

# COMPARISON BETWEEN ON-FARM AND NUCLEUS-FLOCK ESTIMATED BREEDING VALUES IN SARDA DAIRY SHEEP

S.R. Sanna, A. Carta and S. Casu

Istituto Zootecnico e Caseario per la Sardegna, Reg. Bonassai, 07040 Olmedo, Italia.

## SUMMARY

The use of nucleus breeding units (NBU) to accelerate the annual genetic gain in dairy sheep selection programs relies on the hypothesis that traits have the same phenotypic expression of genetic merit both in NBU and in multiplier and commercial flocks. Sarda dairy sheep is bred in Sardinia and continental Italy over a wide variety of climatic conditions and production systems, mainly based on available natural pastures. Thus milking yields of Sarda ewes are heavily affected by various feeding practices and seasonal weather pattern. To investigate the effect of a relative change in milk yield phenotypic expression of Sarda genotypes, raised in different environments, the estimated breeding values (EBV) of 25 widely used AI rams, obtained from daughters performances in 2 large flocks (the NBU) and in the whole Sarda Flock-Book, were compared. Pearson's product moment and Spearman's rank correlation coefficients between nucleus and on-farm EBV were respectively 0.86 and 0.75. Genetic superiority of rams chosen on the nucleus EBV was 17% (in terms of EBV standard deviation) lower than that achievable using on-farm EBV. This fact could be due to different accuracies resulting from the two genetic evaluations and to some differences in Sarda production systems related to availability of feeding resources and machine milking equipment and to economic constraints and management decisions. Such a result decreases the role of a nucleus-flock in the Sarda breeding scheme and supports the choice of an on-farm recording scheme that could ensure a good adaptation of selected animals to Sardinian dairy sheep production environments.

**Keywords:** Dairy sheep, nucleus-flock, genotype by environment interaction.

## INTRODUCTION

Sarda dairy sheep breeding scheme involved, on a national scale, 140,000 milk recorded ewes belonging to about 1,000 flocks (two thirds located in Sardinia). Ram selling and cervical AIs with fresh semen (about 19,000 over 400 flocks in 1997) provides the genetic ties required for a national evaluation of breeding merits for milk yield, realised since 1992 using a BLUP AM with repeated records. Genetic gain is spread to the commercial flocks (4 million heads) by rams born in registered flocks and sold for natural mating. The Istituto Zootecnico e Caseario owns since 1950 two experimental flocks in which 2,000 Sarda ewes are raised on irrigated plains. These flocks, originally constituted as "nucleus breeding units" (NBU), now provide about 10% of the rams used in the Flock-book by natural or artificial matings. Recently some authors emphasised the role of these NBU to accelerate the annual genetic gain in dairy sheep selection programs (Rossi *et al.* 1995). Such a suggestion relies on the hypothesis that the traits of economic interest should have the same phenotypic expression of the genetic merit in the NBU and multiplier or commercial flocks. On the other hand some studies in dairy cattle

reported that the genetic correlation between performance in different environments is substantially less than one, pointing that a genotype by environment interaction could influence phenotypic measures of a trait thus reducing the selection response of best genotypes spreading (Bonaiti and Bertaudiere 1982; Stanton *et al.* 1991). This decrease could be attributed to two types of genotype by environment interaction: the first indicating a different genetic basis for the trait in the environments and the second resulting from heterogeneous means and variances (Van Vleck 1963; Stanton *et al.* 1991). A possible shift on expected breeding values (EBV), following a free range management on low-productive natural pastures of best genotypes detected in more profitable conditions, makes interesting to investigate the effect of a possible genotype by environment interaction in Sarda production systems. So, the objective of this study was to analyse the relative change of phenotypic expression of milk yield Sarda genotypes in different flocks. This objective was met examining the correlation coefficients between EBV from the official genetic evaluation and those estimated exclusively on the nucleus-flock records for the 25 most used AI rams.

### **MATERIAL AND METHODS**

On-farm (official) and nucleus-flock genetic evaluations were performed by repeatability BLUP animal models on milk yield adjusted to 162 days of milking. Both models included a fixed flock-year-age class effect that identifies the management group in which the record was realised, a fixed effect associated with year-lambing month-age-parity classes, the random additive genetic effect, the random permanent environmental effect and the residual term. In the nucleus-flock evaluation two fixed factors were added to take into account for a parity-lambing interval and parity-suckling period length effects. Similar heritability and repeatability coefficients were used (Sanna *et al.* 1994; Sanna *et al.* 1997). To compare official and nucleus EBV a sample of AI most spread rams was used. Rams were chosen following two criteria: a) at least 10 daughters with record in the nucleus-flocks and b) daughters distributed over more than 20 flocks in the official evaluation. The Daughter Yield Deviations (DYD), milk yield adjusted for the dam breeding value and for all the effects included in the model, were calculated from on-farm evaluation data in order to verify the existence of inflating effects on the official EBV (the reference term). Official and nucleus EBV were analysed by correlation analysis using Pearson's product moment, Spearman's rank and Kendall coefficients. Regression analysis was used to test the prediction of the official EBV obtained from the nucleus one and to analyse the trend of their difference D ( $D = \text{nucleus EBV} - \text{official EBV}$ ) at increasing official EBV. The loss in genetic superiority selecting the best 5 rams on official or nucleus EBV was evaluated on the official EBV and expressed in term of their standard deviation.

