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## The Sarda dairy sheep production system: balance and perspectives of the breeding programme

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### PRODUCTION SYSTEM AND ECONOMIC ENVIRONMENT

#### Background and description of the system

Countries with mediterranean climate show peculiar features in particular concerning rainfall and vegetation. Rainfall is concentrated between autumn and spring, being the summer usually dry. A cold, more or less intense, occurs in winter, especially in elevated areas, with occasional snow coverage and temperatures dropping below zero quite often.

Such climatic conditions strongly affects the herbage growth which shows two peaks: one in autumn (september-december) and the other in spring when 2/3 of total forage yield is recorded, everything getting dry in Summer. Grazing availability changes from year to year and so as chemical composition and feeding value.

Another feature, typical of many Mediterranean areas is the evergreen shrub coverage (*macchia*), browsed by livestock when herbage is scarce or less palatable. It protects from erosion slopes and windwards areas. Trees, mostly oaks, evergreen or not, scatter more or less densely in the range.

These traits, together with shallow and rocky soils, steep slopes (where any tillage is difficult) explain the widespreading of large areas where grazing is the only feasible exploitation.

Sardinia, the second Mediterranean island (24,000 km<sup>2</sup>), owns at the highest extent such features: by consequence roughly 3/4 of total area are natural pastures formed by ranges, shrub and woodland more or less degraded, marginal arables no longer ploughed, where livestock (especially rustic or dual purpose cattle, dairy sheep and goats) live permanently free range, feeding on the available natural resources.

#### Sheep industry in Sardinia

In the framework of stock industry the sheep share, with more than 3,000,000 heads, plays an important role, it represents 26% of total agricultural income in Sardinia. Due to its prevailing dairy specialization it supplies 2/3 of the total milk output in the island in terms of volume. Of course its contribution is higher in terms of processed cheese.

The only sheep raised belongs to the Sarda breed, a medium size dairy sheep that reaches an average weight of 50 kg in ewes and 70 kg in rams. It has white open fleece and polled slight head with rectilinear profile. This sheep, well adapted to the environment, exploits fairly well the available feeding resources in marginal areas, in highlands and mountains, as in plains (even irrigated) and lowlands, in large sheep farms set up in recent times (tab.1). Of course the dairy capability is fully expressed where environmental conditions are more favourable and husbandry techniques more accurate. Nevertheless, despite the usual concentrate supplementation, feeding relies prevailingly on the exploitation of natural pastures and limitedly of cultivated meadows. Consequently the productive cycle is heavily affected by seasonal weather pattern.

According to recent statistical figures (1990) sheep breeding involves 20,089 farms with 2,619,000 milkers. In the last twenty years number of farms did not register any substantial change but the stock increased from 109 head in 1970 to 159 in 1990 (tab.2) even though small farms are still numerous (tab.3). During this time the sheep industry improved too due to better management of animals and pasture (fertilization, stones removal, shrub control, overseeding), cultivated meadows introduction and genetic improvement.

Even the feeding started to be carried out according with the physiological and productive requirements, by the above mentioned concentrate supplementation, adequate roughage stock usually as hay and occasionally as silage.

In some plain farms is starting to rise a keen interest to house the flocks and feed by complete diet technique, even though the adaptability (if any) of Sarda sheep to such unusual system has to be pointed out.

Hence milk is the main production of small ruminant industry and represents 70% of the total income, being the remaining 30% represented by meat while wool is valueless. Meat production derives from suckling lamb slaughtered when 30 days old. An average fertility rate ranks between 70 and 90% for yearlings and mature ewes respectively. Prolificacy ranks between 1.0-1.2 for yearlings and 1.2-1.5 for mature ewes.

### **Milk production and processing**

The extraordinary growth of sheep industry in Sardinia started when Roman manufacturers took interest to Sardinian sheep milk, when the home produced became insufficient to their requirements. The early cheese factories were established at the end of last century to increase the *Pecorino Romano* output to be exported to North America. Consequently sheep farms freed themselves from direct milk processing which previously were forced to, and bound themselves more actively in sheep husbandry. Further momentum was gathered by shepherds cooperatives organized in Sardinia, starting before the First World War and gone on after the fifties with the support of the meanwhile established Regional Government.

In 1994 sheep milk yield summed up 260,000 T. The astonishing (tab.4) increase performed in the last 30 years depends not only on the mentioned upgrading of husbandry and feeding techniques but even on widespread selected rams utilization (nearly 3,000 per year).

Yet the determining stimolous is consequent of a lasting favorable marketing of sheep dairy products. This allowed the development of a noticeable export flow to North America (USA and Canada) of *Pecorino Romano* cheese either straightly or via other European countries (mainly The Netherlands), reaching 20,000 T/year. Thanks to such favourable trend, milk price increased till 1400 lit/liter in 1993. This determined the increment of sheep livestock, its scattering in plains even irrigated and the increased milk yield per head.

