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Implementation of a genetic improvement program for Comisana dairy sheep population in Sicily: challenges, solutions and results.

F. Pinelli[1], P.A. Oltenacu[2], M. Scimonelli[1], G. Iannolino[1], A. D'Amico[1] & A. Carlucci[3].

[1]*Istituto Sperimentale Zootecnico per la Sicilia, Palermo, Italy*
[2]*Department of Animal Science, Cornell University, Ithaca, NY, USA*
[3]*Associazione Provinciale Allevatori di Matera, Italy*

Summary

A breeding program to improve milk production in Comisana breed was successfully implemented in Sicily since 1998. The program was designed to overcome the major limitations faced by dairy sheep improvement programs: poor animal identification, limited control of production, use of multiple rams in flocks and lack of a genetic structure in the flock population. The program started with a selection nucleus of 3000 ewes in 7 flocks where 40 young rams are progeny tested each year and the best 6 are selected. Records are collected and stored using a software package that consists of a data base management program, an electronic animal identification system and a field interface program that facilitates the collection of records on farm and their transfer to the data base. Based on 2003 genetic evaluation, the range in the breeding value for milk/day in the nucleus was 879 g and the average of best 4 progeny tested rams was +209 g. The multiplication and dissemination phase are ongoing. The next goal is to increase the testing, multiplication and dissemination capacity of the program by expanding the size of the nucleus.

Keywords: dairy sheep, Comisana breed, data management, genetic evaluation, genetic improvement, software

Introduction

The nucleus breeding program implemented by the *Istituto Sperimentale Zootecnico per la Sicilia* to genetically improve milk production in Comisana dairy sheep in Sicily has addressed the major limitations that are preventing the Comisana breed to benefit from an effective genetic improvement program (Pinelli et al., 2002). A selection nucleus of 7 flocks and 3000 sheep was established in 1998 in order to progeny-test rams every year, estimate the genetic merit of animals in the nucleus flocks, perform the mating between best rams and ewes to produce young rams for progeny testing as well as breeding rams to disseminate the genetic gain achieved in the nucleus through the rest of the population.

The introduction of the electronic identification of animals using the rumen bolus system has been critically important by greatly facilitating an accurate animal identification and control of production in the nucleus. The system also made the collection of records on farm much easier and the flock management more efficient.

A progeny-test program designed to compare, every year, the genetic merit of 40 young rams across flocks, with about 8 daughters per ram, is implemented thanks to the cooperation of the farmers participating in the breeding program. The willingness of the participating farmers to change the breeding management program to insure the progeny testing of the rams assigned to each flock was also critical to the success of the program.

Adequate genetic ties between the nucleus flocks were created through the use of a limited number of rams in two or more flocks during the same breeding season.

A standard A_4 testing program (monthly recording for the two daily milkings) was started in the nucleus flocks in the 1998-1999 production season.

An information system was developed in order to efficiently support the entire genetic improvement program. This system addresses the collection of productive and reproductive records on farm, the storage of data, the genetic evaluation of animals and the mating of rams and ewes to achieve the selection objectives.

This paper presents the main features of the information system to overcome the limitations faced by the dairy sheep improvements programs, along with the results of the genetic analysis of the data collected from 1998 through summer 2003.

Efficient data acquisition and management

Animal identification

The accurate and easy to use identification of animals is a precondition for implementing a genetic improvement program in the field. In the nucleus flocks enrolled in the Comisana breeding program, the electronic animal identification by means of the rumen bolus system was adopted.

The animals are identified by using individual tags and ear tattoos immediately after birth. At the age of six months the lambs receive the rumen bolus (Figure 1), which is ingested orally and will lodge permanently in the animals' reticulum. The rumen bolus is a ceramic capsule (cylindrical in shape and weighing 70gr) containing an ISOHDX type transponder of 32 mm. The transponder is a passive battery-less device functioning between - 25°C and + 85°C.

When stimulated by the handheld reader emitting low frequency electromagnetic waves, the microchip transmits a unique and inviolable number. The stick antenna enables the production controller to identify each animal without having to approach it closely, as shown in Figure 2. The handheld reader is connected to the records keeper. This is actually a field computer, which associates the microchip number with the animal's identification and allows the operator to enter the production and reproduction records for each animal in the flock.

The database

The database to store production and reproduction records for dairy sheep (and goats) was developed by the *Associazione Provinciale Allevatori di Matera* (Italy) and is named *Progecom* (Figure 3).

The program works on a PC with a Windows 95/98/NT/2000 operating system. The general structure and the main functions of the *Progecom* database are:

1. **Farm identification and storage**. This function of the database stores various information related to the farm, such as its name, location, telephone number, type of farm etc. Each farm has a unique code, which allows for a fast and easy search of the database. The date of the last milk control is also automatically reported.
2. **Animal identification and storage**. The identification of animals is associated with a unique microchip number. All the information related to the individual animal, such as its sex, date of birth, sire and dam, farm, last event status code, lactation number, etc., is stored. The database allows for the easy retrieval of the productive and reproductive career of each individual animal.

