Cattle Farm Evolution in Disadvantaged Mountainous Areas of North-Western Spain

Emma SERRANO MARTÍNEZ*, Ana Isabel CERDEÑO SÁNCHEZ*,
Ceferina VIEIRA ALLER*, Ángel RUIZ MANTECÓN*

Jel classification: Q120, Q180

Abstract

Riaño Mountain is a disadvantaged area of north-western Spain that has recorded significant changes in cattle production systems over the last ten years. The aim of this study was to characterise the cattle farms of this area in order to evaluate their sustainability. The data analysis was structured in: 1) a description of the farms, and 2) a farm typology: principal components and cluster analyses were performed on variables concerning technical and economic features. The information on the human, technical and economic characteristics of the farms suggests they have important deficiencies. Eight groups were obtained in typology analysis representative of two divergent forms of development which are moving the farms away from the traditional mixed cattle system: specialisation in milk production and intensification on one hand and specialisation in meat production and extensification on the other. The most profitable systems were those less dependent on labour and, in the context of the Common Agricultural Policy, those capable of maximizing the number of subsidised animals per worker.

Keywords: Cattle farming, sustainability, CAP, profitability

Résumé

La Montagne de Riaño est une zone défavorisée du nord-ouest de l'Espagne. Dans cette région, les systèmes de production des bovins ont connu des changements importants au cours des 10 dernières années. L'objectif de cette étude est donc de caractériser les exploitations bovines de cette région pour évaluer leur durabilité. L'analyse des données a été structurée autour : 1) d'une description générale des exploitations et 2) de la mise au point d' une typologie des exploitations compte tenu des résultats d' une analyse des composants principaux et d'une analyse cluster, réalisées sur des variables techniques et économiques. L'information sur les caractéristiques du facteur humain et sur les caractéristiques techniques et économiques des exploitations met en évidence des faiblesses considérables. La typologie des exploitations obtenue inclut huit groupes représentatifs de deux formes divergentes d'évolution qui incitent les exploitations à s'éloigner du système d'élevage mixte traditionnel: l'intensification couplée à la spécialisation dans la production laitière d'une part et l'extensification couplée à la spécialisation dans la production de viande. Les systèmes les plus rentables sont les moins dépendants du facteur travail et, dans le cadre de la Politique Agricole Commune, ceux qui sont capables de maximiser les effectifs primés par travailleur.

Mots-clés: *Production bovine, durabilité, PAC, rentabilité*

1. Introduction and goals

Changes in the agricultural production systems in numerous disadvantaged areas of Europe have often been associated with environmental problems e.g., the proliferation of bushes, erosion, the loss of biodiversity and fires (Chassany and Flamant, 1996; Caraveli, 2000; MacDonald et al., 2000; Tampakis et al., 2005). Large amounts of money have been spent through the Common Agricultural Policy (CAP) to control production surplus, rural depopulation and environmental deterioration.

Riaño Mountain is located in the Province of León, in northwestern Spain. (Fig. 1). The relief of this area is steep, characterized by harsh weather conditions with long periods of low temperatures (Serrano et al., 2004). In this area, where agriculture is difficult, stock raising is particularly important. Riaño Mountain is a highly humanised territory. Many of the area's social and natural features are the result of the use of natural resources by farming systems adapted to this environment; their preservation is part of the function of the Picos de Europa National and Regional Parks.

Over the last two decades the area has suffered an important loss of population; between 1991 and 2001 it lost 14.4% of its population (JCyL, 1992, 2002). Cattle farming has a relatively high importance in this area. The traditional cattle raising system used in the area is of the mixed type, i.e., in which both milk and meat are produced, and is based on the Brown Swiss breed. All the native breeds were replaced by the Brown Swiss during the 1940s. Cattle farm operations in the area are clearly differentiated into two periods: summer herding in the higher areas, and winter stabling in the lower areas when the animals are fed on stored forage collected in the valleys. During the last decade, a great number of farms have disappeared, and important changes have occurred in cattle production on the remaining ones. Official statistics reflect (Serrano et al., 2004): (1) an increase in the number of livestock, (2) an increase in the number of cattle per farm, and (3) a reduction in dairy and an increase in non-dairy cattle. The area classified as being of agricultural use fell by 32.1% from 1990 to 1999 (JCyL, 2002).

Stemming the depopulation and environmental deterioration of these areas requires the introduction and maintenance of sustainable livestock systems. This requires that information be collected on the status and development of current systems. There are many definitions of the term sustainability (Rigby and Càceres, 2001); in the present context, that of Landais (1999) is appropriate: an economically viable system, supportable by the work and social require-

*Estación Agrícola Experimental del CSIC, León, Spain.

ments involved, inheritable by subsequent generations and from an environmental point of view, reproducible over the long term. Within the current socioeconomic context of European agriculture, one of the most important factors in the change and in the sustainability of farming systems is the CAP (Caraveli, 2000; Caballero, 2001; Léon, 2005; Veysset et al., 2005).