At moment roughly 90% of milk yield is processed in factories either cooperatives (44) or private (39): nowadays the share is 50/50 in terms of quantity. The remaining 10% is processed as raw milk, directly in sheep farms, to produce the *Fiore Sardo*, most typical and ancient sheep cheese in Sardinia.

So far the total output of sheep cheese amounts, for 1994, roughly 55,000 T, fairly above the home demand. Luckily the North American market requests yearly 14,000-15,000 T from Sardinia, thanks to the E.U. subsidy granted to cheese exported in foreign countries. The recent GATT conclusion (Uruguay round), where a significant reduction of subsidy to export is scheduled (50% reduction of the subsidized amount and 30% reduction of subsidy per kg in 6 years), jeopardize the present situation in the future. Diversification of processing and the acquisition of new markets is a must. It can be an opportunity to push the *Fiore Sardo* production and the newly developed technology at the Istituto Zootecnico e Caseario per la Sardegna (I.Z.C.S.), allows its production even in industrial factories, fulfilling the hygienic requirements imposed by the E.U. regulation. In this way it can enlarge its market area, nowadays restricted to small areas in southern Italy.

It is well known in E.U. productive surplus characterize many crops so that a "quota regime" has been established in several cases. So far sheep milk escaped to such regulation firstly because surplus have not yet occurred and secondly because in marginal and disadvantaged areas different productive options are not available. The only limit regards the number of eligible ewes (sheep quota) to premium referred to 1991. If sheep milk "quota regime" would be established the preeminence of Sardinian industry should be secured in confront of many areas without any tradition about. Should be secured too the present level of E.U. subsidy which grants a substantial part of the total income of Sardinian shepherds. The substantial reduction of such support could jeopardize the survival of this industry, so important for rural economy of less favoured areas.

## SELECTION SCHEME

Selection on Sarda dairy sheep started, in a collective form, in 1927 with the institution of the Sarda Herd-Book (Libro Genealogico, LG) and the creation of the *Ovile Sardo* near Cagliari, a nucleus-flock in which ewes from several flocks were grouped, compared on milk-recording basis and mated with rams born from best dams. In 1972 selection criterion was defined as the milk yield strictly recorded in the milking period after the suckling period. Until 1976 young rams for natural mating were selected mainly on dam and half sibs performances and on the morphological breed standard. Since this date progeny test was introduced and ram breeding values obtained by *Contemporary Comparison* method applied to yearlings yields. This implied the introduction of a minimum genetic merit for sires of future rams.

From 1992 breeding values are obtained both for rams and ewes by *BLUP* (Best Linear Unbiased Prediction) using a repeatability animal model including fixed environmental, random additive genetic and female permanent environment effects.

As shown in tab.5 in Sardinia milk recording activity from 1975 to 1994 increased gradually from 30,000 ewes in 400 flocks to 90,000 ewes in 700 flocks. As in the whole Sarda population the average flock-size and yield increased from 1975 to 1994. In the last years due to the spread of the Sarda breed (1 million Sarda ewes are bred in Latium, Tuscany etc.) 80-100 flocks and 15-20,000 ewes from foreign regions were included in selection nucleus.

Since 1986 cervical artificial insemination (A.I.) with fresh semen is used and in 1994 it involved 300 flocks and about 12,000 ewes carrying out 3,500 planned matings among best rams and top ewes. Average conception rate ranged between 40-50% with large variations between flocks. In order to increase the utilization of AI best rams in 1994 320 top ewes from 13 flocks were inseminated with frozen semen by intrauterine method. With this technique an average conception rate of 55% was obtained.

Every year 5-600 young rams are used for the first time by natural mating in the selection nucleus and out of them 400 reach the 10 daughters threshold (necessary for index publication) when 4 or 5 year old.

## INVOLVED STRUCTURES AND ORGANIZATIONS

Milk recording is carried on by Italian Breeders Association (A.I.A.) jointly with pedigree recording, animal identification and lactation computing, through its Regional and Provincial branches (A.R.A. and A.P.A.). The National Shepherds Association (Asso.Na.Pa) is in charge for every selection activity through the Sarda Breed Technical Committee. Due to the large number of sheep breeds, Asso.Na.Pa. charged the I.Z.C.S. for Sarda genetic evaluation and artificial insemination and planned matings in Sardinia. Until 1994 genealogical checks were carried out by blood polymorphism, since 1995 the national Blood Groups Laboratory (Laboratorio Gruppi Sanguigni) will put into practice D.N.A. checks on young rams born in the selection nucleus.

Provincial Breeders Associations (A.P.A.) assure milk yield (A4) and reproduction recording through nearly 50 inspectors. Regional office (A.R.A.) implements A.I. through its veterinary service. A.P.A.'s and A.R.A.'s computing facilities are always linked with I.Z.C.S. computer system.

