ( $\pm$ 1.4)	ns
Evolution of herd size in the last 10 years	56.5 ( $\pm$ 5.5)	67.1 ( $\pm$ 12.7)	62.6 ( $\pm$ 18.5)	71.3 ( $\pm$ 12.6)	ns
Mortality rate	9.0 ( $\pm$ 0.7) a	3.8 ( $\pm$ 0.6) b	8.5 ( $\pm$ 1.2) a	8.0 ( $\pm$ 1.0) a	*
Total area (ha)	19.6 ( $\pm$ 3.9) c	7.8 ( $\pm$ 1.7) c	304.0 ( $\pm$ 57.0) a	183.4 ( $\pm$ 61.3) b	***
Total area per goat (ha/goat)	0.11 ( $\pm$ 0.02) b	0.05 ( $\pm$ 0.01) b	1.00 ( $\pm$ 0.31) a	1.03 ( $\pm$ 0.40) a	***
Proportion of cultivated area	3.1 ( $\pm$ 0.9) b	100.0 ( $\pm$ 10.7) a	3.8 ( $\pm$ 2.3) b	1.7 ( $\pm$ 0.8) b	***
Milk sold per goat (l)	206 ( $\pm$ 11)	232 ( $\pm$ 20)	209 ( $\pm$ 24)	292 ( $\pm$ 59)	ns
Sheep number	9 ( $\pm$ 4) b	0 ( $\pm$ 0) b	1 ( $\pm$ 1) b	350 ( $\pm$ 66) a	***

Values with different letters on the same row are different. \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; ns: not significant.

To summarize, the groups could be described in the following way:

*Group 1.* It is the largest group. Farms within the group have the most little flocks and have little area. Milk production is low. The presence of sheep is not important. This group shall be defined "Typical goat farms".

*Group 2:* Farms within small areas, but totally cultivated for goats. Milk production is medium and very specialized. The flock size is medium. This cluster is defined as "Farms with high cultivated area".

*Group 3:* Farms within large areas and big flocks, defined as "Large farms". They are big, both in terms of area and animal count with a relatively large available area per goat. Sheep are not present.

*Group 4:* Farms within medium area but high area per goat. Size of flocks is medium and the milk production is the highest. Its main particularity is the presence of sheep. This group is henceforth referred to as "Goat-sheep farms".

As regards goat numbers, most farms studied except those belonging to Group 3 are medium size. Bibliography shows a great variation in herd size in the different goat farms. In this study the size of flock is higher to Moroccan systems (Chentouf *et al.*, 2009) (Table 2). But in the case of Group 1, the most large group, its size is similar to French flocks (Bossis *et al.*, 2008) and other andalusian systems (Sánchez *et al.*, 2006). Group 3 is very similar to other Andalusian pastoral systems in reference to size flock (Ruiz *et al.*, 2008). In Group 4 the presence of sheep and goat is important as in other Mediterranean livestock systems (Usai *et al.*, 2006).

As other andalusian system the land area is very important to the feeding management (Ruiz *et al.*, 2008). Groups 3 and 4 have a large-medium area. Its size is very similar to other Mediterranean pastoral systems (between 53 and 368.2 hectares) (Ruiz *et al.* 2009). In Group 2 farmers cultivate all area available. The crop of animal feeding is a strategy recommended in cases where it is possible (Ruiz *et al.*, 2009). This strategy decrease feed cost and increase the autonomy of the farm. There are important differences among the groups regarding the indicator *Total area per goat*. Group 3 and 4 have a high total area per goat, similar to other pastoral systems (Ruiz *et al.*, 2008). But in the case of Group 4, area is shared with sheep. Cluster 2 are indoor farms, surface is only used to cultivate. It is necessary to make an efficient use of grazing resources. Grazing is able to cover an important part of the nutritional needs of animals (Ruiz *et al.*, 2008).

**Table 2. Technical indicators for different Mediterranean areas.**

Reference	Goats	Total area (ha)	Total area per goat (ha/goat)	Milk sold per goat (litres/goat)	Area
Chentouf <i>et al.</i> (2009)	30.7	-	0.34	119.0	North Morocco
Bossis <i>et al.</i> (2008)	231	40	0.17	795	France
Sánchez <i>et al.</i> (2006)	180	-	-	403.1	West Andalusia
Ruiz <i>et al.</i> (2008)	546	454	0.85	400.3	West Andalusia
Usai <i>et al.</i> (2006)	224	-	-	-	Sardinia (Italy)

As for *Milk sold per goat*, there are not significant differences between groups. Milk production is low compared with other goat systems. This may be due to an inferior genetic quality of the herds and possibly to a deficient feeding as occurred in other pastoral goat systems (Ruiz *et al.*, 2009). Unfortunately, in this study no data about the amount and type of feed consumed (concentrate, forage, pasture, etc.) was collected.

The main weaknesses found are linked to less productivity of goats which has direct repercussions on the economic benefits generated. Concerning this productivity of goats, work should be carried out to improve it, but without overlooking the balance between hardiness and productivity.

## IV – Conclusions

There is a wide diversity in the goat systems in Eastern Andalusia. Size of farm and the presence of sheep are the most important variable to classify the farms. The most typical farm is has little flock size and milk productivity, no presence of sheep, and the area per goat and the proportion of cultivated area are small.

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