

Herdbook analyses of the Asturiana beef cattle breeds

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Summary - Data from 2 Asturiana breeds' herdbooks were analysed to study their genetic structure. Herds were assigned to 3 levels by the use of herd sires. Generation intervals averaged 5.3 (Casina) and 5.4 (Carreñana) yr, and for both breeds sires were significantly younger than dams. Determination of the important herds shows the contribution of Caso county (60%) to the total herd appearance of the Casina breed. The overall mean Wright's inbreeding coefficients were 1.2 and 0.2% and the increases of inbreeding level per generation were 0.7 and 0.24% for Casina and Carreñana, respectively. Those low values of inbreeding increase can be partially explained by a relatively low centralization reflecting a high degree of diversity.

pedigree / herdbook / population structure / beef cattle

Résumé - **Analyses des livres généalogiques des races bovines asturiennes à viande.**

L'information des livres généalogiques de 2 races asturiennes a été analysée pour connaître leur structure génétique. Une division des troupeaux en 3 groupes est réalisée en fonction de l'utilisation des taureaux. Les intervalles entre générations s'élevaient à 5,3 ans chez la race Casina et 5,4 ans chez la Carreñana et dans les 2 cas les mâles en service sont plus jeunes que les femelles. La détermination des troupeaux les plus importants montre la contribution de la région du Caso (60%) à l'ensemble des troupeaux apparaissant en race Casina. Le coefficient de consanguinité moyen total de Wright est de 0,7% pour la Casina et de 0,2% pour la Carreñana. Les taux très bas d'augmentation de la consanguinité peuvent en partie s'expliquer par une centralisation relativement faible, qui reflète une grande diversité.

pedigree / livre généalogique / structure de population / bovin à viande

INTRODUCTION

Asturiana de los Valles (Carreñana or Asturiana occidental) and Asturiana de la Montaña (Casina or Asturiana oriental) (Mason, 1988) are 2 local beef cattle breeds located mainly in Asturias (Spain). The Cantabric branch is the common origin of both breeds which are very similar to the French Parthenais and Tarentais breeds. Animal sizes are quite different for both breeds. For instance, the mature weight of Casina cows is 350-400 kg while the mature weight of Carreñana cows is 550-600 kg.

The Casina breed is distributed in the eastern Asturias, around the National Park of Covadonga. The Caso's Breeders Society started in 1910 and in 1929 selection within Casina populations was organized by establishing the herdbook and the milking recording scheme. Production of milk to transform into cheese was the objective for this breed and no more than 5 000 cows were included in the recording scheme. These activities stopped in 1936 because of the civil war. In the 1940s the introduction of the imported Brown Swiss breed began causing a strong recession in population size. In 1978 the herdbook was refounded by the Breeder Association (ASEAMO) including at present 136 breeders and 2 831 animals. The use of AI is marginal, less than 2% of the matings.

Even though Carreñana is distributed in the central and western part of Asturias, genetically important herds also exist outside the region (Pais Vasco, Castilla-León, Castilla-La Mancha, Cantabria and Extremadura). At the beginning of this century the population size was around 100 000 animals but introduction of Friesians after the 1920s and Brown Swiss in the 1940s reduced the census to 40 000 by the end of the 1970s. At present, the population size is around 56 000 and 15 000 animals are registered in the herdbook created in 1976; the Breeder Association (ASEAVA) includes about 1 200 breeders grouped across 13 performance recording nucleus. Their breeding objective is post-weaning growth efficiency while maintaining calving difficulty incidence at a constant level. AI within the breed is increasing and is around 20%. Most of the semen doses demand (2.5×10^5 to 3.0×10^5) comes from Holstein farmers to increase the added value of calves.

An important characteristic of these breeds is the lean carcass they produce, with lower fat percentage than most of the European beef cattle breeds (Vallejo *et al*, 1992).

However, although 25 cattle breeds are officially recognized in Spain (Mapa 1981), herdbook studies for only 2 cattle breeds have been carried out: Avileña (Vasallo *et al*, 1986) and Pirenaica (Altarriba and Ocariz 1987).

The objective of this work was to use data from the Asturiana Societies' herdbooks to determine the structure and organization of these breeds.