Currently the cooperative A.I. center is not yet realised, so 90 mature rams and 70 lamb rams are bred and collected in I.Z.C.S. experimental farm where in 1995 15,000 straws of fresh semen will be prepared and distributed in May and June (mating season).

## COST/BENEFIT DISCUSSION

In tab. 6 breeding program subsidies for LG ram purchase, ewe lambs identification, AI born yearlings milk recording, 7 days milk discarding after FGA treatment, are reported and are granted by the Regional Administration (Regione Autonoma Sardegna, RAS). Milk recording and LG maintenance cost (APA activities) is shared 80% to National Ministry of Agriculture, 10% to RAS and 10% to breeders. AI materials (FGA sponges, PMSG injections etc.) are charged to Asso.Na.Pa. funded by Ministry of Agriculture. Explicit costs for both sheep and goat breeding programs are nearly 6,000 millions lit (tab.6).

From 1983 to 1992 (Sanna et al., 1994; Barillet et al., 1993) milk yield in first lactation expressed as mature ewe equivalent lactation increased with a trend of 2.17 l/year with large variation between years. About 75% of the phenotypic trend could be accounted for the management improvement. The genetic trend is estimated as 0.54 l/year in females which is about one fourth of the phenotypic trend.

These results could be explained with the small selection pressure realised on the gene transmission pathways from sires (Sire-Son 16% and Sire-Daughter 9% of the total genetic gain, tab.7). The only really efficient pathway is the Dam-Son pathway which provides 1.3 l/year (62%).

The influence of the selection program on the global productivity of sheep industry in Sardinia is not easy to be determined due to important changes introduced in last years (AI, genetic evaluation etc.): as a matter of fact the most recent innovations will be fully appreciated only in the coming 10-15 years.

An empirical way to estimate the benefits of the Sarda breeding program in such a phase is to keep in mind that the genetic gain realized in the selection nucleus at a certain extent can be transferred to commercial flocks (about 2,600-2,800,000 ewes). But the genetic gain to be considered computing the benefits over the whole population could not be that estimated in the starting phase. So it seems more correct to consider the theoretical genetic gain, focusing causes that can reduce this gain or its transfer to the commercial population.

Often theoretical genetic gain is estimated in 2% of the average yield and the Lacaune and Manech french breeds clearly shows that this result can be reached also in dairy sheep. This genetic gain for Sarda could be estimated in 3.5-4 liters per year. Of course if this amount

could be entirely transferred to commercial population, the increase in total milk yield can recover the high costs for breeding program granted from National and Regional Administrations.

Nevertheless nowadays the breeding scheme is not able to produce this genetic gain and its full transfer mainly for these reasons:

a) the AI efficacy has not yet reached the optimum in the nucleus flocks and it is still not diffused to commercial ones;

b) the number of rams born in the nucleus that are used by natural mating in the commercial population it is still reduced, nearly 3,000 per year, face to a potential number of 20,000. This fact is probably due to the still small yield difference recorded between the selected and the commercial population;

c) the size of the selection nucleus appears to be small to cover all ram needs of the commercial population. It can be estimated that for a 3,000,000 sheep population about 100,000 rams, about 30,000 per year, are needed.

It can be also pointed out that an increase of the individual milk yield could offset a decrease of sheep stock coming from the possible rearrangement of the production system, a great number of very small farms are directly managed by elderly breeders which have little chance going on their activity. Moreover it could also lead to a more sensible exploitation of pastures and soils. However this possible evolution is nowadays prevented by E.U. subsidies granted on the basis of sheep heads present in 1991-1992.

Moreover an analysis of a dairy sheep breeding program should consider the increase of the cheese amount produced per head, an objective that can be sought only acquiring the full control of the selection tools.

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Tab.1 - Location of dairy sheep farms in Sardinia.  
(ISTAT, 1990.Censimento generale dell'Agricoltura)

| Location  | Heads/farm | Farms (%) | Heads (%) |
|-----------|------------|-----------|-----------|
| Mountains | 183        | 13        | 15        |
| Highlands | 144        | 71        | 66        |
| Plains    | 186        | 16        | 19        |

Tab.2 - Farms and dairy sheep heads in Sardinia.  
(ISTAT,1970-1982-1990.Censimenti generali dell'Agricoltura)

| Year | Farms  | Heads     | Milkers   | Heads/farm |
|------|--------|-----------|-----------|------------|
| 1970 | 19,703 | 2,153,226 | 1,889,606 | 109        |
| 1982 | 20,080 | 2,374,500 | 2,092,776 | 118        |
| 1990 | 20,089 | 3,131,599 | 2,619,424 | 159        |