### **RESULTS AND DISCUSSION**

In Table 1 the main features of the ram sample chosen for the EBV comparison are reported. As expected the threshold of daughters in 20 flocks, ensured a sound evaluation of breeding values but it was fulfilled only by 25 very widely distributed rams. In average they were indexed on 173 daughters in 61 flocks, an unusual and attractive situation in Sarda sheep breeding. The official EBV and the related average DYD per ram revealed fairly different genetic values among rams. The 10% CV value (2.7/26.1) showed a satisfying homogeneity of

DYD standard deviation within ram and did not reveal any evident effect of possible heterogeneous variances between flocks on the 25 official EBV.

**Table 1. Statistics for 25 most spread AI rams with official and nucleus EBV.**

		Mean	Std Dev	Minimum	Maximum
Official evaluation	EBV (l)	15.4	14.1	-6.2	51.7
	Daughters (n)	173	107	66	479
	Lactation records (n)	368	208	117	927
	Flocks (n)	61	39	23	158
	DYD mean (l)	8.1	7.3	-3.4	27.0
	DYD std (l)	26.1	2.7	20.4	31.3
Nucleus evaluation	EBV (l)	10.2	16.1	-24.0	45.3
	Daughters (n)	29	20	10	74

Comparison between the datasets used for genetic evaluations and their subset related to 25 AI rams daughters is reported in Table 2. Official EBV for the 25 rams concerned about 13% of the lactation records (daughters and contemporaries) and 8% of the contemporary groups (CG) used in the analysis. The 25 rams nucleus EBV embraced 80% of lactation records and CGs. Average individual milk yield appeared poorer in the nucleus than in the entire Flock-book (176 vs 194 litres in 162 days of milking) and its standard deviation was also lower (43 vs 56). A similar pattern was detected for the average milk yield per CG, an index of the environmental conditions shared by contemporary ewes. The large difference recorded between the standard deviation of milk yield per CG in the two datafiles (18 vs 45 liters) revealed the different environmental and managing conditions of Sarda flocks.

**Table 2. Mean and standard deviations for official and nucleus evaluation datafiles and for 25 rams daughters contemporary groups (CG).**

	On-farm		Nucleus-flock	
	All	Sample "25"	All	Sample "25"
Number of records (n)	756,522	95,385	6,309	5,153
Milk yield (l)	194.9 ± 56.2	191.1 ± 54.2	176.3 ± 42.7	176.2 ± 43.0
Number of ewes (n)	324,316	53,884	4,081	3,422
Number of CG (n)	28,413	2,180	42	34
Average milk yield per CG (l)	189.7 ± 45.3	190.1 ± 43.3	176.8 ± 17.6	178.2 ± 18.8
Records per CG (n)	26.6 ± 25.6	43.8 ± 42.7	150.2 ± 71.0	156.2 ± 76.9

The differences between production systems could explain to a certain extent the correlation coefficients found between the two 25 EBV series (Table 3). A Pearson's correlation coefficient of 0.86 appeared low if compared to those frequently found in international comparisons of EBV in dairy cattle. Spearman's correlation coefficient (0.76) showed some differences on the rank of the animals, with some nucleus top rams that resulted not so interesting in different environments. Kendall's correlation coefficient supported this judgement. It must be noticed that correlation coefficients could result overestimated because

of the inclusion of nucleus-flock lactation records in the official genetic evaluation database. Nucleus EBV appeared lower than official EBV probably because of the lower yield variation in the nucleus. A 25% precision loss in predicting the official EBV from the nucleus one was measured by  $1-R^2$  of the regression for official and nucleus EBV. The regression coefficient ( $b_{YX}$ ) resulted significantly different ( $P<0.05$ ) from 1, thus the bias and the random error could affect simultaneously any prediction of the official EBV from the nucleus EBV. The regression analysis for

bias (D) did not reveal any trend at increasing official EBV.

**Table 3. Relationships between official (Y) and nucleus EBV (X) for the 25 AI rams.**

Parameter	Value
Pearson's product moment correlation	0.86
Spearman's rank correlation	0.76
Kendall's Tau b correlation	0.57
$D = X - Y$ (% of Y)	33
$1 - R^2$ ( $Y = a + bX$ ) (%)	25
$b_{YX}$	0.76
$H_0: b_{YX} = 1$	$P = 0.014$
$b_{DY}$ ( $D = a + bY$ )	-0.01
$H_0: b_{DY} = 1$	NS
$\Delta S$ loss selecting the best five rams on nucleus EBV (% of Y std)	17.8

Choosing the best five progeny tested rams on nucleus EBV instead of official EBV could lessen the genetic superiority of selected rams by 17% in term of standard deviation of official EBV, thus reducing the expected genetic gain. Relationships between EBV calculated on nucleus-flock and on-farm lactation records resulted low because of dissimilar accuracies of ram estimates and detectable differences in Sardinian production systems. Differences are related to availability of feeding resources and machine milking equipment, and to economic constraints and management decisions. Different rainfall, areas with 258 and 1335 mm over the last 30 years exist in Sardinia, produces very diverse feeding practices and lead to stocking rates ranging between 3 and 20 ewes/ha. The reduced genetic gain found using nucleus EBV decreases the possible role of a nucleus-flock in the Sarda breeding scheme and supports the choice made in the '70s for a on-farm recording scheme (Barillet, 1997). Such a scheme ensures that the animals perform and are measured in flocks and environments similar to those for which they are being bred. This could guarantee adaptation, net production efficiency and a more reliable selection response over the whole population.

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