

Crossbreeding the *Sardinian* and *East Friesian* breeds in Sardinia

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Summary

The genetic improvement of the milk production and prolificacy of dairy ewe populations can be obtained through the crossbreeding and upgrading of the ewes of the local breed with imported male lines. Until recently, the most interesting breed for this purpose in the Mediterranean Basin has been the *East Friesian*.

More recent information (ZERVAS *et al.*, 1975; FLAMANT *et al.*, 1976; FOX *et al.*, 1976; KALAISSAKIS *et al.*, 1977; FLAMANT and CASU, 1977) indicates that one of the prolific Eastern Mediterranean dairy breeds might have been a better choice; particularly in the light of the general lack of adaptability of both the *East Friesian* and some of its crosses in most regions where the breed had been recently introduced outside its zone of origin (DOMINGOS BORREGO, 1968; EYAL and GOOT, 1968; RICORDEAU and FLAMANT, 1969a, b; TANEV *et al.*, 1971; KATSAOUNIS, 1972; ZERVAS *et al.*, 1975; GOOT, 1976; CUMLIVSKI, 1976; F.A.O., 1977; KALAISSAKIS *et al.*, 1977; SÖNMEZ, 1977).

The purebred *Friesian* ewes adapt poorly to the dryland and high temperature conditions of the local ecosystem. Even with no nutritional deficiencies, as in the case of the intensively irrigated plain environment in Sardinia, it appears to be of no economic value to produce crossbred females with a *Friesian* blood component of over 50 p. 100 for reproduction purposes.

Our observations in the present paper confirm information obtained from other similar experiments in the Mediterranean, i.e. that with more than 50 p. 100 *Friesian* blood, the same difficulties of adaptation as with the purebred *East Friesian* ewes tend to be found. No noteworthy increase in milk yield and prolificacy is obtained with a higher *Friesian* blood component. Our data, in fact, shows the 75 p. 100 Fr to be less productive than the 50 p. 100 Fr (F₁), while there is no difference in productivity between the 25 p. 100 Fr and the purebred *Sardas*.

Introduction

The *Sarda* ewe, which gives very satisfactory results under the typical extensive Mediterranean husbandry conditions in Sardinia, has four major limitations for intensive husbandry systems:

- a relatively low average level of milk production,
- a relatively small body size,
- a relatively low reproduction ability,
- limited growth capacity of the lambs, with poor carcass conformation.

To correct these deficiencies and to obtain an animal better adapted to the more intensive husbandry conditions of the lowlands, it was decided in the early sixties, as in other Mediterranean countries, to introduce the *East Friesian* for crossbreeding purposes. According to the bibliography known at the time (SCHEINGRABER, 1933, 1934; CREMER, 1934; MÜHLBERG, 1934; ZEEB, 1934, 1941; EBBINGHAUS, 1949; BUITKAMP, 1952; GROENEVELD, 1953; LANTINGA, 1961; STEPHAN, 1961; BOYAZOGLU, 1963; DIJKSTRA, 1966), it appeared to be the most prolific and productive of the dairy breeds, despite its difficulty in adapting to high temperature dryland environments in the Mediterranean and para-Mediterranean zone (DIMAKOPOULOS, 1960; GOOT, 1966; TANEV *et al.*, 1968; FLAMANT and RICORDEAU, 1969).

The development of irrigation and intensive pastures in Sardinia called for a more intensive system of dairy sheep husbandry than had hitherto been practised in these regions (CASU, 1971; BATICLE, 1974). A major problem was to know whether the *Sarda* ewe could still be used successfully under these improved conditions or whether it would be better to replace her with a more productive kind of animal. A crossbreeding experiment was undertaken on the partly irrigated Bonassai experimental farm of the *Istituto Zootechnico e Caseario per la Sardegna*, situated in the Sassari plain (North-west Sardinia).

For purposes of comparison, a small flock of 17 purebred *Friesian* ewes in lamb was introduced. As in other similar experiments elsewhere in the Mediterranean environment (FLAMANT and RICORDEAU, 1969; FLAMANT, 1974), the adaptation of purebred *East Friesian* animals proved to be exceedingly poor. In this instance, half the ewes died during the first year; the remainder lambed and the mortality of the offspring in their first year was 80 p. 100.

It is important to stress that all the available information from the various Mediterranean experiments indicates that the *Friesians* initially show inadaptability, due to introductory stress in the new more arid environment. This could be bypassed, in some cases, by the importation of large populations, although it is doubtful whether this is economically valid. In this case, the so-called "routine or cruising mortality" would occur. The mortality level is linked to the local climate, poor resistance to diseases (pulmonary, piroplasmosis) and parasites, and nutritional and management stress. In some cases, the *Friesian* disappears within a generation of its introduction, while in others it adapts better and survives, although still with a relatively high rate of mortality (ZERVAS *et al.*, 1975; FLAMANT *et al.*, 1975).

Material and methods

The possibility of improving the production potential of the *Sarda* breed by crossbreeding to the *East Friesian* (*Ostfriesisches Milchschaaf*) was studied from as early as 1966. The crossbreeding experiments were not limited to the first generation (F_1), and back-crosses were also carried out to obtain 25 p. 100 and 75 p. 100 *Friesian* females, the objective being to compare these three female genotypes with purebred *Sarda* contemporaries. In order to obtain the four genotypes (Table 1), seven *Friesian* (Fr), nine *Sarda* (S) and four crossbred rams (50 p. 100 Fr) were used.

TABLE I
Number of breeding ewes
Effectifs des brebis

Genotype	First year of breeding			Total
	1967-1968	1968-1969	1969-1970	
S	55	36	48	139
25 % Fr (♂ 50 % Fr × ♀ S)		43		43
50 % Fr (♂ Fr × ♀ S)	54			54
75 % Fr (♂ Fr × ♀ 50 % Fr)			22	22
Total	109	79	70	258

Because of the considerable climatic variability from one year to another in the Mediterranean region, a contemporary system of comparison was imperative. Thus, each of the groups of crossbred ewes (25 p. 100 Fr, 50 p. 100 Fr, 75 p. 100 Fr) was compared with a contemporary group of *Sarda* (S) animals, always originating from the same flock.

Management conditions never varied during the experiment: intensive pasture (oats, lucerne, rye-grass, clover, etc.), with a maximum daily dose of 500 g of concentrates per ewe during the winter months, if necessary. These conditions are thus typical of the intensive irrigated regions of the Mediterranean Basin. Milking was carried out by machine without hand stripping⁽¹⁾. From the total available population (ewes having completed four lactations), 258 ewes were chosen at random for this study. There was no planned selection programme, so as to allow free interplay of the normal genetic population factors.

Lambs were weighed at birth and then weekly until weaning at an average age of 35 days; thereafter, they were weighed monthly. Continuous observations on the reproduction of the ewes were carried out during the breeding season (individual mating). Milk yield and protein and fat content of the milk were measured twice monthly, starting after weaning. The first recording was made during the second month of lactation, but in most cases, 40 to 45 days after lambing. Both the total lactation yield and the standard reference lactation yield over 150 days of milking (120 days for the first lactation) were calculated.

⁽¹⁾ As defined at the International Symposium on the Machine Milking of Small Ruminants, Alghero, Sardinia, May 1978.

For the present paper, only the results of four consecutive complete lactations were taken from the data obtained over the ten years of the study, except when otherwise indicated (e.g. the comparisons of wool quality). As far as more specific evaluation methods are concerned, the means and standard deviations were evaluated in all cases, while an attempt was made, where necessary, to express the averages (in percentage) of the different crossbred populations in relation to their contemporary purebred Sarda populations (taken as 100 p. 100) and to calculate the necessary standard errors.

Figure 1 gives a complete explanatory reference of the body measurements, while the classification used for the udder conformation is presented in figure 4. The live weights of the ewes were measured at lambing and shearing.

In 1976, fleeces from a random sample of 15 adult ewes of each of the four genotypes were weighed at shearing and samples of the wool were analysed for staple length, crimping, percentage clean wool and fibre thickness at the wool laboratory of the S.A.A.D.S.R.I. (2) by the standard methods normally used.

Results

a. — Ewe weight and body measurements

While there is generally little difference in weight between the 25 p. 100 Fr and the comparable Sarda ewes, the 50 p. 100 Fr animals are significantly heavier at first œstrus than the comparable Sarda purebreds (table 2).

TABLE 2
First œstrus
Premières chaleurs

Year of first lambing Genotype	1968-1969			1969-1970			1970-1971		
	N	1st œstrus		N	1st œstrus		N	1st œstrus	
		Age (days)	Live-weight (kg)		Age (days)	Live-weight (kg)		Age (days)	Live-weight (kg)
S	55	303 (100 %)	32,7 (100 %)	36	295 (100 %)	32,3 (100 %)	48	269 (100 %)	34,4 (100 %)
25 % Fr.				43	264 (90 %)	32,0 (99 %)			
50 % Fr.	54	263 (87 %)	36,8 (113 %)						
75 % Fr.							22	238 (89 %)	44,9 (130 %)

(2) South African Animal and Darry Sciences Research Institute.