Tab.3 - Surface availability of dairy sheep farms in Sardinia.  
(ISTAT, 1990.Censimento generale dell'Agricoltura)

| Surface   | Heads/farm | Farms (%) | Heads (%) |
|-----------|------------|-----------|-----------|
| < 10 ha   | 68         | 24        | 10        |
| 10-50 ha  | 118        | 45        | 34        |
| 50-100 ha | 223        | 19        | 27        |
| > 100 ha  | 368        | 12        | 29        |

Tab.4 - Processed sheep milk in Sardinia.  
(ISTAT; modified from Nuvoli *et al.*, 1991)

| Year | Milk yield<br>(T x 1000) |
|------|--------------------------|
| 1960 | 153.4                    |
| 1962 | 152.3                    |
| 1964 | 149.2                    |
| 1966 | 162.7                    |
| 1968 | 119.3                    |
| 1970 | 147.4                    |
| 1972 | 148.6                    |
| 1974 | 151.4                    |
| 1976 | 157.2                    |
| 1978 | 169.6                    |
| 1980 | 188.1                    |
| 1982 | 189.8                    |
| 1984 | 194.8                    |
| 1986 | 194.5                    |
| 1988 | 200.5                    |
| 1990 | 233.2                    |
| 1992 | 250.0                    |
| 1994 | 260.0                    |

Tab.5 - Recorded ewes and flocks in Sarda L.G. in Sardinia.  
(AIA, Bollettino ufficiale dei controlli).

| Year | Flocks | Ewes   | Ewes/flock | Days in milking | Milk yield (lt.) |
|------|--------|--------|------------|-----------------|------------------|
| 1975 | 399    | 30,428 | 76         | 160             | 166              |
| 1976 | 408    | 30,133 | 74         | 164             | 168              |
| 1977 | 399    | 29,600 | 74         | 163             | 163              |
| 1978 | 435    | 31,553 | 73         | 163             | 173              |
| 1979 | 451    | 35,598 | 79         | 157             | 162              |
| 1980 | 441    | 36,635 | 83         | 162             | 191              |
| 1981 | 579    | 43,521 | 75         | 159             | 159              |
| 1982 | 592    | 47,203 | 80         | 157             | 178              |
| 1983 | 572    | 47,976 | 84         | 158             | 177              |
| 1984 | 627    | 54,612 | 87         | 163             | 185              |
| 1985 | 670    | 61,238 | 91         | 156             | 167              |
| 1986 | 703    | 68,261 | 97         | 159             | 182              |
| 1987 | 666    | 64,808 | 83         | 160             | 185              |
| 1988 | 682    | 69,440 | 102        | 163             | 191              |
| 1989 | 717    | 73,599 | 103        | 158             | 194              |
| 1990 | 730    | 76,358 | 105        | 154             | 193              |
| 1991 | 736    | 78,656 | 107        | 161             | 200              |
| 1992 | 724    | 82,265 | 114        | 160             | 195              |
| 1993 | 715    | 82,135 | 115        | 160             | 197              |
| 1994 | 724    | 92,873 | 128        | 162             | 202              |

Tab. 6 - Sheep and goat breeding programs costs in Sardinia 1994.  
(Ass.to Reg.le Agricoltura RAS 1994)

|   |       |
|---|-------|
| LG ram purchase (Lit x 10 <sup>6</sup> )                | 669   |
| Pedigree recorded ewe lambs (Lit x 10 <sup>6</sup> )    | 533   |
| Milk recording AI ewe lambs (Lit x 10 <sup>6</sup> )    | 75    |
| AI milk compensation (Lit x 10 <sup>6</sup> )           | 296   |
| Others (Lit x 10 <sup>6</sup> )                         | 62    |
| APA - Sheep & goat expl. costs (Lit x 10 <sup>6</sup> ) | 3,200 |
| APA - General expenses (Lit x 10 <sup>6</sup> )         | 990   |
| Pedigree checks (Lit x 10 <sup>6</sup> )                | 120   |
| AI materials and treatments (Lit x 10 <sup>6</sup> )    | 150   |
| Total (Lit x 10 <sup>6</sup> )                          | 6,095 |

Tab.7 - Annual genetic gains (b), generation intervals (I), genetic superiorities ( $\Delta G$ ), percentual contribution to realized genetic gain for selection paths (from Sanna et al., 1994).

| Selection pathway | b (lt/year) | I (years) | $\Delta G$ (lt) | %  |
|-------------------|-------------|-----------|-----------------|----|
| Sires of rams     | 0,28        | 3,6       | 1,0             | 16 |
| Dams of rams      | 1,11        | 4,8       | 5,3             | 62 |
| Sires of ewes     | 0,16        | 3,4       | 0,5             | 9  |
| Dams of ewes      | 0,23        | 4,3       | 1,0             | 13 |