The aims of the present study were to characterise cattle farming in the mountains of León, an example of a European disadvantaged area, to establish a typology of the area's cattle farms, to acquire a better understanding of the factors determining the changes that have occurred in production systems over the last decade, with special reference to CAP application, and to evaluate their sustainability

Figure 1. *Location of Riaño Mountain*

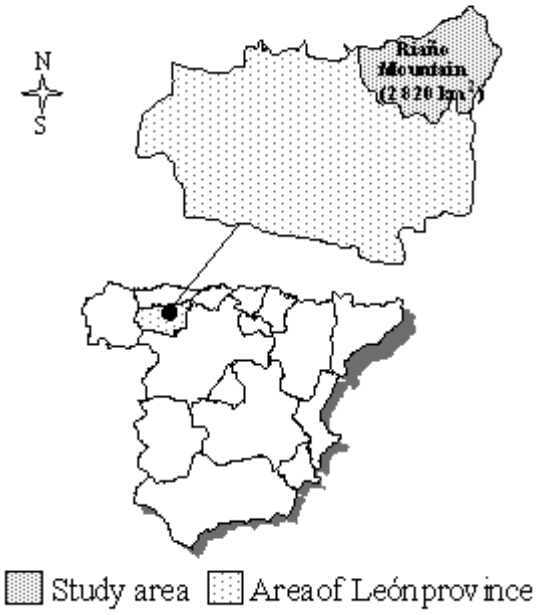

Table 1. *Variables considered in Principal Component Analysis*

Labour	Production
breeding cows/AWU-cattle [a,b]	litres milk sold/farm*
Land use	Dif. litres milk sold-quota (%) [e*]
LU-total [c]/UAA [d]	% weaned grazing calves [h]
Stock base	% finished calves [h]
breeding cows/farm	% bought fattened calves [h]
dairy cows (%) [e*]	calves sold/breeding cow
Brown Swiss breed (%) [e]	calves born/breeding cow
crossbreeds (%) [e]	
LU-other species (%) [f]	
Costs	Income
cattle costs [i]/breeding cow	total income [l]
forage/breeding cow	income from cattle [k]/breeding cow
concentrates/breeding cow	calves/breeding cow
fuel/breeding cow	adults slaughtered/breeding cow
electricity/breeding cow	milk/breeding cow*
social security /breeding cow	subsidies/breeding cow
replacement cattle/breeding cow	capitalisation calves [o]/breeding cow
re-sold cattle/breeding cow	capitalisation adults [p]/breeding cow
maintenance/breeding cow	
sanitary/breeding cow	
Profits	
income from subsidies/GM-cattle [n](%)	
GM-cattle [n]/AWU-cattle [b]	
GM-cattle [n]/breeding cow	

*Calculated considering only milk producing farms (n=70); **AWU**[a]: annual work unit, work performed by one full time agricultural worker in one year. **AWU-cattle**[b]: annual work units referring specifically to the activity of cattle production. **LU-total**[c]: livestock units considering the number of breeding cows, ewes, goats and mares calculated according to the conversion indices described in the Council Regulation (EEC) No. 1254/99, 17 May 1999. **UAA**[d]: utilised agricultural area (ha). **dairy cows (%), Brown Swiss breed (%), crossbreeds (%)**[e]: % of dairy cows, Brown Swiss breed and crossbreed cows respectively. **LU other species (%)** [f]: % of the LU-total of a farm made up by sheep, goats and mares, calculated according to the conversion indices described in the Council Regulation (EEC) No. 1254/99, 17 May 1999. **Dif. litres milk sold-quota (%)**[e]: percentage of the difference between the number of litres of milk produced on the farm and that assigned by milk quota. **% weaned grazing calves, % finished calves, % bought fattened calves**[h]: percentage of calves sold at weaning before fattening and fed only on milk and pasture; for slaughter; resold after their acquisition to another farm after a period of fattening. **cattle costs** [i]: sum of costs of feeding, sanitary products, fuel, electricity, facilities maintenance, cattle purchase, labour, insurance and other associated exclusively with cattle production. **income from cattle** [k]: sum of the income from the sale of calves, adult cattle for slaughter, adult cattle not for slaughter, milk, subsidies and from the estimated variation in the number of animals held by farm (capitalisation of livestock). **total income** [l]: sum of income from cattle and from other species or the sale of agricultural products. **GM-cattle** [n]: gross margin for cattle, difference between income from cattle and cattle costs. **income from calf capitalisation** [o]: estimated value of variation in number of calves for one year. **income from adults capitalisation** [p]: estimated value of variation in number of breeding cows and studs for one year.

2. Materials and Methods

First of all, it was necessary to deepen our knowledge of the social, techno-economic and operational characteristics of the area's cattle farms. In this disadvantaged area, which has relatively marginal farming activity compared to other areas, farmers' associations are poorly developed and the flow of information between the farmers, the authorities and the agricultural technicians is poor. Contacting farmers and gathering information on their operations can therefore be difficult. In 1997 a “Meat Project” was developed in this area for the production of high quality beef. Within this framework, a large number of farmers from the Riaño Mountain area joined the León Cattle Farmers' Association with the aim of selling their animals for slaughter to a private company (NEAL S.A.) for processing and marketing. This favoured the contact with a group of farms.

Information was collected by direct enquiry on these farms in 1996, 1997 and 1998. Information for 1996 and 1997 was gathered in a single survey performed during the first three months of the following year. In 1998, information was gathered during monthly farm visits. The data collected were completed and checked against those gathered during other visits, from the farms' Official Registration Books, and with information provided by NEAL S.A.

The number of surveys performed during the first year of the project was 75, but only the information provided by 41 farms was considered valid. During the second year 45 surveys were carried out, 35 of which were considered valid. During the third year the number of surveys performed was 47, 35 of which were considered valid. To be considered as such, information had to be sufficient

and consistent. The main reasons for exclusion were reticence to provide information and the lack of economic or technical/production records.

The information gathering process was approached from the "farming system" conceptual framework (Osty, 1978; Béranger and Vissac, 1994; Landais, 1998; Belgacem, 2005); this requires collecting data on human factors, animal base, production characteristics, technical and structural characteristics, and economic factors.