There is also no real difference between the lambing and shearing weights of the 25 p. 100 Fr and the contemporary purebreds for all four lactations. Upgrading towards 50 p. 100 Fr and 75 p. 100 Fr is, however, always followed by a considerable increase in body size. This confirms the advantage of introducing heavier breeds to obtain females of better size and conformation than the ones traditionally found in the Mediterranean (table 3). The heavier adult weights of the upgraded crossbred animals are in line with the weights at first oestrus, the 50 p. 100 Fr and 75 p. 100 Fr crossbreds in all cases being much heavier than their purebred contemporaries.

TABLE 3

Age, gestation period and liveweight at lambing and at shearing (indicative)
Age, durée de gestation et poids vif à la mise-bas et à la tonte (valeurs indicatives)

Variable		Liveweight at lambing (kg)		Gestation per. (days)		Age at lambing (months)		Liveweight at shearing (kg)	
		$\bar{x} \pm S.E.$	<i>t</i> -Test	$\bar{x} \pm S.E.$	<i>t</i> -Test	$\bar{x} \pm S.E.$	<i>t</i> -Test	\bar{x}	<i>t</i> -Test
First	S.	38,1 ± 0,8	N.S.	149,4 ± 0,6	N.S.	15,1 ± 0,1	**	40,7	N.S.
	25 % Fr . . .	38,6 ± 0,7		148,6 ± 0,4		14,2 ± 0,1		40,8	
	S.	36,0 ± 0,8	**	149,4 ± 0,5	**	16,2 ± 0,1	**	34,7	**
50 % Fr . . .	45,1 ± 0,8		147,5 ± 0,3		15,2 ± 0,2		44,1		
S.	37,1 ± 0,7	**	148,8 ± 0,5	**	13,7 ± 0,2	*	39,7	**	
75 % Fr . . .	50,6 ± 1,5		145,5 ± 0,8		14,5 ± 0,2		53,1		
Second	S.	41,4 ± 0,7	N.S.	149,5 ± 0,5	N.S.	25,0 ± 0,2	N.S.	46,5	N.S.
	25 % Fr . . .	41,9 ± 1,0		148,1 ± 0,5		24,7 ± 0,2		45,9	
	S.	45,5 ± 0,9	**	144,4 ± 0,4	N.S.	26,0 ± 0,2	N.S.	46,8	**
50 % Fr . . .	55,9 ± 0,8		145,5 ± 0,3		27,1 ± 0,7		56,6		
S.	43,0 ± 1,1	**	148,3 ± 0,6	*	25,0 ± 0,3	N.S.	45,4	**	
75 % Fr . . .	55,2 ± 1,9		144,8 ± 0,9		24,5 ± 0,2		64,4		
Third	S.	46,0 ± 0,8	N.S.	148,3 ± 0,9	N.S.	37,2 ± 0,2	**	50,2	*
	25 % Fr . . .	48,5 ± 1,0		147,5 ± 0,6		35,7 ± 0,2		53,9	
	S.	43,4 ± 0,9	**	148,1 ± 0,4	*	37,0 ± 0,2	**	46,5	**
50 % Fr . . .	52,0 ± 0,8		146,3 ± 0,5		36,0 ± 0,2		58,2		
S.	44,1 ± 1,3	**	146,7 ± 0,3	**	35,7 ± 0,2	N.S.	—		
75 % Fr . . .	58,3 ± 1,6		144,9 ± 0,5		36,1 ± 0,1		—		
Fourth	S.	47,7 ± 1,1	**	147,8 ± 0,4	N.S.	48,2 ± 0,1	N.S.	—	—
	25 % Fr . . .	48,3 ± 1,3		146,4 ± 0,6		47,6 ± 0,2			
	S.	45,9 ± 1,0	**	146,9 ± 0,5	*	48,7 ± 0,2	*	49,6	**
50 % Fr . . .	56,6 ± 0,9		145,5 ± 0,3		47,9 ± 0,2		59,0		
S.	50,3 ± 1,2	**	148,2 ± 0,5	**	47,4 ± 0,2	N.S.	—		
75 % Fr . . .	60,9 ± 1,8		145,4 ± 0,5		48,0 ± 0,2		—		

A representative number of one-year old ewes from the different genotypes were measured (fig. 1) and the various body measurements and live weights recorded as an indication of the conformation changes obtained through cross-breeding (table 4).

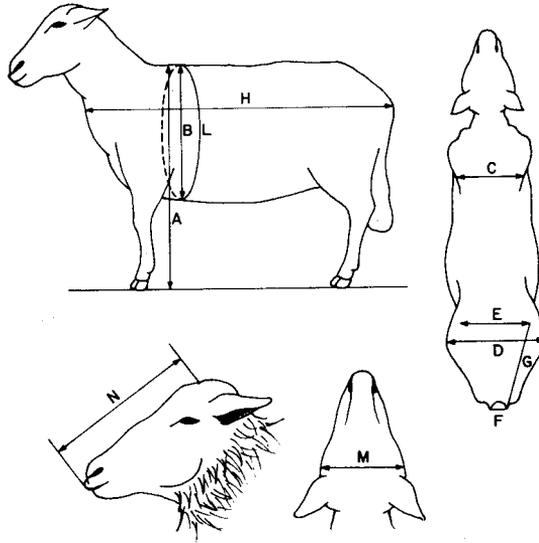


FIG. 1. — Measurements.
Mensurations.

TABLE 4

Measurements (cm) of the breeding ewes at one year of age (see fig. 1)
Mensurations (cm) des brebis à l'âge d'un an (voir fig. 1)

Genotype Measurements	S (n = 32)	25 % Fr (n = 24)	50 % Fr (n = 19)	75 % Fr (n = 20)
A.	62,012 ± 2,880	61,383 ± 2,946	63,805 ± 3,119	66,655 ± 2,303
B.	27,293 ± 1,301	27,500 ± 1,710	28,500 ± 2,220	31,975 ± 2,049
C.	19,290 ± 1,666	18,900 ± 1,490	20,005 ± 3,101	23,400 ± 2,423
D.	21,265 ± 1,387	20,720 ± 2,009	20,810 ± 2,610	24,845 ± 2,532
E.	15,796 ± 1,669	15,341 ± 1,182	15,963 ± 1,968	17,845 ± 1,218
F.	6,687 ± 0,833	7,300 ± 1,232	7,226 ± 1,240	7,725 ± 0,979
G.	19,765 ± 1,754	20,862 ± 2,473	20,389 ± 2,077	21,310 ± 1,634
H.	64,118 ± 2,215	64,733 ± 2,837	65,563 ± 3,268	72,305 ± 3,908
I.	7,046 ± 0,216	7,220 ± 0,515	7,531 ± 0,418	8,125 ± 0,447
L.	82,525 ± 3,852	82,454 ± 5,262	83,694 ± 8,648	94,770 ± 5,360
M.	12,321 ± 0,456	12,433 ± 0,500	12,826 ± 0,590	13,495 ± 0,548
N.	20,390 ± 0,894	20,441 ± 1,105	20,157 ± 1,240	21,790 ± 0,987
Kg	39,375 ± 3,678	38,045 ± 4,721	40,860 ± 6,174	54,044 ± 6,656

b. — *Precocity, gestation and lambing*

From tables 2 and 3, the following values can be obtained when expressing the ewes' live weight at first œstrus as a percentage of their weight at fourth lambing (kg), which is considered as indicative of precocity:

S:	33 kg/48 kg = 69 %
25 % Fr:	32 kg/48 kg = 67 %
50 % Fr:	37 kg/57 kg = 65 %
75 % Fr:	45 kg/61 kg = 74 %

Thus, as previously shown by HAFEZ (1953) and WALRAVE *et al.* (1975), there is little variation between the purebreds (*Sarda*) and the 25 p. 100 and 50 p. 100 (*Friesian*) crossbreds, with a slightly better precocity for the F₁ as compared with the *Sardas* (first œstrus at a lower weight as a percentage of the adult weight). The extremely high percentage (74 p. 100) obtained for the upgraded (75 p. 100 Fr) ewes, which could be interpreted as an indication of poor precocity, is contrary to all expectations. This could, however, be the result of the small numbers (22 ewes) involved.

A better indication of sexual precocity is probably the age at first œstrus, which gives very coherent average results:

S:	270-300 days
25 % and 50 % Fr:	± 263 days
75 % Fr:	± 238 days

When compared with their contemporary *Sardas*, the crossbreds show a pronounced tendency for an earlier first œstrus, from just over a 10 p. 100 difference for the 25 p. 100 Fr to 13 p. 100 for the 50 p. 100 Fr and over 11 p. 100 for the 75 p. 100 Fr. This is confirmed by an earlier average age at first lambing for all groups of crossbred females, when compared within years, to the contemporary purebred groups (table 2). An interesting feature is the highly significant difference in age at first lambing (table 3), to the advantage of the less upgraded crossbreds (25 p. 100 Fr and 50 p. 100 Fr).