MATERIAL AND METHODS

Evolution of the herds and animals registered in the herdbooks and distribution of herd size are shown in tables I and II, and in figure 1.

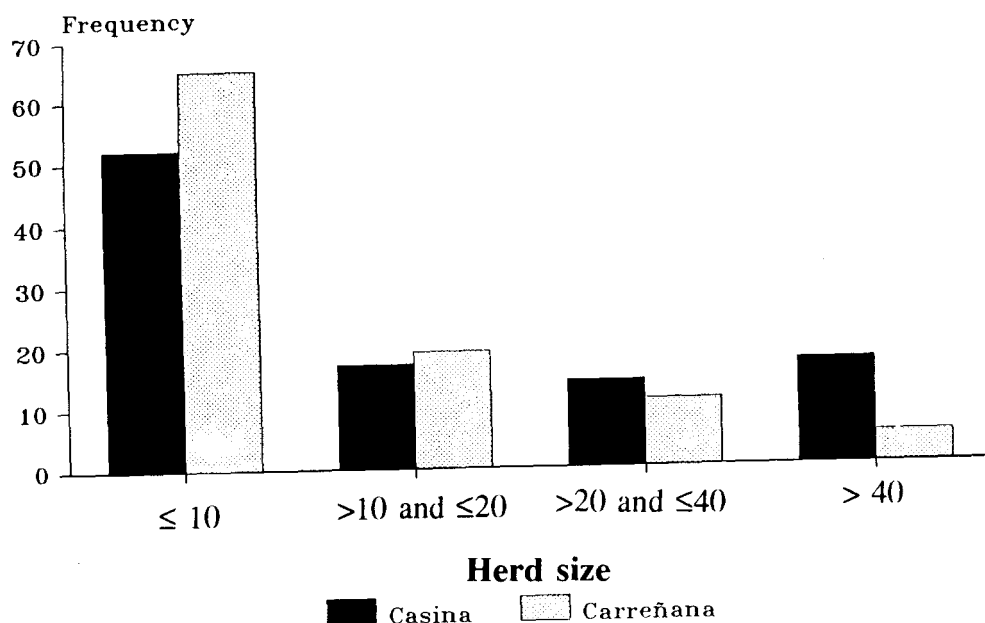
The information registered in the herdbook indicated that about 2 800 animals of the Casina breed were distributed across 136 herds, from which 170 were parent

Table I. Evolution of numbers of breeders and animals registered in the Breeder Associations.

Year	Casina		Carreñana	
	Breeders	Animals	Breeders	Animals
1986	106	1402	481	4 013
1988	108	2 107	747	8 156
1990	126	2 279	921	12 593
1992	136	2 831	1 193	15 536

Table II. Number of births per period of time

Period of time	Casina	Carreñana
≤ 1978	416	897
1979-1982	529	2 038
1983-1986	679	4 591
> 1986	1 065	5 761

**Fig 1.** Distribution of herd size for Casina ■ and Carreñana ▨ breeds.

males and 777 parent females. A total of 15 500 animals of the Carreñana breed were distributed across 1 200 herds, from which 913 were parent males and 4 090 parent females. This information was used to compute the following items: genetically important herds; effective number of herds; generation length; and inbreeding and relationships.

The structure of the population can be observed by describing the use of herd sires. The herds can be classified into: a) nucleus herds; b) multiplier herds; and c) commercial herds. Tables III and IV were built considering only herds with at least 6 registered animals following the classification given by Vasallo *et al* (1986), where herds are classified according to the degree of confidence of the breeders in their own genetics. According to these authors, breeders of nucleus herds never purchase bulls, but they sell bulls; breeders of multiplier herds use purchased bulls and also sell bulls to other multipliers or commercial herds; and breeders of commercial herds never sell bulls. This way of classifying herds is conceptually different from what Stewart (1952 and 1955) and Barker (1957) describe, in which movement of bulls within the nucleus is possible and in which there is no exchange of bulls between multiplier herds.

Table III. Herds of Casina classified according to the origin and use of the herd sires.