3. **Record collector identification**. The names of the technicians of the breed or the farmer association who are responsible for the collection of records on each farm are recorded.
4. **Productive and reproductive data management**. This function of the database allows the operator to store the production and reproduction data collected in the field, such as date and type of lambing, milk yield, dry-off date, sale or elimination date and reason, etc.. The operator is also enabled to transfer this information to the main database. A number of editing filters are built into the system to ensure the high accuracy of the collected records. The lactation curve is also constructed for each ewe, if requested.
5. **Breeding groups management**. This procedure assigns a ram to a single ewe or a group of ewes, either with natural mating or with artificial insemination. The operator enters the starting date and the last breeding date for each group as well as the result of the pregnancy diagnosis. When the lamb's date of birth is entered, the program automatically assigns the sire according to the time interval between the breeding dates of the group and the birth date of the lamb.
6. **Milk composition storage**. The database can import the milk components, such as fat, protein, SCC, urea, lactose, total dry matter, etc., which are associated with the milk yield records for the corresponding test day.
7. **Building the dataset for the genetic analysis**. A specific function of the program extracts the dataset used by the genetic evaluation program to estimate the genetic merit of all animals.
8. **Genetic indexes storage**. The estimated genetic merit (the breeding values) can be automatically imported and stored in the database.
9. **Interrogating the database via screen reports**. The database provides a number of reports that have a direct application to flock management. These include: the list of the farm animals (the entire flock, the males, the lambs, etc.), the milk production for each farm at each control, the milk production in a predefined time interval for each farm, the list of animals that have produced more than a predefined amount of milk, the productive and reproductive career of each individual, the breeding groups, the morphological evaluation of each animal, the list of ewes that have lambed in a predefined time interval and the main statistical parameters. An image of the database highlighting the list of screen reports is shown in Figure 3.

Collecting records in the field

When dealing with dairy sheep, the collection of milk records on a farm is particularly laborious and sometimes biased, mostly generated by the difficulty to correctly identify ewes using year tags/tattoo system during milking. This is why a specific field interface program has been implemented in the nucleus flocks involved in the Comisana breeding project. The field interface program consists of two software components named *Progport* and *Ovichip*.

Progport works on a portable personal computer and is designed to manage the productive and reproductive data on a farm. The software imports the records collected on the farm and provides the farmer with all the information related to the milking.

Ovichip works on the portable keeper and has two important functions: it associates the microchip number with the animal's identification and allows the operator to enter the individual milk production measured in the field. This program allows the records keeper to interrogate the identification of animals and greatly facilitates the collection of records on a farm and their transfer to the data-base, while maximizing the accuracy of the records.

Genetic evaluation 2003

The genetic evaluation of animals in the nucleus is routinely performed using a software which has been developed as a component of the entire information system supporting the implementation of the breeding program. An important feature of this software is to edit the data coming from the *Progecom* database and structure them in a format required by the genetic evaluation program. The data set collected from the start of the project till June 2003 consisted of 5854 animals of which 2818 had production records for a total of 26445 test day records.

To perform the genetic analysis, the software uses the statistical model developed by J. Carvalheira *et al.* (1998). In the first stage of the analysis, the variance components, heritability and repeatability for the data set are estimated and used as inputs for the subsequent genetic evaluation analysis to determine the genetic ranking of all individuals in the data set. The values of heritability and repeatability estimated in the 2003 evaluation were 0.25 and 0.74, respectively. Note that these estimates were similar for first, second and third or greater parity.

Using the BLUP methodology, in the second stage of the analysis the breeding values (EBV) and the accuracy of EBV were estimated for all the animals in the data set, after adjusting for the effect of environmental factors such as of farm, age, parity and days in milk. The EBV milk yield per day for all 5854 animals in the data set had a mean of 17 g and a minimum and maximum EBV values of – 289 and + 590, respectively, for a total range of 879 g. When only the 542 sires in the data set were considered, the mean EBV was + 49 g, and the minimum and maximum EBV values were – 213 and 281, for a total range of 494 g.

With the milk records collected in the 2002-2003 production season the progeny-testing of the rams used in spring 2000 was completed. Figure 5 shows the distribution of the genetic merit estimated for all rams progeny-tested in 1999 and 2000. Through intensive use of the best progeny-tested rams in the nucleus flocks as sires of the next generation we were able to produce superior replacement ewes for the nucleus as well as superior breeding rams for disseminating genetic progress through the flocks outside the nucleus.

Figure 6 shows the quadratic regression of the values of EBV of all males and females born in the nucleus, fitted on the year of birth. The graph shows the increase of the frequency of genetically superior animals in the nucleus resulting from the selection of better young rams for progeny test since the beginning of the breeding program, as well as from the multiplication stage started in year 2002. The figure also shows that, as expected, in the nucleus a higher selection intensity was achieved in the male paths.