The data were analysed in two parts: 1) a general description of human factors, facilities, and reproduction and sanitary management characteristics (quantitative variables were expressed as means and ranges, qualitative variables as number of farms and percentages), and 2) a farm typology was constructed using principal components analysis (PCA), cluster analysis and a group of 85 quantitative variables regarding technical and economic features (Table 1).

The PCA analysis implied the use of the FACTOR and VARIMAX rotation procedures included in the SAS statistical package (SAS, 1989). The information collected over the three years of the study was analysed together. Data pertaining to each farm and to each year of the study were taken as single observations, and the PCA was performed with a total of 111 observations (41 for 1996, 35 for 1997 and 35 for 1998). Using a starting set of 85 variables (Annex 1), correlation analysis was performed to eliminate those providing redundant information (e.g., suckling cows [%] correlated with income from subsidies/breeding cow). A total of 43 variables were discarded in this way (r e 0.50 and $p<0.005$ for all of them). Preliminary PCA was then performed to remove variables that provided little information (variables with low communality indices) (Cody and Smith, 1997). The variables eliminated at this stage were: pasture costs/breeding cow, stud costs/breeding cow, insurance costs/breeding cow, other costs/breeding cow, dead calves/calves born (%) and income from adult cattle not for slaughter/breeding cow. The final set of variables examined by PCA was 35 (Table 1).

Cluster analysis was carried out using the CLUSTER procedure of the SAS program (SAS, 1989); the Average Link procedure was used as classification method. Axes obtained from PCA were used as classification variables. Two cluster analyses were performed, one taking into account all 7 factors determined by PCA, the other taking into account only the first two. The usefulness and interpretability of the two sets of results obtained were compared and the two-factor option proved to be the most reliable. The groups obtained were compared by variance analysis using the SAS GLM procedure (SAS, 1989).

Table 2. *Human factor characteristics.*

	YEAR 1996			YEAR 1997			YEAR 1998		
	Mean	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**	**Min.**	**Max.**
Holder age	**44.8**	23	62	**46.1**	24	63	**45.9**	25	64
Principal worker age	**40.6**	20	64	**41.3**	21	65	**41.9**	22	66
N° of workers	**2.4**	1	5	**2.5**	1	5	**2.3**	1	5
AWU-total[a]	**1.9**	0.5	3.5	**1.9**	0.5	3.4	**1.8**	0.5	3.4
AWU-cattle[b]	**1.8**	0.3	3.5	**1.8**	0.4	3.4	**1.7**	0.5	3.4
Breeding cow/AWU-cattle[b]	**21.4**	3.9	100.0	**22.2**	5.0	81.0	**25.4**	5.0	87.0
	n° and (%) of farms			**n° and (%) of farms**			**n° and (%) of farms**		
Male holder	**30** (73.1)			**25** (71.4)			**26** (74.3)		
Male principal worker	**39** (95.1)			**33** (94.3)			**33** (94.3)		
Non-married holder	**13** (31.7)			**12** (34.3)			**13** (37.1)		
Non-married main worker	**19** (46.3)			**18** (51.4)			**19** (54.3)		
Succession: Yes	**11** (26.8)			**9** (25.7)			**6** (17.1)		
No	**11** (26.8)			**9** (25.7)			**11** (31.4)		
Not sure	**19** (46.3)			**17** (48.6)			**18** (51.4)		
Livestock main source of income	**38** (92.7)			**32** (91.4)			**32** (91.4)		

[a]AWU-total: Annual Work Units referring to the overall exploitation. [b]AWU-cattle: Annual Work Units referring specifically to cattle production.

Table 3. *Installation characteristics*

		YEAR 1996	YEAR 1997	YEAR 1998
		n° and (%) of farms		
Type of stable:	recently built installations	**9** (21.9)	**7** (20.0)	**9** (25.7)
	traditional stable	**8** (19.5)	**8** (22.9)	**8** (22.9)
	several traditional stables	**16** (39.0)	**13** (37.1)	**12** (34.3)
	recent installations + traditional stable	**8** (19.5)	**7** (20.0)	**6** (17.1)
Stable facilities:	running water	**33** (80.5)	**27** (77.1)	**28** (80.0)
	electrical wiring	**33** (80.5)	**27** (77.1)	**28** (80.0)
	dung collection system	**3** (7.3)	**2** (5.7)	**4** (11.4)
	enough room for tractor to enter	**8** (19.5)	**5** (14.3)	**8** (22.9)
	feeding passages	**24** (58.5)	**7** (20.0)	**10** (28.6)
Farm machinery:	tractor	**39** (95.1)	**34** (97.1)	**34** (97.1)
	baler	**37** (90.2)	**32** (91.4)	**32** (91.4)
	big baler	**5** (12.2)	**4** (11.4)	**7** (20.0)
Milking system:	no milking	**12** (29.3)	**13** (37.1)	**15** (42.9)
	churn milking machine	**26** (89.7)	**18** (81.8)	**14** (70.0)
	direct stable milking	**2** (6.9)	**3** (13.6)	**5** (25.0)
	direct milking in a milk parlour	**1** (3.5)	**1** (4.5)	**1** (5.0)

3. Results

3.1. Human factors

Table 2 shows some of the human factor data recorded in the surveys. All the farms studied were family farms; none had any workers who were not members of the family.

Taking into account the average age of the farm holders and the main workers, the percentage of

non-married people was high. This situation is in line with the relatively high frequency (35 % of the farms in 1996) of family structures formed by both parents, elderly or retired in some instances, by a farm holder and one or more non-married sons aged over 35. In 28 % of the surveyed farms, no family member would eventually take over the farm once the current owners retired. Only three of all the surveyed farms did not consider cattle farming the family's main source of income. On 11 farms, the principal worker or his wife had paid jobs outside the farm.