<i>Using purchased bulls</i>	<i>Using own bulls</i>	<i>Selling bulls</i>	<i>No of herds</i>	<i>% purchased bulls</i>	
No	Yes	Yes	4	0	(Nucleus herds)
Yes	Yes	Yes	17	59	(Multiplier herds)
Yes	No	Yes	5	100	
Yes	Yes	No	6	65	(Commercial herds)
Yes	No	No	13	100	

Table IV. Herds of Carrefiana classified according to the origin and use of the herd sires.

<i>Using purchased bulls</i>	<i>Using own bulls</i>	<i>Selling bulls</i>	<i>No of herds</i>	<i>% purchased bulls</i>	
No	Yes	Yes	8	0	(Nucleus herds)
Yes	Yes	Yes	125	47	(Multiplier herds)
Yes	No	Yes	11	100	
Yes	Yes	No	17	63	(Commercial herds)
Yes	No	No	30	100	
No	Yes	No	3	0	(Herds disconnected)

The structure of the population has also been analysed using Robertson's method (1953) for determining the effective number of herds supplying sires, grand sires and great-grand sires and comparing them with the actual number of herds

supplying sires, grand sires and great-grand sires which gives some information on the concentration of origins.

Genetically important herds were analysed by the 3 methods proposed by Barker (1957): 1) total appearances as males; 2) appearances of each herd in the sire-of-sire line; and 3) total score of males appearances: an appearance in the parental generation scored 4, an appearance in the grandparental generation scored 2, and an appearance in the great-grandparental scored 1. The original method proposed by Wiener (1953) to analyse breed structure was also used. In order to apply this method, the description given by Barker (1957) was followed.

Generation length was computed for the 4 pathways (sire-son, sire-daughter, darn-son and dam-daughter) using birth dates of registered animals together with those of their sires and dams.

Wright's inbreeding coefficients for all registered bulls and cows were estimated using a modified Quaas' computing strategy (Gutierrez et al 1990) and an average coefficient of relationship between bulls in each population was computed. The known generations number represents the maximum number of generations known and is obtained by looking for the furthest known ancestor. The amount of available pedigree information is described for the 2 breeds in the table V.

Table V. Pedigree information available for the 2 breeds expressed as percentages.

<i>Furthest known ancestor number</i>	<i>Casina</i>	<i>Carrehana</i>
0 (Base Population)	40.8	52.3
1 (One parent known)	13.2	21.9
2 (One grandparent known)	14.2	14.0
3 (One great-grandparent known)	13.5	5.7
4 (One great-great-grandparent known)	14.8	5.0
≥ 5 (Rest)	3.4	1.1

RESULTS AND DISCUSSION

Casina breed

Four herds were assigned to the nucleus level, 22 herds to multipliers and 19 herds were assigned to the commercial level (table III). Of the bulls purchased by the breeders of multiplier herds 35% comes from what we call nucleus herds and 65% comes from other multiplier herds. Of bulls purchased by breeders of commercial herds, 17% come from nucleus herds and 83% come from multiplier herds. Although there is a low number of herds considered at the top of the structure, the estimates of the effective number of herds supplying sires, grand sires and great-grand sires indicate that a relatively large number of herds contribute with grand sires and great-grand sires. Two animals taken at random from the pedigree book have a similar probability of having their great-grand sires from the same herd if these ancestors had been contributed equally by 9 herds. This relatively high degree of

diversity of origins for the reproductive animals is also confirmed by comparing the actual and effective number of herds (table VI). Herds in the Caso county have contributed to more than 60% of the total appearances. This highlights the importance of this county in which the origin of this breed is believed to be (table VII). The rank of important herds does not significantly change between the 3 different methods of Barker. The values of rank correlation are greater than 0.90 ($p < 0.01$). Dividing the whole period of time in 3 parts (< 1983 , $1983-1987$ and > 1987) and using method 2, which can be considered as the most precise (the total number of appearances, method 1, can depend on a previous appearance of that herd in the same pedigree), the value of rank correlation between periods of time is 0.94 ($p < 0.01$) showing that the importance of the herds is unchanged with time. This can also be confirmed using a variant proposed by Wiener (1953). This method gives the evolution of the importance of a herd in terms of change in genetic contribution per generation and represents the contribution of a herd based on the number of appearances of this herd, independently of an earlier chronological appearance (table VIII). The genetic contribution of the 6 major herds to registered females is 47.5% and the relative order is quite similar to that reflected in table VII.