The gestation period of the purebred *Sarda* is longer (in most cases significantly longer) than that of all crossbred groups (table 3). Our data confirms the results obtained in Greece by Zervas *et al.* (1975), when comparing the *Friesian* (146 days) and its crosses (147 days) with the local *Chios* sheep (150 days). The gestation period of the *Sarda* was, with few exceptions, between 148-150 days, while that of the crossbreds was 144-146 days.

In Southern France, FLAMANT and JACQUIN (1978) obtained very similar results (purebreds):

112 <i>Lacaune</i> , adult ewes:	147,8 days
112 <i>Lacaune</i> , one year old:	146,8 days
132 <i>Sarda</i> , adult ewes:	149,1 days
40 <i>Sarda</i> , one year old:	148,9 days

The purebred *Sardas* always lamb later in the season (also longer lactation) than the 25 p. 100 Fr and the 50 p. 100 Fr. The situation is reversed when comparing the 75 p. 100 Fr with its contemporary *Sarda*. This could naturally be confounded with a year effect. It can be considered as an indication of the lower adap-

tability of the more upgraded ewes (75 p. 100 Fr) to local environmental conditions (despite good feeding and the particularly favourable year in which they were bred).

As in most other Southern European countries, the lambing season extends from October to early April (fig. 2). Contrary to the results obtained in Greece (ZERVAS *et al.*, 1975), there is no important difference between the ewes of the local breed and the crossbreds (not even the 75 p. 100 Fr). The adult crossbred ewes (2nd, 3rd and 4th lactation), however, generally tend to lamb earlier on average than the purebred *Sardas*. The results obtained by MANNUTA and CASU (1968) suggest that the *Sarda* is more seasonal in its breeding than other Mediterranean breeds.

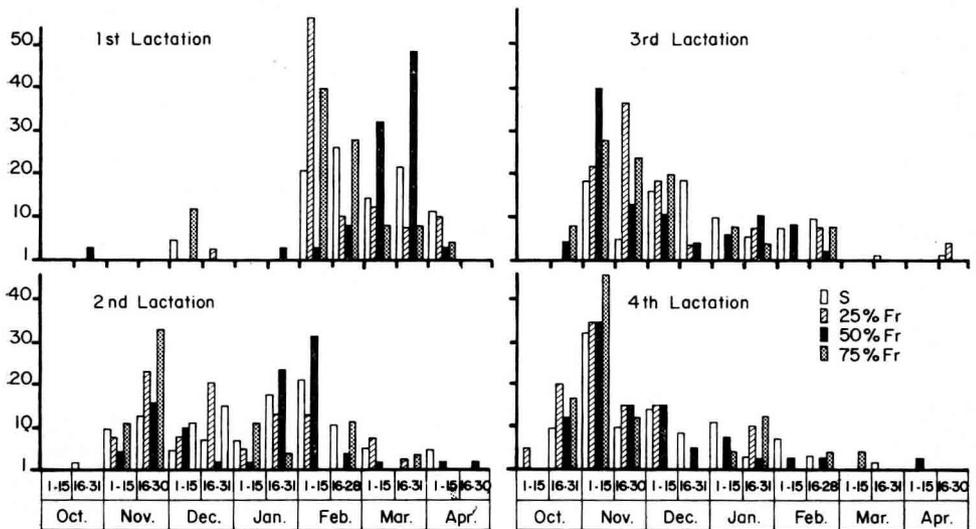


FIG. 2. — Distribution of lambing dates.
Distribution des dates d'agnelage.

c. — Numerical productivity and viability

There was little difference between the purebred *Sarda* ewes and the crossbreds in the percentage of ewes pregnant. However, there is apparently a slightly lower percentage of ewes actually lambing in the case of the crossbreds, particularly the 75 p. 100 Fr and 50 p. 100 Fr, when compared to their contemporary *Sardas*. The most interesting feature, though, is the high prolificacy of the crossbreds. The 25 p. 100 Fr are slightly superior to the *Sarda* ewes, but the 50 p. 100 Fr and 75 p. 100 Fr are significantly better (table 5).

It is important to note the high percentage of early lamb mortality in the 75 p. 100 Fr group and the continued rise in total lamb mortality, up to one year of age, with the higher proportions of *Friesian* blood (table 6), despite almost optimum intensive husbandry conditions. Data on the reasons for lamb mortality (table 7) show the main cause of death to be respiratory diseases. The limited available data on purebred *Friesians* on the farm is even more conclusive, as

SARDINIAN AND EAST FRIESIAN CROSSES

TABLE 5

Reproduction data
 Données de reproduction

Lac- tation	Genotype (* Characteristics)	S	25 % Fr	S	50 % Fr	S	75 % Fr
First	Pregnant (%)	80,55	92,86	80,00	85,18	97,92	84,21
	Lambled (%)	80,55	92,86	67,27	77,78	95,83	78,95
	Lambs born (%)	94,44	104,76	80,43	116,66	102,08	131,58
Second	Pregnant (%)	88,89	97,50	97,06	96,15	97,14	100,00
	Lambled (%)	88,89	97,50	97,06	96,15	80,00	75,00
	Lambs born (%)	113,88	142,50	111,76	136,54	100,00	125,00
Third	Pregnant (%)	96,15	100,00	90,70	100,00	96,43	100,00
	Lambled (%)	96,15	96,30	90,70	97,92	96,43	100,00
	Lambs born (%)	130,76	151,85	130,23	170,83	135,71	178,57
Fourth	Pregnant (%)	100,00	90,48	100,00	100,00	95,83	92,86
	Lambled (%)	100,00	90,48	100,00	93,02	95,83	92,86
	Lambs born (%)	147,83	166,67	154,17	162,79	129,17	192,86

(* Expressed as a percentage of the ewes served.

TABLE 6

Death rates from birth to one year old expressed as a percentage of lambs born (alive and stillborn)
 Mortalité de la naissance à un an, exprimée en pourcentage des agneaux nés (vivants et morts-nés)

Genotype	Period	0-4 days (%)	4 days- weaning (%)	Weaning shearing (%)	Shearing- 1 year (%)	0-1 year (%)
	S		3,62	2,47	2,08	—
25 % Fr		4,53	3,52	2,51	—	10,55
50 % Fr		3,18	5,56	—	3,17	11,90
75 % Fr		9,19	2,56	1,00	3,56	15,87

(* The average death rate from 1 455 lambings of the Institute's purebred Sardinian flock for the years 1968-1970 was 9,42 p. 100.

77,78 p. 100 of all lambs born died with a year of birth (61,11 p. 100 due to respiratory diseases). This information confirms our previous findings in Greece (ZERVAS *et al.*, 1975) and that of other authors (SHIMSHONI and LAVI, 1972; FLAMANT, 1974). When considering all lambings during the experimental period, we find 94 lambs weaned for every 100 *Sarda* ewes originally available for breeding, while the respective values for the crossbreds were 115 for the 25 p. 100 Fr, 163 for the 50 p. 100 Fr and 110 for the 75 p. 100 Fr.

TABLE 7

Causes of death (indicative information only) from birth to one year old (% of lambs born)
Causes de mortalité (valeurs indicatives seulement), de la naissance à l'âge d'un an
 (% d'agneaux nés)

Genotype \ Causes	Still-born (%)	Enteritis and coccidiosis (%)	Respiratory diseases (%)	Blood pois. (%)	Enterotoxemia (%)	Others (%)	Total (%)
S.	0,96	2,00	0,46	2,40	1,68	0,72	8,17
25 % Fr	2,27	2,29	2,27	2,20	1,52	—	10,55
50 % Fr	1,30	1,98	3,17	1,95	2,60	0,90	11,90
75 % Fr	3,17	4,80	7,90	—	—	—	15,87

d. — *Lamb growth rates and fattening*

The growth rates of the different genotypes, from birth to weaning, obtained by the average weights of all lambs born on the experimental farm of Bonasai during the experimental period (table 8) confirm the possibility of obtaining much heavier lambs, particularly from the F₁ genotype. This data coincides with that of PAPADOPOULOS *et al.* (1972), obtained in Greece during a similar project, when crossbreeding the local *Chios* to the *East Friesian*.

One of the more positive results obtained through crossbreeding the *Sarda* to the *East Friesian* is that of body size, better growth rates and the obtention of crossbred male lambs more suitable for modern fattening techniques. The production of heavier lamb carcasses is naturally particularly interesting on the European continent where heavy lambs are more acceptable than on the island where the "agnello di latte" of 8-10 kg remains the consumer's choice.