3.2. Building characteristics

Table 3 shows that most farms had traditional stables for housing their cattle. These were old, generally stone buildings sometimes integrated into the urban area of a village or part of the farmer's house. These types of construction generally have deficient lighting and ventilation, and tasks such as feeding and dung removal are difficult to perform. Modifying them or making extension to them would be very difficult. Due to farm concentration and the enlargement process that has occurred over the last few years, several traditional stables were found on the farms. Recent and more suitable buildings located outside the villages were the minority.

Manual milking was performed on none of the surveyed farms. Three types of mechanical milking systems were recorded: those with intermediate milk collection tanks requiring periodic, manual emptying into a general storage tank (churn milking machine); milking machines with a direct inlet into the storage tank (direct stable milking); and milk parlour systems with direct inlet into the storage tank (direct milking in a milk parlour). Table 3 shows that the churn milking system (the oldest type) was the most common one.

3.3. Technical characteristics: reproduction management, sanitary conditions and fodder production

Table 4 shows that most farmers lacked even elementary technical knowledge regarding basic sanitary conditions and reproduction management. Sanitary products were used indiscriminately, the sanitary status of farms was poor, and reproduction management plans were mostly absent.

Table 4 also shows the practically non-existent agricultural activity on the surveyed farms. Most had only one harvest for all their pastures, which indicates low exploitation possibilities for their grass surfaces. Only a few farms produced silage.

3.4. Principal components analysis

Table 5 shows the characteristics of the seven initial axes obtained with PCA. These axes were all chosen by the program, taking into account the evolution of explained variance. All had auto-values of >1.

Axis 1 shows high values for farms with Brown Swiss breeding cows orientated towards dairy production, with high production per cow and relatively intensive production systems. This factor can be defined as dealing with “dairy production orientation, production system intensification and productivity per cow.”

Axis 2 can be defined as dealing with “Farm size and work productivity” and classifies farms depending on their size (number of cows) depending on labour requirements and work productivity. This axis showed high values for farms with many head of cattle and with production systems which allow a single worker to handle many cows with high productivity.

3.5. Cluster Analysis: farm association

The classification according to the first two PCA factors allowed farms to be grouped depending on their productive

Table 4. *Technical characteristics of farms*

		YEAR 1996		YEAR 1997		YEAR 1998	
		n° and (%) of farms					
Reproductive management							
Reproduction planning techniques:	not used	37	(90.2)	32	(91.4)	31	(88.6)
	management techniques	3	(7.3)	2	(5.7)	3	(8.6)
	hormonal	1	(2.4)	1	(2.9)	1	(2.9)
Type of breeding:	artificial	10	(24.4)	8	(22.9)	9	(25.7)
	natural with own studs	14	(34.2)	13	(37.1)	12	(34.3)
	both	14	(34.2)	11	(31.4)	11	(31.4)
	natural with shared bulls	3	(7.3)	3	(8.6)	3	(8.6)
Routine pregnancy testing		0	(0.0)	0	(0.0)	0	(0.0)
Reproductive register		8	(19.5)	7	(20.0)	8	(22.9)
Sanitary management							
Frequency of anthelmintic treatments:	once a year	29	(70.7)	26	(74.3)	25	(71.4)
	twice a year	10	(24.4)	7	(20.0)	8	(22.9)
Frequency of faecal examinations:	occasionally	2	(4.9)	2	(5.7)	3	(8.6)
	regularly	0	(0.0)	0	(0.0)	0	(0.0)
	never	39	(95.1)	33	(94.3)	32	(91.4)
Sanitary preventive measures in purchased animals:							
	neither	32	(78.1)	27	(77.1)	26	(74.3)
	deworming	5	(12.2)	4	(11.4)	5	(14.3)
	serology	2	(4.9)	2	(5.7)	2	(5.7)
	both	2	(4.9)	2	(5.7)	2	(5.7)
Preventive sanitary measures in case of abortion		5	(25.0)	3	(16.7)	3	(15.8)
Official sanitary campaign results:	Brucellosis positive	5	(12.2)	4	(11.4)	5	(14.3)
	tuberculosis positive	1	(2.4)	1	(2.9)	0	(0.0)
	positive for several diseases	2	(4.9)	0	(0.0)	0	(0.0)
Animal feed production							
One harvest on all farm pastures		30	(73.2)	26	(74.3)	26	(74.3)
No silage made		27	(65.9)	25	(71.4)	22	(62.9)
Forage bought:	none	12	(29.3)	7	(20.0)	5	(14.3)
	only straw	24	(58.5)	20	(57.1)	24	(68.6)
Selling forage:		0	(0.0)	1	(2.9)	1	(2.9)
Agricultural activity:	none	34	(82.9)	29	(82.9)	29	(82.9)
	only forage production	6	(14.6)	6	(17.1)	6	(17.1)
	cereals or legume seed production	1	(2.4)	1	(2.9)	1	(2.9)

Table 5. *Factors selected by PCA, the variance explained, the significance of each factor, and correlation coefficients between each factor and the variables that characterise it*