Table VI. Effective and actual number of herds.

	<i>Sires</i>		<i>Grand sires</i>		<i>Great-grand sires</i>	
	<i>Casina</i>	<i>Carreñana</i>	<i>Casina</i>	<i>Carreñana</i>	<i>Casina</i>	<i>Carreñana</i>
Effective	22	136	9	73	9	28
Actual	45	277	18	76	6	16

Table VII. Large herds of Casina breed for (1) total appearances as males, (2) appearances of each herd in the sire-of-sire line and (3) total score of males appearing (expressed as percentages).

<i>Herd</i>	<i>County</i>	(1)	(3)	<i>Herd</i>	<i>County</i>	(2)
Alfredo Armayor	Caso	36	36	Alfredo Armayor	Caso	33
Rogelio González	Caso	26	25	Manuel Cueto	Ponga	28
Manuel Cueto	Ponga	19	19	Rogelio Conzález	Caso	22
Jose Ramon Concha	Cangas	6.5	7.4	Alousa and Ramon Vega	Caso	7.3
El Abuelo, SA	Piloña	6.5	6.8	Jose Ramon Cocha	Cangas	6.5
Alouso and Ramon Vega	Caso	6.0	5.4	El Abuelo, SA	Piloña	2.8

Generation intervals, which averaged 5.3 yr, are significantly higher (50%) for dams (6.35) than for sires (4.19), and sires of males (or females) are younger than their mates (table IX). It seems evident that the use of sires to breed bulls is performed before any progeny information is available. This could be a sign that breeders are using type and/or pedigree information for selecting bulls. Bulls and cows are selected from dams with similar age which means a similar amount of

Table VIII. Genetic contribution of the 6 major herds to pedigree Casina females

<i>Herd</i>	<i>Total genetic contribution (%)</i>	<i>Genetic contribution (%)</i>					
		<i>Generation 1</i>		<i>Generation 2</i>		<i>Generation 3</i>	
		<i>Males</i>	<i>Females</i>	<i>Males</i>	<i>Females</i>	<i>Males</i>	<i>Females</i>
Alfredo Armayor	15.15	7.1	1.0	3.3	0.6	2.4	0.1
Rogelio González	10.5	3.9	0.7	2.0	0.6	1.4	0.8
Manuel Cueto	8.7	4.6	0.3	3.2	0.1	0.5	0.0
El Abuelo, SA	7.6	1.8	0.9	0.5	0.7	0.5	1.5
Jose Ramon Concha	3.0	1.8	0.6	0.6	0.0	0.0	0.0
Alouso and Ramon Vega	2.5	1.0	0.2	0.8	0.6	0.0	0.0
Total	47.5*	20.2	3.7	10.4	2.6	4.8	2.4

* This value differs from the sum of the contributions of the 3 generations (44.1) because it corresponds to the sum of the 4-generation pedigree genetic contributions

information. Similar generation interval differences are found for the Avileña breed in Spain (Vasallo *et al*, 1986) and for other breeds such as the Shorthorn in Australia (Herron and Pattie, 1977) or the Hereford in UK (Ozkütük and Bichard, 1977) and very similar values have been published for Poll Hereford in Australia (Herron 1978; Toll and Barker 1979).

Table IX. Generation intervals for pedigree Asturiana beef cattle breeds.

<i>Parent-offspring</i>	<i>Asturiana breeds</i>			
	<i>N</i>	<i>Casina</i>	<i>N</i>	<i>Carrefiana</i>
Sire-son	550	4.3 ± 0.07 ^a	2 111	5.0 ± 0.06 ^a
Sire daughter	843	4.1 ± 0.05 ^b	3 418	4.8 ± 0.04 ^b
Dam-son	619	6.4 ± 0.11 ^c	2 153	6.0 ± 0.06 ^c
Dam-daughter	911	6.3 ± 0.10 ^c	3 506	5.8 ± 0.05 ^d
Weighted average		5.30 ± 0.08		5.4 ± 0.05

Means with different letters are significantly different ($p < 0.05$).