An experimental attempt to evaluate the fattening potential of the crossbreds (SANNA and RUDA, 1970; COSSEDU *et al.*, 1972; CASU *et al.*, 1976) confirmed the better growth potential and daily weight gains of these animals, when using both barley and maize rations; a very interesting feature was the better carcass conformation of the crossbred lambs.

e. — *Milk production and culling*

An attempt was made to study the causes of culling of the different genotypes, taking into consideration the number of ewes of each group originally available and their performance to the end of the fourth lactation. There has to date been no conclusive indication between the different genotypes, although the most important reason for culling appears to be udder conformation and the related sanitary problems (table 9). Information on the milking period is presented in

TABLE 8

Growth rates
Taux de croissance

Geno- type	Sex	Birth type (*)	Birth weight (kg)		Weaning			
					Liveweight (kg)		Age (days)	
			<i>n</i>	$\bar{x} \pm s$	<i>n</i>	$\bar{x} \pm s$	<i>n</i>	$\bar{x} \pm s$
S . . .	♂♂	S	646	3,895 ± 0,595	618	10,790 ± 2,541	618	31,550 ± 8,891
		T	709	3,311 ± 0,554	568	9,496 ± 2,450	586	33,918 ± 9,697
	♀♀	S	684	3,592 ± 0,539	639	11,077 ± 2,397	639	36,866 ± 8,239
		T	714	3,097 ± 0,517	582	9,730 ± 2,220	582	38,376 ± 9,195
25% Fr	♂♂	S	96	4,362 ± 0,619	94	10,415 ± 1,958	94	27,234 ± 6,222
		T	75	3,746 ± 0,576	65	8,636 ± 1,407	65	27,676 ± 6,953
	♀♀	S	96	4,204 ± 0,610	95	12,530 ± 1,946	95	37,726 ± 6,184
		T	75	3,552 ± 0,550	71	10,480 ± 1,854	71	38,225 ± 6,009
50% Fr	♂♂	S	179	4,684 ± 0,751	165	13,557 ± 3,065	165	31,751 ± 7,937
		T	303	3,810 ± 0,688	275	11,381 ± 2,907	275	32,687 ± 9,476
	♀♀	S	172	4,296 ± 0,775	163	14,038 ± 2,416	163	37,895 ± 5,971
		T	386	3,504 ± 0,646	331	12,283 ± 2,032	331	39,283 ± 5,658
75% Fr	♂♂	S	31	4,932 ± 0,735	27	15,407 ± 3,613	27	34,000 ± 7,189
		T	76	3,846 ± 0,808	70	12,721 ± 2,718	70	32,914 ± 8,308
	♀♀	S	28	4,367 ± 0,745	27	14,677 ± 2,461	27	36,148 ± 6,987
		T	89	3,688 ± 0,724	83	12,812 ± 2,596	83	38,096 ± 6,705

(*) Single (S) and twin (T) births.

TABLE 9

Causes of culling up to the 4th lactation
(expressed as a percentage of the original numbers of breeding ewes)
Causes de réforme jusqu'à la 4^e lactation
(exprimée en pourcentage du nombre de brebis présentes au départ)

Causes	Comparison of genotypes					
	S (%)	25 % Fr	S (%)	50 % Fr	S (%)	75 % Fr
Mastitis	2,86	2,38	6,52	4,34	—	5,71
Other udder problems	11,43	26,19	19,57	15,22	6,82	2,86
Low productivity	5,71	2,38	—	—	—	2,86
Accidents	—	—	2,17	—	2,27	—
Others	—	—	2,17	6,51	4,54	2,86
Total	20,00	33,95	30,43	26,07	13,63	14,29

TABLE IO
Milk yield and quality ($\bar{x} \pm S.D.$ and t -Test)
Production laitière et qualité du lait

Variable		Suckling (days)	Milking (days)	Milked yield (kg)	Aver. daily yield (kg)	Fat (%)	Protein (%)	
Lactation in/genotype	First	S	28 ± 11	162 ± 20	240 ± 55	1,480 ± 270	6,3 ± 0,3	5,5 ± 0,2 *
		25 % Fr	26 ± 6	168 ± 22	263 ± 55	1,570 ± 280	6,2 ± 0,3	5,6 ± 0,2
		S	29 ± 6	137 ± 9 **	190 ± 43	1,370 ± 280	5,8 ± 0,3	5,5 ± 0,1 N.S.
		50 % Fr	26 ± 6	152 ± 26	251 ± 60	1,650 ± 320	5,7 ± 0,4	5,6 ± 0,2
		S	22 ± 6	179 ± 29	204 ± 46	1,120 ± 240	6,3 ± 0,4	5,5 ± 0,2 N.S.
	75 % Fr	27 ± 6	177 ± 33	250 ± 57	1,423 ± 326	6,3 ± 0,4	5,6 ± 0,2	
	Second	S	33 ± 9	200 ± 38	264 ± 64	1,330 ± 300	6,4 ± 0,5	5,7 ± 0,3 N.S.
		25 % Fr	33 ± 7	211 ± 36	279 ± 64	1,330 ± 280	6,2 ± 0,5	5,7 ± 0,2
		S	38 ± 7	196 ± 40	284 ± 58 **	1,470 ± 300 **	6,5 ± 0,3	5,6 ± 0,2 N.S.
		50 % Fr	38 ± 8	200 ± 34	353 ± 60	1,800 ± 340	6,4 ± 0,4	5,7 ± 0,3
S		28 ± 7	200 ± 38	266 ± 44 **	1,370 ± 320	7,1 ± 0,5	5,9 ± 0,3 N.S.	
75 % Fr	33 ± 7	222 ± 30	338 ± 66	1,527 ± 380	6,5 ± 0,6	5,8 ± 0,2		

Third	S	32 ± 7	209 ± 39 *	303 ± 67	1,490 ± 420	6,6 ± 0,6	5,9 ± 0,3
	25 % Fr	32 ± 7	232 ± 32	311 ± 91	1,330 ± 400	6,8 ± 0,6	6,1 ± 0,4
	S	37 ± 9	218 ± 35 *	254 ± 59 **	1,180 ± 320 **	6,7 ± 0,5 *	5,9 ± 0,3
	50 % Fr	38 ± 7	240 ± 35	367 ± 89	1,520 ± 290	6,4 ± 0,5	5,9 ± 0,2
	S	36 ± 6	200 ± 35 *	262 ± 51 **	1,323 ± 253 *	—	—
	75 % Fr	38 ± 7	221 ± 27	346 ± 65	1,584 ± 312	—	—
Fourth	S	38 ± 6	225 ± 22	295 ± 73	1,306 ± 289	6,9 ± 0,6	5,8 ± 0,2
	25 % Fr	36 ± 6	232 ± 18	293 ± 109	1,260 ± 480	6,7 ± 0,5	5,8 ± 0,2
	S	35 ± 9	221 ± 38 *	251 ± 84 **	1,130 ± 330 **	6,9 ± 0,5	6,2 ± 0,4
	50 % Fr	34 ± 9	237 ± 35	375 ± 82	1,620 ± 450	6,7 ± 0,6	6,1 ± 0,3
	S	33 ± 10	220 ± 37	260 ± 56 **	1,197 ± 263 **	—	6,3 ± 0,4 *
	75 % Fr	35 ± 8	220 ± 46	339 ± 87	1,583 ± 388	—	6,1 ± 0,4

TABLE II

Milk yield and quality (standard lactation)
Production laitière et qualité du lait (lactation type)

Lactation genotype		Measurements	Milked yield (kg)	Average daily yield (g)	Fat (%)	Protein (%)
First (120 days)	S.	196 (100 %)	1630	6,0	5,3	
	25 % Fr	208 (106 %)	1730	5,9	5,4	
	S.	171 (100 %)	1420	5,8	5,5	
	50 % Fr	207 (121 %)	1720	5,6	5,5	
Second (150 days)	S.	160 (100 %)	1320	6,3	5,5	
	75 % Fr	190 (119 %)	1575	6,1	5,7	
	S.	226 (100 %)	1500	6,4	5,6	
	25 % Fr	236 (104 %)	1570	6,0	5,7	
Third (150 days)	S.	237 (100 %)	1580	6,3	5,5	
	50 % Fr	291 (123 %)	1930	6,2	5,6	
	S.	228 (100 %)	1510	6,8	5,9	
	75 % Fr	280 (123 %)	1673	6,3	5,8	
Fourth (150 days)	S.	256 (100 %)	1700	6,4	5,9	
	25 % Fr	242 (95 %)	1600	6,5	6,1	
	S.	211 (100 %)	1400	6,6	5,9	
	50 % Fr	281 (133 %)	1870	6,3	5,9	
Fourth (150 days)	S.	260 (100 %)	1415	7,0	5,9	
	75 % Fr	303 (117 %)	1698	—	—	
	S.	269 (100 %)	1488	6,8	5,8	
	25 % Fr	258 (96 %)	1426	6,5	5,8	
Fourth (150 days)	S.	206 (100 %)	1350	6,7	6,3	
	50 % Fr	284 (138 %)	1890	6,6	6,2	
	S.	236 (100 %)	1298	—	6,4	
	75 % Fr	296 (125 %)	1638	—	6,3	

table 10, while that of the standard lactations (120 days of milking for the first lactation and 150 for the other three lactations) is given in table II.

As expected under the intensive rearing conditions of the experiment, the milked yield of the crossbreds is higher than that of the purebred *Sarda*, after a suckling period of nearly a month for the first lactation and over a month (± 35 days) for the adult lactations. Three interesting comments should be made at this stage:

— There is no significant difference (not even at the first lactation) between the milk yield of the 25 p. 100 Fr and their contemporary *Sardas*.