	% of Variance explained (accumulated % of variance explained) eigenvalue	Significance of Factor	Variables and correlation coefficients with factors	
FACTOR 1	**18.9**	• Dairy production	*income from milk/breeding cow*	**0.91**
	(18.9)	orientation	*dairy cows (%)*	**0.83**
	6.6	• Intensification of	*litres milk sold/farm*	**0.83**
		production system	*income from cattle/breeding cow*	**0.82**
		• Individual	*Brown Swiss breed (%)*	**0.71**
		productivity	*costs of concentrates/ breeding cow*	**0.68**
		per breeding cow	*GM-cattle [a] /breeding cow*	**0.66**
			electricity cost/breeding cow	**0.61**
			Dif.[b] litres milk sold-quota (%)	**0.59**
			cattle costs/breeding cow	**0.53**
			crossbreeds (%)	**-0.57**
FACTOR 2	**12.2**	• Productivity	*GM-cattle [a] /AWU-cattle [c]*	**0.87**
	(31.1)	of labour	*breeding cows/farm*	**0.87**
	4.3	• Farm size	*total income*	**0.86**
			breeding cows/AWU-cattle [c]	**0.73**
			social security costs/breeding cow	**-0.55**
FACTOR 3	**9.5**	• General	*cattle-costs/breeding cow*	**0.73**
	(40.6)	management	*replacement costs/breeding cow*	**0.71**
	3.3		*fuel costs/breeding cow*	**0.68**
			forage costs/breeding cow	**0.56**
			maintenance costs/breeding cow	**0.53**
			sanitary costs/breeding cow	**0.52**
FACTOR 4	**7.7**	• Complementary	*costs of re-sold cattle/breeding cow*	**0.74**
	(48.3)	activities	*% bought fattened calves*	**0.73**
	2.7		*LU-other species [d] (%)*	**0.70**
			income from capitalisation of adults /breeding cow	**0.56**
FACTOR 5	**6.9**	• Efficiency of	*calves sold/breeding cow*	**0.91**
	(55.2)	calf production	*income from calves/breeding cow*	**0.87**
	2.4		*income from capitalisation of calves /breeding cow*	**-0.57**
FACTOR 6	**6.8**	• Grazing	*LU-total [e] /UAA [f]*	**0.77**
	(62.0)	system	*income adults slaughtered/breeding cow*	**0.73**
	2.4		*% weaned grazing calves*	**0.50**
			calves born/breeding cow	**-0.61**
FACTOR 7	**5.1**	• Importance of	*% finished calves*	**0.85**
	(67.1)	calf finishing	*% weaned grazing calves*	**-0.55**
	1.8			

[a]GM-cattle: gross margin for cattle production. [b]Dif: difference. [c]AWU-cattle: annual work units referring specifically to the activity of cattle production. [d]LU-other species: livestock units of a farm made up by sheep, goats and mares. [e]LU-total: livestock units of a farm calculated considering the number of cows, sheep, goats and mares. [f]UAA: utilised agricultural area (ha).

orientation, their size, and productivity criteria per cow and per work unit. Production type and quality, farm size and productivity were not independent aspects of farm operations in the remaining axes. Thus, the classification obtained by cluster analysis also grouped farms by these variables. When only the first two PCA axes were taken into account, 8 groups of farms were obtained:

Group 1. Farms mainly intended for milk production.

Group 2. Farms specialised in calf production with a large number of breeding cows and a high number per work unit (extensive production systems with respect to the factor 'labour').

Group 3. Medium-sized milk-producing farms with a high percentage of breeding cows specialised in calf production.

Group 4. Farms specialised in calf production, with a small number of breeding cows per farm and annual work unit.

Group 5. Farms moving towards specialisation in calf production.

Group 6. Traditional mixed farms (production of milk and different types of calf).

Group 7. Farms specialised in calf production, with a medium number of breeding cows per farm and annual work unit.

Group 8. Subgroup of group 3.

Tables 6 and 7 show the average values of the different variables with respect to each group, their level of significance and the residual standard deviation (RSD) obtained in the variance analysis of the 35 variables included in the PCA.

Six of these eight groups were gathered into two general typologies: farms specialising in calf production (Groups 2, 4 and 7) and farms combining dairy and different types of calf production (Groups 1, 3 and 6). The first group can be divided into three subgroups depending on the number of cows per farm: Groups 2, 7 and 4 from the smallest to the largest. Within the second group, three subgroups can be distinguished depending on their size and orientation towards dairy production: Groups 3, 1 and 6 from the smallest to the largest. Group 5 was made up of farms in transition between those of smaller size in the dairy production typology and those specialised in calf production. Group 8 can be considered a subgroup of Group 3 if farm size is taken into account.

4. Discussion

The number of livestock, farms and their size suggests that the CAP favours beef production in this area and the enlargement of farms for securing economic viability. However, with respect to human factors and the productive, structural, technical and economic characteristics of the sample, the sector has important deficiencies and its viability without EU help is reduced. Certainly, the negative feelings demonstrated by most of the surveyed farmers towards their job, the living they made and their working conditions - and thus toward the possibility of their being succeeded by their descendants - makes the continuation of the activity seem unlikely (Potter and Lobley, 1996; Vipond, 1996; Caballero, 2001).

The economic viability of some livestock systems is conditioned by other local social and economic characteristics that determine the possibilities of providing additional income. Some authors (Olaizola and Manrique, 1992; Havet et al., 1994;) agree that part time dedication to stock raising/agriculture is an important adaptation strategy for farms located in less favoured areas, and that complementary economic activities could help achieve sustainable farming systems. However, this adaptation strategy had not been followed by the majority of the farms studied.