The overall mean Wright's inbreeding coefficient was 1.2% and, when only animals with at least 3 pedigree generations registered are considered, the level of inbreeding averaged 2.5%. Although the Casina breed was 1.7% more inbred in 1991 than it was in 1978, which supposes an increase of 0.7% per generation, the inbreeding level does not increase significantly during the last 9 yr (1.7 generations), whereas the number of pedigree generation does (table X). The average coefficient of relationship between bulls was 0.8×10^{-2} .

Conservation efforts must be applied to this breed as the real population size is closer to 1 400 females than to the number of 7 568 given by the MAPA (1989). The number of 1400 can be obtained by considering that the average annual registration of females for Casina was 143 for the last 4 yr, and that all females coming from pure mates are registered, and by assuming a replacement index of 10%.

Carreñana breed

The number of herds considered as nuclei were 8 ; 136 herds can be considered as multipliers as their breeders purchase and sell bulls to other herds; and 47 herds could be considered as commercial since their breeders do not distribute bulls out of their own herd (table IV). Five per cent of the bulls purchased by breeders of herds come from nucleus herds while breeders of commercial herds only buy bulls from multiplier herds. The low percentage of bulls purchased into nucleus herds is a consequence of the relatively low size of those herds with an average of 12 animals registered.

The numerical description of the breed structure given in table VI shows the effect of centralization, which is comparatively less marked with regard to other beef cattle breeds, particularly in comparison with the Casina breed. The greater values for grand sires and great-grand sires levels reflect a higher degree of goal diversity

Table X. Inbreeding mean values and mean number of generations available per year of birth.

	b ¹	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
<i>Casina breed</i>											
Inbreeding coefficient (%)	0.06 NS	0.9		1.8		1.7		1.2		1.9	1.7
Mean number generations	0.32*	2.5		3.5		3.7		3.8		4.3	4.3
No of observations		95		74		165		224		229	164
<i>Carreñana breed</i>											
Inbreeding coefficient (%)	0.07**	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.4	0.5	0.7
Mean number generations	0.26**	1.3	1.3	1.4	1.5	1.7	2.3	2.4	2.7	3.2	3.4
No of observations		764	886	1 024	1 259	1 422	1 175	1 168	1 351	1 060	965

¹ Regression coefficients on year; NS and * not significant and significantly different from 0 respectively ($p < 0.05$)** significantly different from 0 ($p < 0.05$).;

between breeders. This can also be argued by comparing the number of herds supplying sires (grand sires or great-grand sires) with the effective number of herds supplying sires (grand sires or great-grand sires). Results for genetically important herds also reflect this diversity. Geographic dispersion of the most important herds is difficult to justify by looking at the current knowledge on the genetic herd levels.

The average generation length was 5.4 yr and generation lengths for the 4 pathways of the parent-offspring are shown in table IX.

The ages of the sires at the birth of offspring were significantly ($p < 0.05$) lower than the ages of dams, 4.9 vs 5.9. The ages of sires varied among birth years of progeny and the analysis showed a trend towards the use of older animals ($b = 0.08$) since 1975. Although this is a smooth trend, it seems evident that, as before, the use of sires to breed bulls or cows is made before any progeny information is available. Different ($p < 0.05$) herd practices in selecting sires were found since the age of sires also varies between herds in which progeny were born. Similar figures apply for dams. The ages of dams varied between years of birth of progeny and herds.

The overall mean inbreeding coefficient was 0.2%. When including only animals with more than 2 pedigree generations known, the average was 0.7%. The increase of inbreeding per generation was 0.24%, this value being significantly different from 0 (table X) and the average coefficient of relationship between bulls was 0.5×10^{-3} . These results show that a strict control on the relationships between the animals to be mated is not very necessary.

It can be concluded that most of the parameters estimated are typical in developing breeds. The results show that if any selection has been practiced, it was based on type and/or pedigree information, and that from the generation length observed (> 5 yr) rather low genetic progress within each breed can be expected to be observed at present. Genetic evaluation for economic traits began 2 yr ago and preliminary estimates of genetic variability for the most important characters (birth, weaning and yearling weights) show high values, which could be a consequence, as stated earlier, of the lack of previous selection.

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