— Strictly speaking, the best dairy ewe of the four genotypes appears to

TABLE 12

Maximum recording (cc) and date (expressed in days after birth; $\bar{x} \pm S.D.$)
 Date (exprimée en jours après la mise-bas) et quantité de lait au contrôle maximum (cc)

Geno- type	First lactation		Second lactation		Third lactation		Fourth lactation	
	Days	cc	Days	cc	Days	cc	Days	cc
S	74 ± 26	1,892 ± 350	67 ± 16	1,944 ± 323	65 ± 21	2,242 ± 436	66 ± 23	2,145 ± 408
25 % Fr.	73 ± 27	1,965 ± 353	69 ± 27	2,018 ± 313	68 ± 18	2,104 ± 581	47 ± 9	2,110 ± 777
Diff. . . .	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	**	N.S.
S	88 ± 26	1,686 ± 370	72 ± 34	1,995 ± 369	70 ± 19	1,858 ± 411	71 ± 27	1,845 ± 480
50 % Fr.	92 ± 28	2,086 ± 372	88 ± 51	2,438 ± 477	72 ± 26	2,326 ± 458	76 ± 43	2,399 ± 585
Diff. . . .	N.S.	**	N.S.	**	N.S.	**	N.S.	**
S	66 ± 20	1,586 ± 347	60 ± 18	2,031 ± 426	61 ± 22	1,997 ± 334	70 ± 20	1,789 ± 334
75 % Fr.	90 ± 48	1,891 ± 504	98 ± 63	2,156 ± 466	68 ± 24	2,279 ± 462	93 ± 57	1,854 ± 591
Diff. . . .	*	**	**	N.S.	N.S.	*	N.S.	N.S.

TABLE 13

Distribution of the udders according to type and genotype (see fig. 4)
 Distribution des mamelles d'après leur type et le génotype des brebis (voir fig. 4)

Genotype	Type	1 (%)	2 (%)	3 (%)	4 (%)
	S		4,1	31,4	61,2
50 % Fr		33,3	44,4	22,2	—
75 % Fr		42,9	—	57,1	—

be the 50 p. 100 Fr; this confirms the information obtained from other similar Mediterranean projects (FLAMANT, 1974; KALAISSAKIS *et al.*, 1977; FLAMANT and CASU, 1977). The indication is that there is a drop in absolute and relative milk production when arriving at the 75 p. 100 *Friesian* blood level. This is clearer from the complete lactation data (table 12) than from the standard lactation data (table 13). It will eventually be interesting to compare this information with the data of the 87,5 p. 100 Fr genotype—which, unfortunately, is not yet available.

— Contrary to Greek findings (KALAISSAKIS *et al.*, 1977), there is no significant difference between the different crossbred genotypes and their contemporary purebred groups in respect of milk quality (fat and protein content), although as expected, the milk of the purebreds is richer in fat content than that of the contemporary crossbreds (tables 10 and 11).

There is no significant difference between the lactation periods of the crossbreds and the purebreds, although the purebreds on average always show a relatively shorter lactation period than their contemporary crossbreds, which could be attributed to the slightly earlier average date of lambing of the crossbreds (fig. 2).

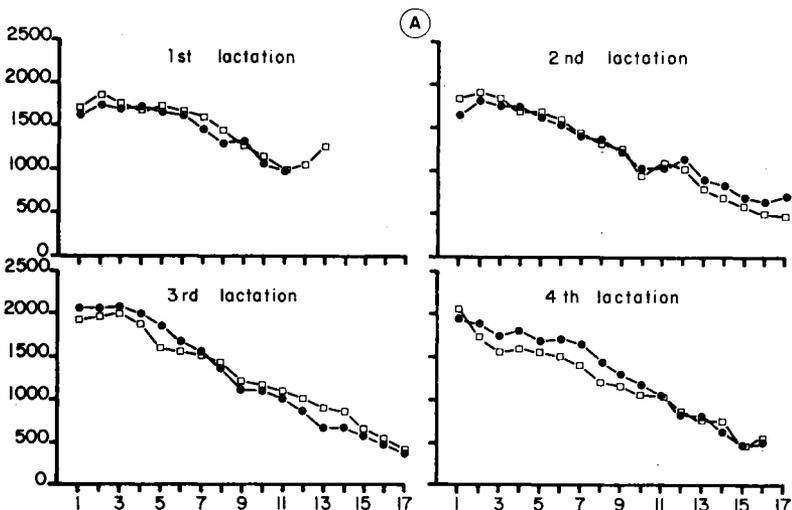
f. — Lactation curves

An investigation within genotype and number of lactation of the average date on which the first milk records were effected, very seldom shows differences between the comparable genotypes (crossbreds and contemporary *Sardas*) from one year to another. Whenever a difference does occur, however, the average date of the first milk recording of the crossbreds—which is naturally linked to the date of lambing—is always the earlier of the two.

It is also interesting to note that the first milk recording (linked to the date of lambing) of the truly adult lactations (3rd and 4th) is always carried out in January and early February, within a period of one month. On an average, the first controls of the second lactation take place a month later (February and early March). The average duration of the milking period of the crossbreds is comparable to the milking periods for similar crossbreds in other parts of the Mediterranean.

— The following observations can be made on the lactation curves (fig. 3):

— There is considerable similarity between the total quantity of the milked yield of the *Sardas* and the 25 p. 100 Fr (table 10). However, the initial yield by the 25 p. 100 Fr crossbreds at the beginning of lactation (after weaning) is higher and the final yield at the end of lactation (11th to 17th control) is lower than that of their contemporary *Sardas*. This applies parti-



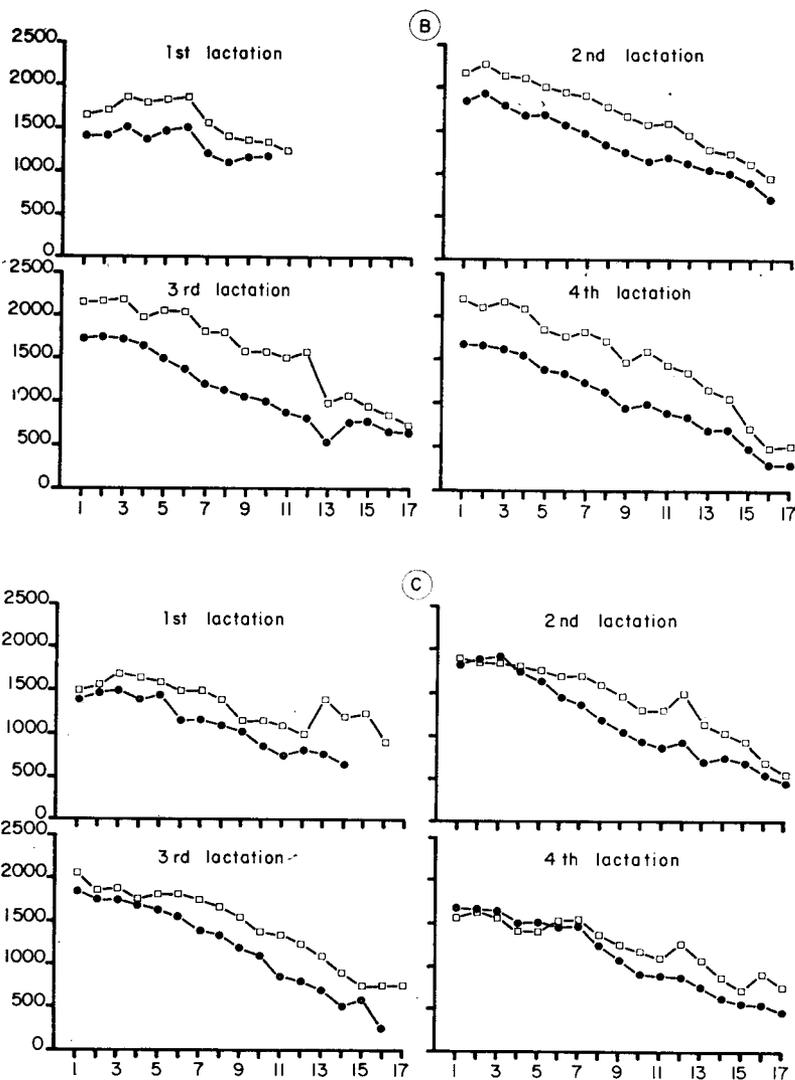


FIG. 3. — Lactation curves.

- A) 25 % Friesian ewes compared to contemporary Sarda.
- B) 50 % Friesian ewes compared to contemporary Sarda.
- C) 75 % Friesian ewes compared to contemporary Sarda.

Courbes de lactation

- A) Brebis 25 % Frison comparées à des contemporaines Sardes.
- B) Brebis 50 % Frison comparées à des contemporaines Sardes.
- C) Brebis 75 % Frison comparées à des contemporaines Sardes.

Sarda ●
 Sarde
 Friesian cross □
 Croisées Frison

cularly to the 2nd-4th lactations, whereas no noteworthy differences exist for the 1st lactation.

— A comparison of the lactation curves between the 50 p. 100 Fr and their contemporary purebreds is always to the advantage of the crossbreds. The two lactation curves tend to be similar in evolution, but the individual milk controls of the crossbreds are consistently between 200-500 gm higher than those of the purebreds. This confirms the value of F_1 ewes under intensive rearing conditions.