Crop and forage production was practically nil. This is frequently seen in less favoured areas (Dobremez et al.,

Table 6. *Labour, stock base, production characteristics and land use of the farm types identified by Clusters Analysis*

	GROUP 1 n=4	GROUP 2 n=3	GROUP 3 n=8	GROUP 4 n=25	GROUP 5 n=13	GROUP 6 n=47	GROUP 7 n=7	GROUP 8 n=3	RSD[a]	P
Labour										
breeding cows/AWU-cattle[b]	12.96	89.33	23.51	27.68	21.64	13.48	42.14	38.17	7.98	0.0001
Stock base										
breeding cows/farm	26.50	89.33	39.13	34.52	24.54	25.62	58.86	76.33	9.50	0.0001
dairy cows (%)	100.00	0.00	50.95	3.58	12.16	64.29	0.00	48.67	21.09	0.0001
Brown Swiss breed (%)	100.00	5.73	80.68	31.75	28.68	76.37	25.76	85.67	23.51	0.0001
crossbreeds (%)	0.00	82.07	14.64	42.72	27.52	13.86	60.56	14.33	20.24	0.0001
LU-other species[c] (%)	0.00	0.00	1.53	3.13	18.03	2.38	6.89	0.00	9.70	0.0001
Production characteristics										
litres milk sold/farm	114 250	0	58 750	3 080	10 230	38 387	0	169 630	16 711	0.0001
Difference litres milk sold-quota (%)	110.39	0.00	26.22	-6.71	-19.34	12.51	0.00	6.02	38.21	0.0001
% weaned grazing calves	0.00	44.07	0.99	12.19	4.17	3.08	24.46	0.00	18.32	0.0006
% finished calves	63.69	55.93	72.65	76.12	64.97	65.44	72.80	95.83	33.75	0.7270
% bought fattened calves	5.95	0.00	2.38	0.00	4.55	0.00	0.00	0.74	11.29	0.9073
calves sold/breeding cow	0.42	0.36	0.49	0.44	0.41	0.49	0.49	0.53	0.19	0.7196
calves born/breeding cow	0.81	0.60	0.77	0.81	0.78	0.79	0.71	0.96	0.14	0.0993
Land use										
LU-total[d] /UAA[e]	0.76	3.17	1.42	1.60	1.29	1.67	1.82	1.53	1.42	0.5311

[a]RSD: residual standard deviation
[b]AWU-cattle: annual work units referring specifically to the activity of cattle production. [c]LU-other species: livestock units of a farm made up by sheep, goats and mares. [d]LU-total: livestock units of a farm calculated considering the number of cows, sheep, goats and mares. [e]UAA: utilised agricultural area (ha).

Table 7. *Economic characteristics (mean annual costs, income and profit expressed in Euros) for the different types of farm identified by cluster analysis.*

	GROUP 1 n=4	GROUP 2 n=3	GROUP 3 n=8	GROUP 4 n=25	GROUP 5 n=13	GROUP 6 n=47	GROUP 7 n=7	GROUP 8 n=3	RSD[a]	P
Costs										
cattle costs/breeding cow	797	283	62	307	456	524	253	813	205.4	0.0001
sanitary costs/breeding cow	41	17	38	28	27	34	17	55	16.0	0.0066
forage/breeding cow	26	22	32	22	26	29	21	43	27.4	0.8914
concentrates/breeding cow	464	64	249	95	139	248	48	502	108.0	0.0001
fuel/breeding cow	16	21	21	15	16	22	22	19	15.6	0.7051
electricity/breeding cow	16	0	13	4	8	13	2	5	4.3	0.0001
social security/breeding cow	136	19	59	53	78	81	35	37	26.5	0.0001
replacement cattle/breeding cow	6	93	96	16	52	21	32	3	68.2	0.0579
re-sold animals/breeding cow	20	0	28	8	28	1	1	12	32.7	0.1266
maintenance/breeding cow	33	12	22	19	23	25	24	32	17.7	0.6001
Income										
Total income	49 846	59 441	50 572	26 990	16 791	25 070	48 197	122 196	9 308	0.0001
Income-cattle/breeding cow	1 931	665	1 316	795	680	1 001	722	1 584	216	0.0001
calves/breeding cow	251	221	319	310	262	292	343	461	139	0.3860
adults for slaughter/breeding cow	25	91	50	36	24	47	33	21	47	0.3494
milk/breeding cow	1 188	0	487	20	88	421	0	653	175	0.0001
subsidies/breeding cow	116	168	198	215	184	155	241	245	51	0.0001
capitalisation of calves/breeding cow	78	89	85	110	19	13	40	89	115	0.0561
capitalisation of adults/breeding cow	42	95	99	39	62	34	56	96	103	0.7104
Economic and productivity results										
GM-cattle[b] /breeding cow	1 133	382	696	443	224	477	469	771	156	0.0001
GM-cattle[b] /AWU-cattle[c]	14 605	33 853	16 508	12 587	5 450	6 527	18 213	30 712	5 335	0.0001
Income subsidies/GM-cattle[b] (%)	10	45	31	51	79	8	64	36	150	0.8569

[a]RSD: residual standard deviation
[b]GM-cattle: gross margin for cattle production. [c]AWU-cattle: annual work units referring specifically to the activity of cattle production.

1990; Balent and Gibon, 1996; Caraveli, 2000) and can be attributed to the low yields obtained compared to areas with more favourable weather and soil conditions. Other reasons include the abandonment of a subsistence economy, more possibilities of buying feed, and the reduction of demographic pressures decrease for larger farms.

The adaptation of traditional mountain cattle raising systems to current socioeconomic conditions has led to great diversity in the production systems followed (Olaizola et al., 1995; Chatellier et al., 2000; Veysset et al., 2005). The eight different farm types described in this paper are an expression of this diversification, and they represent different stages in the move away from the traditional cattle-raising model of the mountains of León (which nowadays brings only small profits). Group 6 is the closest to the traditional model. Two major divergent trajectories from this model were apparent (Table 7):

- Specialisation in dairy production with intensification of the production system.
- Specialisation in beef production with extensification of the production system.