— The results of the comparison between the 75 p. 100 Fr and the Sardas are far less striking, since the two lactation curves (S and 75 p. 100 Fr) are almost identical, particularly after the third lactation. The two groups of ewes in all cases start at a very comparable level of production, differing only towards the 7th or 8th control effected at about 140-150 days from lambing.

A study of the maximum recordings (table 12) confirms the relatively late stage at which the *Sarda* ewe attains her maximum daily yield. It is interesting to note that some of the crossbreds also reach maximum yield rather late in comparison with results obtained with purebred *Friesians* elsewhere (BOYAZOGLU, 1963). KALAISSAKIS *et al.* (1977) arrive at similar conclusions with their *Friesian* × *Chios* crossbreds, but at a much earlier stage after birth (adult lactations, 45-60 days vs. 70-90 days in our case; F_1 and 75 p. 100 Fr material). The fact that the maximum daily yield is attained at such a late stage could at least partially be ascribed to problems in adapting to machine milking.

With regard to the maximum recording data, two main remarks can be made:

— The negligible difference between the purebred *Sarda* and the 25 p. 100 Fr can be confirmed. The volume of the maximum daily yield and the interval between birth and maximum yield are similar for these two genotypes.

— There are highly significant differences (PL 0.01) between the volume of the maximum recording only in the case of the S/50 p. 100 Fr comparisons, while in the S/75 p. 100 Fr comparisons, this is only true for the first lactation (also difference at PL 0.05 ewes in the third lactation).

Comparisons of the yield of the *Préalpes* and *Friesian* crossbreds (50 p. 100 and 75 p. 100) in the very short ascending period of the lactation curve (IZQUIERDO PRIMO *et al.*, 1969) show that maximum recorded yield was lower for the 75 p. 100 crossbreds than for the 50 p. 100 and that, contrary to our data, the crossbreds attain their maximum recorded yield at an earlier stage than the purebred *Préalpes*.

g. — *Milking ability and machine stripping*

Machine milking is essential to the development of the dairy industry under intensive husbandry conditions. It is thus important to consider the udder conformation of breeds to be used under these conditions. A valuable presentation of the udder conformation of the Sardinian breed was made by SANNA and PICINELLI (1973) and for comparative purposes, an attempt was made here to classify the different genotypes in our experiment according to the type of udder (fig. 4). Observations made at Bonassai with a random sample of contemporary Sardinian and crossbred ewes (50 p. 100 Fr and 75 p. 100 Fr) show that while only 4 p. 100 of the controlled purebred ewes had the "hard" type of udder, the comparative values for the 50 p. 100 Fr was 33 p. 100 and that for the 75 p. 100

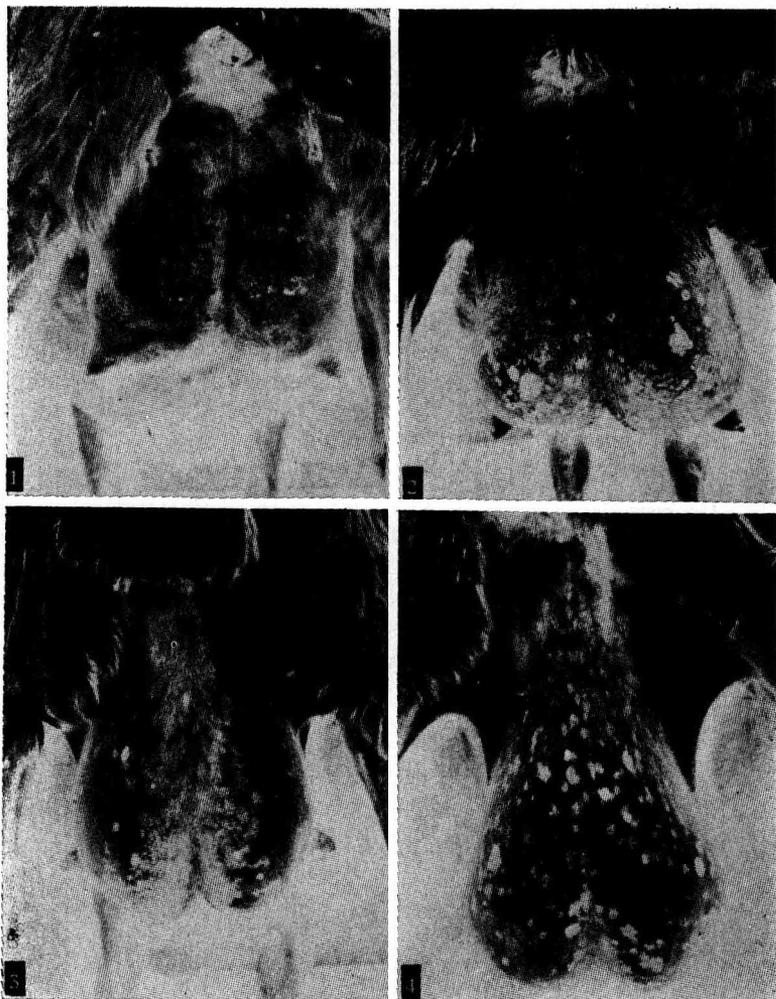


FIG. 4. — *Main udder types.*
Principaux types de mamelles.

Fr nearly 43 p. 100. In the light of the observations of PARTE ARROYO and FLAMANT (1978), this could be interpreted as indicating a better average milking ability of the purebreds, despite a less attractive udder conformation in general and some milk retained in the udder after each milking (table 13).

The relation between the facility of machine milking, milk retention, etc., on the one hand, and the form of the udder, hardness, general conformation and position of the teats, on the other, is a very complex matter, approached by the farmer ("éleveur" in French) and the milker ("trayeur" in French) in different ways. In a recent publication, PARTE ARROYO and FLAMANT (1978) used three criteria to evaluate the milking ability of ewes of three dairy genotypes (*Lacaune*, *Sarda* and the *F.S.L.*, the result of a *Friesian*, *Sarda* and *Lacaune* cross): milking characteristics, udder conformation and loss in milk production in relation to

the reduction in the number of daily milkings. The milking characteristics of the Sarda ewes are apparently the least adequate, with the highest percentage of milk retained following udder massage. However, the average loss in production (one versus two milkings) is the least significant. Under simplified milking conditions, the *F.S.L.* ewes appear to have inherited the most favourable factors from their parental breed, the *Sarda*, at the same time maintaining the better udder conformation of the *Lacaune* breed.

According to CASU and RUDA (1973), machine stripping has little economic value under the local (even intensified) husbandry conditions. A study was consequently undertaken on the different genotypes to determine the quantity of milk obtained through stripping (table 14). The information thus obtained confirms their findings and indicates that in the case of the purebred Sardas and the 25 p. 100 Fr and 50 p. 100 Fr crossbreds, the percentage of milk obtained through stripping is less than 5 p. 100 of the total milk yield; it is higher for the 75 p. 100 Fr group of ewes (6,8 p. 100: 1st lactation; 5,3 p. 100: 2nd lactation; 5,4 p. 100: 3rd lactation). Even when referring to the standard lactation period, the 75 p. 100 Fr group always shows the highest quantity and relative percentage of stripped milk.

TABLE 14

Comparative value of machine stripping
Valeurs comparées de la repasse

Lactation	Genotype	Total (milking) lactation		Standard lactation	
		(kg)	% of total yield	(kg)	% of total yield
		$\bar{x} \pm s$	$\bar{x} \pm s$	$\bar{x} \pm s$	$\bar{x} \pm s$
First	S	7,5 ± 3,1	3,6 ± 1,3	5,9 ± 2,4	3,2 ± 1,3
	25 % Fr	10,1 ± 3,2	3,8 ± 3,9	8,2 ± 2,6	4,0 ± 4,1
	50 % Fr	5,2 ± 1,2	2,1 ± 2,0	4,3 ± 1,2	2,1 ± 2,0
	75 % Fr	18,3 ± 30,7	6,8 ± 11,6	8,6 ± 2,1	4,1 ± 4,2
	Differ.	**	**	**	**
Second	S	10,9 ± 2,7	4,0 ± 1,0	8,6 ± 2,1	3,8 ± 1,0
	25 % Fr	12,9 ± 2,9	4,7 ± 4,8	10,0 ± 1,9	4,3 ± 4,4
	50 % Fr	15,3 ± 4,2	4,3 ± 4,4	12,3 ± 3,9	4,3 ± 4,4
	75 % Fr	18,2 ± 7,4	5,3 ± 5,6	12,3 ± 5,2	4,6 ± 4,8
	Differ.	**	**	**	N.S.
Third	S	12,0 ± 3,0	4,5 ± 1,1	9,0 ± 2,2	4,0 ± 1,0
	25 % Fr	12,7 ± 2,6	4,4 ± 4,7	9,4 ± 1,4	4,2 ± 4,4
	50 % Fr	16,1 ± 3,3	4,4 ± 4,5	11,1 ± 2,5	3,9 ± 4,0
	75 % Fr	18,2 ± 5,5	5,3 ± 5,6	13,1 ± 3,6	5,0 ± 5,3
	Differ.	**	N.S.	**	N.S.

h. — *Wool characteristics*

Carpet wool production still plays an important role on the island where carpet weaving is traditional, particularly in the light of the recent re-activation of the family operated carpet industry. The development of tourism in recent years created a growing market for all handwoven textiles and the determined action of the local institute for popular arts (ISOLA) revived the interest in carpet weaving and local textile production.

The basic material for the traditional carpet industry has always been the wool of the longwool *Sarda* dairy breed, known for its high staple length, convenient

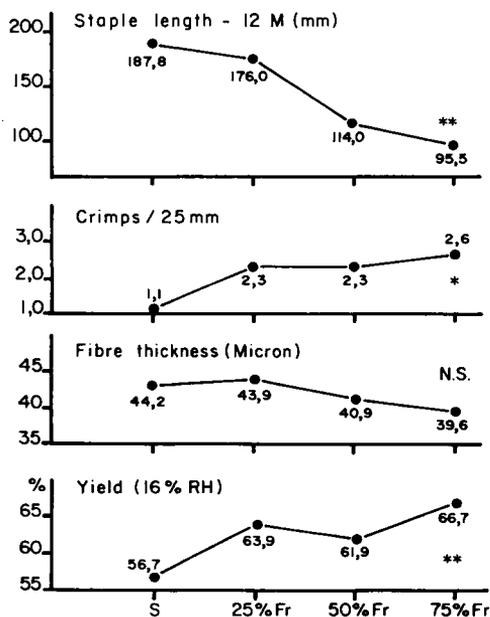


FIG. 5. — *Wool characteristics.*
Caractéristiques lainières.

TABLE 15

Wool quantity (kg)
Quantité de laine (kg)

Lac. period \ Genotype comp.	S		50 % Fr		75 % Fr	
	S	25 % Fr	S	50 % Fr	S	75 % Fr
First	1,9 ± 0,4	2,1 ± 0,4	1,7 ± 0,3	2,8 ± 0,5	2,0 ± 0,4	2,9 ± 0,8
Second	2,0 ± 0,4	2,0 ± 0,3	1,7 ± 0,4	2,9 ± 0,6	2,1 ± 0,6	3,7 ± 0,9

fibre thickness and crimp value. Its quality and technical possibilities are amongst the best in the Mediterranean Basin (FERRERO, 1972). It thus appears important to have an indication of the effect of crossbreeding on wool quality and type.

The average of the data obtained is presented in figure 5. It is evident that, despite the higher average quantity of shorn wool (table 15) from the crossbreds, the wool is less suitable for carpet weaving than that of the purebreds. It will undoubtedly be interesting to undertake a future study on the variability of the different measurements when a more representative number of animals will be available.

Discussion and conclusion

1. The analysis and publication of the results obtained in Sardinia complete the crossbreeding experiments carried out over the past twenty years between the *East Friesian* breed and a number of the local Mediterranean breeds: the *Awassi* in Israel, the *Chios* in Greece and the *Préalpes (Lacaune)* type in France. In general, these experiments were aimed at finding a genotype likely to improve the cheese industry and fully exploit the investments in the dairy sheep industry (machine milking, husbandry buildings and other facilities) undertaken in the richer agricultural areas (cereal planted plateaus and irrigated plains). By eliminating most of the constraints pertaining to the traditional animal husbandry systems, it is, in fact, possible to use more demanding animal material, however with all the productive qualities: milk yield, numerical productivity, high growth rate of the lambs, etc. It has been customary to use the *East Friesian* breed in improved husbandry conditions to correct the shortcomings of the local breeds, such as:

- low numerical productivity of the *Awassi* and *Sarda* breeds;
- low growth capacities of the *Awassi*, *Sarda* and *Chios* breeds, and the fat-tail of the *Awassi* breed;
- low milk yield (*Préalpes-Lacaune*), average milk yield (*Sarda*) or high milk yield, but lower than that of the purebred *East Friesian* (*Chios*).

The *East Friesian* undoubtedly possesses all the above qualities in its own environment, but experiments as a whole reveal certain qualities specific to the local breeds and which might deteriorate by crossbreeding with the *Friesian* breed. These qualities essentially concern adaptability in difficult environments, which better husbandry conditions have not or cannot completely correct: resistance to heat due to strong thermic variations (FLAMANT and RICORDEAU, 1969), possibility of out-of-season sexual activity whereby the natural growth of the grass in autumn and spring can be used (GOOT, 1966; ZERVAS *et al.*, 1975). It can also be assumed that the high nutritional requirements of the *East Friesian* or its crossbreds are not always satisfied, even under improved husbandry conditions. Frequent sanitary problems are found in the purebred *Friesian* or the crossbred 75 p. 100 *Friesian* ewes.

The experiments with the *Sarda* breed confirm, however, that under certain improved and controlled conditions, the defects of the *East Friesian* can be reduced. Thus, sexual seasoning observed elsewhere with an increased proportion of *Friesian* blood (ZERVAS *et al.*, 1975) was not found in the Sardinian experiments and the sanitary problems appear less frequently with the crossbreds than indicated, for

example, by GOOT (1966), RICORDEAU and FLAMANT (1969) and ZERVAS *et al.* (1975). The observations of SHIMSHONI and LAVI (1972) in Israel, ZERVAS *et al.* (1975) in Greece and FLAMANT and CASU (1977) in the Roquefort region (France) confirm our own observations; through various methods of flock management a farmer can attain a certain amount of success. In general, the rearing of ewes with over 50 p. 100 of *Friesian* blood cannot be recommended without risking setbacks.

The lower productivity of crossbred *Friesian* ewes beyond the first generation (F₁) is due to the influence of unfavourable factors at several levels (KALAISSAKIS *et al.*, 1977):

— on the reproduction efficacy, resulting in a decrease in the birth rate of lambs and the milk yield of ewes;

— on the viability of the crossbred lambs and adults;

— on the level of milk yield per lactation, either through a direct effect on the lactation curve or its level at different stages (IZQUIERDO PRIMO *et al.*, 1969), or through an indirect effect: the reproductive ability and viability as an intermediary, determining the number of reproductive females available for renewal and consequently a possible rate of selection.

2. In comparison with the other Mediterranean sheep breeds, the *Sarda* has other particularities: milking ability and interesting fleece characteristics.

Observations made on the morphology of the udder and the milk fractions collected during milking were not really conclusive with regard to the milking ability of the various crossbred genotypes in comparison with the *Sarda* ewes. They thus had to be submitted to the same experimental schemes, whereby stripping was suppressed or a single daily milking was carried out, thus revealing the particularities of the *Sarda* ewes in comparison with other breeds (CASU *et al.*, 1978).

With regard to the fleece characteristics, the East Friesian crossing undeniably lowers the qualities required for carpet making. Crossbreeding thus has to be accompanied by the regional planning of the area concerned. It can, for example, be considered limiting the rearing of crossbred ewes in the irrigated plains, however maintaining the rearing of *Sarda* ewes in the extensive and mountainous regions covering most of the island (LE LANNOU, 1941). The combination of farming with the local breed and a homecraft industry, technologically linked to it and likely to bring about an important increase in value, probably constitutes one of the conditions for the perpetuation of rural society in this region. On the contrary, farms in the irrigated plains can undertake specialised dairy and meat production (CASU, 1971).

3. Through these results different crossbreeding strategies can be foreseen for farmers having undertaken a degree of improvement. It is thus possible to compare the milk yield of the following flocks, taking a 20 p. 100 renewal rate of the flock into account (table 16):

a) purebred *Sarda*,

b) purebred *Sarda* + production of the F₁ ewe with a second meat crossing,

c) purebred *Sarda* + production of the F₁ ewe + production of the 25 p. 100 *Friesian* ewes,

d) idem c, but with 75 p. 100 *Friesian* ewes.

TABLE 16

Evaluation of the global productivity of different crossbreeding strategies between the Sarda and Friesian breeds (flocks in equilibrium)
Evaluation de la productivité globale d'après différentes stratégies de croisement entre les races Sarde et Frisonne (troupeaux en équilibre)

Genotype	Relative proportion of the different genotypes (%)	Adult ewes in the flock	
		Milk production (kg)	Lambs sold (n)
Pure Sarda	100	271	67
Production of 50 % Fr (F ₁) ewes:			
♂ S × ♀ S	19		
♂ Fr × ♀ S	24	324	113
♂ R × ♀ F ₁	57	(+ 20 %)	(+ 69 %)
Production of 25 % Fr ewes:			
♂ S × ♀ S	6		
♂ Fr × ♀ S	7	303	100
♂ S × ♀ F ₁	17	(+ 12 %)	(+ 49 %)
♂ R × ♀ 25 % Fr	70		
Production of 75 % Fr ewes:			
♂ S × ♀ S	6		
♂ Fr × ♀ S	7	335	97
♂ Fr × ♀ F ₁	17	(+ 24 %)	(+ 45 %)
♂ R × ♀ 75 % Fr	70		

In spite of a ± 34 p. 100 higher milk yield for F₁ ewes in comparison with the Sarda ewes, the global superiority of a flock which would assure the renewal of purebred *Sarda* females and the production of F₁ females is only 20 p. 100. On the other hand, an additional 69 p. 100 of lambs can be sold, which amongst others, have a higher growth rate than the purebred Sarda lambs. It can also be observed that despite a fall in production of the 75 p. 100 Fr ewes, in comparison with F₁ ewes, the producer centres practising this type of crossbreeding can hopefully use the better milk potential of the *East Friesian* breed. It must, however, be considered whether the slow progress aimed at is worth the risk engendered by the higher frailty of the genotypes produced, since the production of lambs is generalised in comparison with flocks which are only limited to first generation crossbreeding.