Group 1 is the most representative of the first of these trajectories (Tables 6 and 7). A large increase in production per breeding cow is obtained with this system, although a large

proportion of their feed is concentrated material which has to be purchased. This increase in production is accompanied by greater productivity per breeding cow. However, this type of system has high labour requirements and therefore high costs that do not allow high productivity per farm or per work unit to be achieved. An increase in Group 1 farm productivity, based on an increase in size, is limited by the characteristics of these farms and milk production quotas, (in this group, sold milk surpasses the milk quota by 110%). These farms are therefore forced to devote part of the milk they produce to feeding calves. Increased calf fattening, the sale of Brown Swiss heifers as replacement animals, and the adaptation of the milk production system towards one based on the use of farm-produced forage might provide economic alternatives. The latter might also be of environmental interest (Chatellier and Vérité, 2003).

Group 3 includes farms on which breeding cattle for milk production follows a production system similar to that of Group 1. These have enlarged their size by adding a specialised calf production herd to their milk herd and have reduced their milk quota overshoot to 26%. The margin obtained per breeding cow in Group 3 is lower than that in Group 1. Productivity is similar in both groups since a larger number of cows can be managed per work unit. Given the existence of milk quotas, the only way to greatly increase productivity would be to increase the size of the herd oriented towards calf production.

Group 2 follows the second of the general trajectories (specialisation in beef production and extensification of the production system). These farms, which are specialised in calf production, achieve maximum productivity per work unit, which compensates for poor technical and economic results per breeding cow. The production system is very extensive; herd size is very large, and large numbers of breeding cows are managed per work unit and at a very low cost per breeding cow. This system allows for high extra income from subsidies (large numbers of nursing cows) upon which farms depend.

The other two groups specialised in calf production are Groups 4 and 5. Owing to their smaller size, Group 4 farms have lower productivity per farm and per work unit than those of Group 2, while Group 9 farms show lower productivity per work unit than Group 2. In the present socioeconomic context, the best way forward, especially for Group 4, would be to increase the number of breeding cows and extensify the production system to the limits imposed by pasture availability and the subsidy system.

The results of this work confirm that the recent socioeconomic context has led to the increased importance of work productivity in the profitability of production systems (Tirel, 1991; Landais and Balent, 1995). The most profitable systems are those less dependent on labour and capital per hectare, and in the context of ruminant meat production and CAP subsides, those capable of maximizing the number of subsidised animals per work unit (in some circumstances almost independently of other factors affecting productivity) (Veysset et al., 1999; Caraveli, 2000; Caballero, 2001; Júdez et al., 2001; Veysset et al., 2005). The question arises as to whether these systems contribute to the long term maintenance of the social and natural environment or limit the development of a larger number of farms with more adequate production systems (Veysset et al., 1999; Chatellier and Verité, 2003; Léon, 2005).

The two diverging pathways of development described above are common to many disadvantaged areas where the CAP is applied, and have often had opposite impacts on the mountainous regions of Mediterranean Europe (Caraveli, 2000; MacDonald et al., 2000): the overuse of resources in some areas (often those richer and more accessible, where animal management requires less work), and the abandonment and marginalisation of others (i.e., those that are less productive, with poorer access, or which require the management of a high number of animals per work unit).

Agricultural progress (mechanisation, intensification, increase in farm size) in mountainous regions in general, and in the Mediterranean in particular, has been limited (Caraveli, 2000; McDonald et al., 2000). The maintenance of viable exploitations in these areas requires that CAP measures, such as the imposition of milk quotas, be applied only after taking the above into account. For example, quotas higher than historic production values should be allowed, accompanied by other measures such as the development of beef processing activities and quality labels. This special kind of application of the CAP has been successful in other mountain areas (Chatellier and Delattre, 2003).

6. Conclusions

This work shows that the CAP has been a determining factor in the changes experienced by the farming systems of the mountains of León. The results suggest that measures included in the CAP, and subsidies in particular, have not contributed to the improvement of cattle farm sustainability in this area, as understood in social, economic and environmental terms. Farm abandonment, together with some of the political measures applied (among which subsidies for nursing cows and milk quotas stand out), favour the development of systems mainly orientated towards calf production. These are based on large numbers of breeding cows and very extensive farming systems in which subsidised suckling cows represent a very high percentage of farm profits.

Acknowledgements

This work was part of the Research Project 1FD1997-0776, which is financially supported by the Spanish Ministry of Science and Technology and EU FEDER funds within the framework of the Research Contract between NEAL S.A and the CSIC.

References

Balent G., Gibon A., 1996. Organisation collective et individuelle dans la gestion des ressources pastorales: conséquences sur la

durabilité agroécologique des ressources. In: The Optimal Exploitation of Marginal Mediterranean Areas by Extensive Ruminant Production System, Elsevier, Amsterdam, 365-375.

Belgacem Z., 2005. Vers une approche de développement basée sur l'agriculteur. New Medit, 3, 12-21.

Béranger C., Vissac B., 1994. A holistic approach to livestock farming systems: theoretical and methodological aspects. In The Study of Livestock Farming Systems in a Research and Framework, Wageningen Press, Wageningen, 5-17.

Caballero R., 2001. Typology of cereal-sheep farming systems in Castile-La Mancha (south-central Spain). Agricultural Systems, 68, 215-232.

Caraveli H., 2000. A comparative analysis on intensification and extensification in Mediterranean agriculture: dilemmas for LFAs policy. Journal of Rural Studies, 16, 231-242.