The effective productivity of the flock where the F₁ ewes are fully used, could be increased by guaranteeing the renewal of the *Sarda* females through outside purchases or in a satellite flock (under more difficult husbandry conditions) in the mountainous areas. It could also be envisaged to supplement the flocks in the plains with F₁ females produced directly in the satellite flock (genetic and geographical stratification of breeding systems). A system of this nature, however,

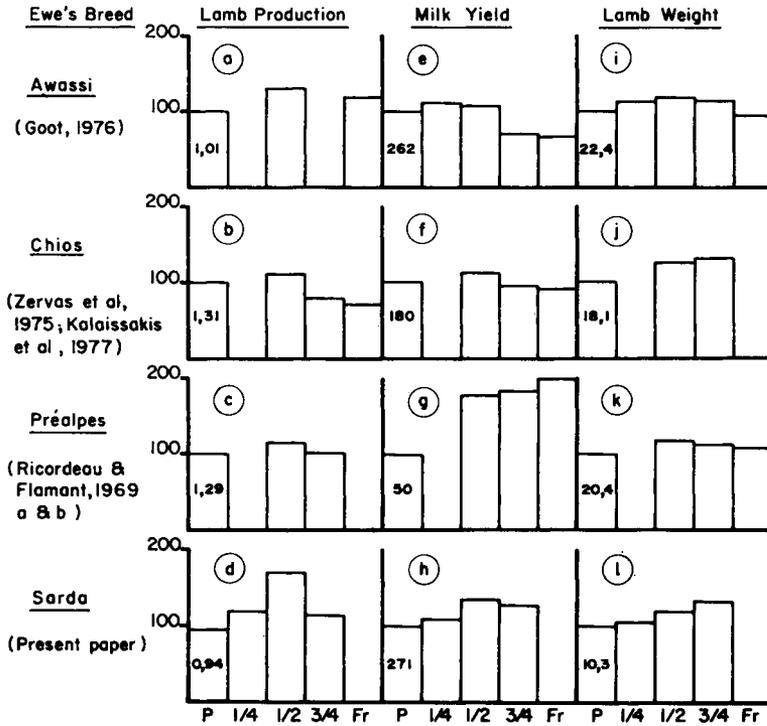


FIG. 6. — Recapitulation of the principal most recent results of grading up to the East Friesian (*Fr*) with four Mediterranean breeds: Awassi, Chios, Préalpes (Lacaune type) and Sarda in reference (percentage) to the pure breed (*P*).

Récapitulation des principaux résultats récents de croisements de la race Frisonne (*Fr*) avec quatre races méditerranéennes Awassi, Chios, Préalpes (type Lacaune) et Sarde exprimés en pourcentage des résultats en race pure (*P*).

a, c : Lambs born per adult ewe present.

Agneaux nés par brebis adulte présente.

b, d : Lambs weaned per adult ewe present.

Agneaux sevrés par brebis adulte présente.

e, f, h : kg milk per adult lactation.

kg de lait par lactation adulte.

g : kg milk during the first 60 days of 2 year old ewe lactations.

: kg de lait pendant les premiers 60 jours de lactation (brebis de 2 ans).

i : Average weight (kg) of simple male lambs.

Poids vif moyen (kg) d'agneaux mâles simples.

j : Average weight (kg) of 56 days old lambs.

Poids vif moyen (kg) d'agneaux de 56 jours.

k : Average weight (kg) of 90 days old lambs.

Poids vif moyen (kg) d'agneaux de 90 jours.

l : Average weight (kg) at weaning.

Poids vif moyen (kg) au sevrage.

comes up against definite difficulties which, other than organisatory problems, essentially reside in the extremely poor adaptation of *East Friesian* rams to Mediterranean husbandry conditions and notably with regard to reproduction. This handicap probably also exists under plain conditions and would limit the theoretic effectiveness of the schemes that could be established. In order to solve the adaptation problem of the males under extensive pasture conditions, *East Friesian* rams were used in Greece mainly for artificial insemination over a period of approximately twenty years (ZERVAS and BOYAZOGLU, 1977). Supposing that one even succeeded in mastering the crossbreeding technique and limiting it to the first generation, which was never the case, the global effectiveness of the operation would appear doubtful, since it was not possible to maintain a sufficient number of purebred Friesian flocks and since there was a high rate of mortality amongst the rams in the production centres, necessitating frequent imports.

The crossbreeding experiments with the *East Friesian* breed undertaken over the past twenty-five years in Israel, France, Greece and Sardinia have thus proved that the use of rams of this breed on a large scale is not to be recommended. It would appear preferable to exploit investments in the Mediterranean region by the creation of synthetic lines where the *East Friesian* breed can be used (FLAMANT *et al.*, 1975: *F.S.L.* in France, *Assaf* in Israel), or perhaps even better, if the local breeds possess relatively high productive qualities (*Chios* and *Kyme-Skopelos* in Greece) or are characteristically linked to the local economy (*Sarda* in Italy, *Lacaune* in France), to establish a purebred selection programme of these breeds (fig. 6).

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Résumé

Croisement entre les races ovines Sarde et Frisonne en Sardaigne

Le développement de l'irrigation dans les plaines a ouvert ces dernières années des possibilités de production agricole intensive dans plusieurs régions de Sardaigne. On s'est demandé si l'élevage des brebis laitières pouvait valoriser cette amélioration; un programme de recherches sur la possibilité d'élever des brebis laitières dans des conditions intensives a donc été envisagé et entrepris à l'*Istituto Zootecnico e Caseario per la Sardegna*. Il s'agit notamment de déterminer le type génétique le plus adapté à cette nouvelle situation. Les investissements importants exigés par ce type d'amélioration ne peuvent être valorisés que par l'obtention d'un haut niveau de productivité individuelle.

La brebis *Sarde*, dont la productivité est normalement satisfaisante dans les conditions d'élevage extensif de l'intérieur de l'île présente certains inconvénients dans des conditions alimentaires plus intensives :

- fécondité relativement basse,
- capacité limitée de croissance des agneaux.

Du point de vue de la production laitière on peut également rechercher le génotype réalisant la transformation la plus efficace. A cet effet, il a été décidé d'essayer un croisement avec la race *Frisonne* qui parmi toutes les races laitières présente le potentiel de production laitière le plus élevé ainsi qu'une grande fécondité dans son pays d'origine.

Néanmoins, tenant compte des difficultés d'adaptation que cette race rencontre normalement en dehors de son milieu d'élevage d'origine, il a été réalisé un schéma expérimental qui ne se limite pas au croisement de première génération F_1 , mais réalise une deuxième génération de croisements vers les races parentales (*Sarde* et *Frisonne*). Les animaux ainsi obtenus (F_1 , $1/4$ *Frisonne*, $3/4$ *Frisonne*) ont été comparés à des brebis de race *Sarde* strictement contemporaines et conduites de façon identique.

Les résultats confirment l'information obtenue dans d'autres parties du bassin méditerranéen (France, Grèce, Israël, Portugal, Espagne, Turquie) : même dans des conditions de nutrition et d'élevage les meilleures possibles — du fait de la température élevée et du climat sec régnant dans le milieu méditerranéen — il n'est pas profitable et dans la plupart des cas même pas recommandé d'élever des brebis avec plus de 50 p. 100 de sang *Frison*.

Les observations Sardes démontrent à nouveau la fragilité de la race *Frisonne* et de ses produits de croisement au delà de la première génération, même si les résultats obtenus dans les conditions d'irrigation intensive des plaines n'atteignent pas le même niveau catastrophique enregistré lorsque la race *Frisonne* est utilisée dans des conditions d'élevage plus difficiles. En outre dans le cas de la Sardaigne, le croisement *Frison* risque d'être extrêmement préjudiciable à une activité économique très importante pour les régions de l'intérieur : le tissage artisanal des tapis Sardes. En ce qui concerne la facilité de la traite des observations complémentaires sont nécessaires pour préciser l'incidence du croisement *Frison* sur une qualité essentielle des brebis *Sardes*.

La comparaison avec les différents résultats d'amélioration génétiques réalisés depuis vingt ans en Israël, Grèce et France nous incite à penser que seules deux voies sont possibles pour les élevages de brebis laitières méditerranéennes : la sélection et l'utilisation en race pure des races locales, la création de lignées synthétiques ne présentant pas plus de 50 p. 100 de sang *Frison*.

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