Chassany J.P., Flamant J.C., 1996. Contexte économique, social et institutionnel de la question pastorale et des systèmes d'élevage extensif en région méditerranéene. In The Optimal Exploitation of Marginal Mediterranean Areas by Extensive Ruminant Production System. Elsevier, Amsterdam, 15-32.

Chatellier V., Colson F., Fuentes M., Vard T., 2000. Les exploitations d'élevage herbivore dans l'Union européenne. INRA Production Animal, 13, 201-213.

Chatellier V., Delattre F., 2003. La production laitière dans les montagnes françaises: une dynamique particulière pour les Alpes du Nord. INRA Production Animal, 16, 61-76.

Chatellier V., Verité R., 2003. L'élevage bovin et l'environnement en France: le diagnostic justifie-t-il des alternatives techniques ?. INRA Production Animal, 16, 231-249.

Cody R.P., Smith J.K., 1997. Applied Statistics and the SAS Programming Language. Prentice Hall, New Jersey, 153 pages.

Dobremez L., Lienard G., Barret M., 1990. Systèmes de production laitière en montagne: Evolutions récentes et adaptations possibles. Exemple d'exploitation en Haute-Loire. INRA Production Animale, 3, 329-345.

Havet A., Gibon A., Hubert B., Roux M., 1994. Méthodologie d'étude des relations élevage-environnement. In The Study of Livestock Farming Systems in a Research and Development Framework, Wageningen Press, Wageningen, 101-105.

JCyL, 1992. Anuario Estadístico de Castilla y León, 1991. Junta de Castilla y León, Valladolid, 312 pagg.

JCyL, 2002. Anuario Estadístico de Castilla y León, 2001. Junta de Castilla y León, Valladolid, 315 pagg.

Jùdez L., Chaya C., Martìnez S., Gonzàlez A.A., 2001. Effects of the measures envisaged in “Agenda 2000” on arable crop producers and beef and veal producers: an application of Positive Mathematical Programming to representative farms of a Spanish region. Agricultural Systems, 67, 121-138.

Landais E., 1998. Modeling farm diversity. New approaches to typology building in France. Agricultural Systems, 58, 505-527.

Landais E., 1999. Agriculture durable et plurifonctionnalité de l'agriculture. Fourrages, 160, 317-331.

Landais E., Balent G., 1995. Introduction à l'étude des systèmes d'élevage extensif. In Pratiques d'élevage Extensif. Identifier, Modéliser, Évaluer. Etudes et Recherches sur les Systèmes Agraires et le Développement Nº 27, INRA, Dijon, 13-35.

Léon Y., 2005. Rural Development in Europe: A research frontier for agricultural economists. European Review of Agricultural Economics, 32, 301-317.

MAPA, 2002. Cartografía general, mapas temáticos sobre variables agroclimáticas e informe sobre municipios y estaciones meteorológicas. In Sistema de Información Geográfica de Datos Agrarios. Page web WWW. http://www.mapya.es/siga/inicio.htm. Mars 1, 2002.

Macdonald D., Crabtree J.R., Wiesinger G., Dax T., Stamou N., Fleury P., Gutierrez-Lazpita J., Gibon A., 2000. Agricultural abandonment in mountain areas of Europe: environmental consequences and policy response. Journal of Environmental Management, 59, 47-69.

Olaizola A.M., Manrique E., 1992. Estrategia de adaptación de pequeñas explotaciones en el marco de la PAC. La agricultura a tiempo parcial en un área de montaña. Revista de Estudios Agro-Sociales, 161, 99-122.

Olaizola A.M., Manrique E., Maza M.T., 1995. Tipos de sistemas de producción y rendimientos económicos en las explotaciones de vacuno de montaña. ITEA Producción Animal, 91, 47-58.

Osty P.L., 1978. L'exploitation agricole vue comme un système. Bulletin Technique d'Information du Ministère de l'Agriculture, 326, 43-49.

Potter C., Lobley M., 1996. The farm family life cycle, succession paths and environmental change in Britain's countryside. Journal of Agricultural Economics, 47, 172-190.

Rigby D., Càceres D., 2001. Organic farming and the sustainability of agricultural systems. Agricultural Systems, 68, 21-40.

SAS, 1989. SAS/STAT Æ User's Guide Int. (Version 6, 4th Ed.) Statistical Analysis Systems Institute Inc., Cary, NC. USA.

Serrano E., Lavín P., Mantecón A. R., 2004. Censos de ganado y de explotaciones, distribución de la población y del uso del territorio, en la provincia de León: situación actual y evolución. Polígonos, Revista de Geografía, 11-12, 167-197.

Tampakis S., Papageorgiou A., Karanikola P., Arabatzis G., Tsantopoulos G., 2005. The forest fires in the Mediterranean from a policy point of view. New Medit, 3, 47-51.

Tirel J.C., 1991. L'extensification: chance ou défi pour les exploitations agricoles. INRA Production Animal, 4, 5-12.

Veysset P., Bebin D., Lherm M., 2005. Adaptation to Agenda 2000 (CAP reform) and optimisation of the farming system of French suckling cattle farms in the Charolais area: a model-based study. Agricultural Systems, 83, 179-202.

Veysset P., Gasqui P., Lherm M., Bebin D., 1999. Determinants of the farm income for suckling cattle farms. Principal component analysis with a 64 Charolais farm sample in north Massif Central. Rencontres autour des Recherches sur les Ruminants, 6, 23-26.

Vipond J.E., 1996. Pressures on managers of extensive livestock systems. In Livestock Farming Systems: Research, Development-Socioeconomics and the Land Manager. Wageningen Press Wageningen, 50-57.