Another software has been developed in order to plan the best breeding between animals and achieve the selection objectives. This computer program allows the breeding groups to be formed for the progeny testing of young rams or for the matching of available rams and ewes for breeding by using a set of criteria chosen by the operator. The matching can be effected on the basis of age, production, location of sheep, genetic merit, etc, while controlling at the same time for the level of inbreeding in future offspring.

These components of the information system are completely integrated with each other and are mainly used to run the genetic evaluation of animals on a routine basis and plan optimum mating within the nucleus. Figure 4 shows the general data flow in the information system to evaluate animals and monitor the population.

Production of breeding rams

The multiplication stage of the genetic program started in the spring 2002 breeding season using genetically best rams that were progeny tested in 1999. In the 2003 breeding season the best rams progeny-tested in 2000 were also used for multiplication.

As a consequence, the first batch of breeding rams for dissemination will be available for distribution in spring 2004 breeding season and will be used in flocks enrolled in the National Production Recording program that have adequate management and have most of their animals registered in the Breed Book. This group of farms should represent the second stratum of the genetic pyramid. With the above requirements, these flocks should be able to produce breeding rams, which are expected to be sold for use in the base stratum of the pyramid representing all other commercial flocks within and outside Sicily.

Conclusions

The information system that has been developed to support the nucleus-based breeding program aimed at improving Comisana dairy sheep is making a significant contribution by increasing the management level in the nucleus flocks. This information system facilitates the monitoring and management of the sheep population and supports all selection and breeding decisions needed for the genetic improvement program.

The 2003 genetic evaluation of animals in the nucleus flocks confirms the great opportunity for genetic progress which exists in Comisana dairy sheep population, with a range of genetic potential for milk of 800-900 g of milk per day. The average genetic merit of the best 4 rams out of 82 rams progeny-tested in 1999 and 2000 was higher that 200 g of milk per day. Due to the use of superior rams, the frequency of sheep with a higher genetic merit for milk production in the nucleus is increasing relative to the base population when the breeding program started.

The multiplication stage of the breeding program started in 2002. The first batch of breeding rams for dissemination will be used in flocks enrolled in the National Production Recording program in the spring 2004 breeding season.

The results are strong evidence that the breeding program implemented by the *Istituto Sperimentale Zootecnico per la Sicilia* and the information system that was developed to support it can efficiently work in a wide variety of management systems, including those which are typical of dairy sheep farming in the Mediterranean areas. The technology involved in the breeding program makes the most of natural resources available, without interfering with traditional farming systems.

Figure 1. Rumen bolus microchip.

Figure 2. Reading an animal's identification in the field.

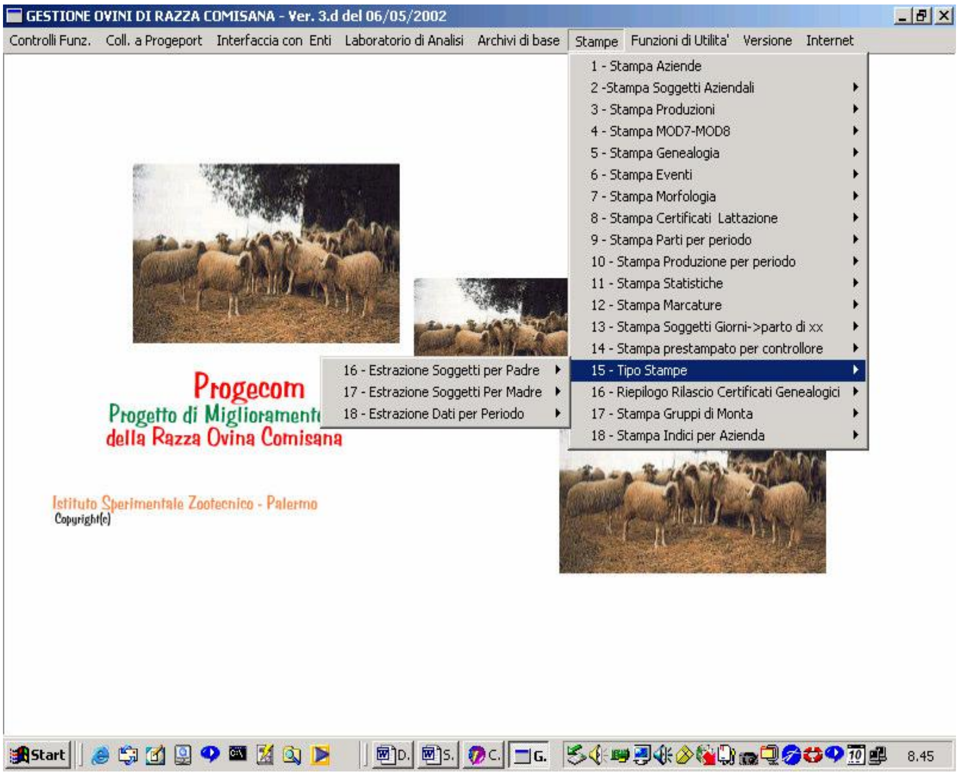

Figure 3. Progecom opening screen.

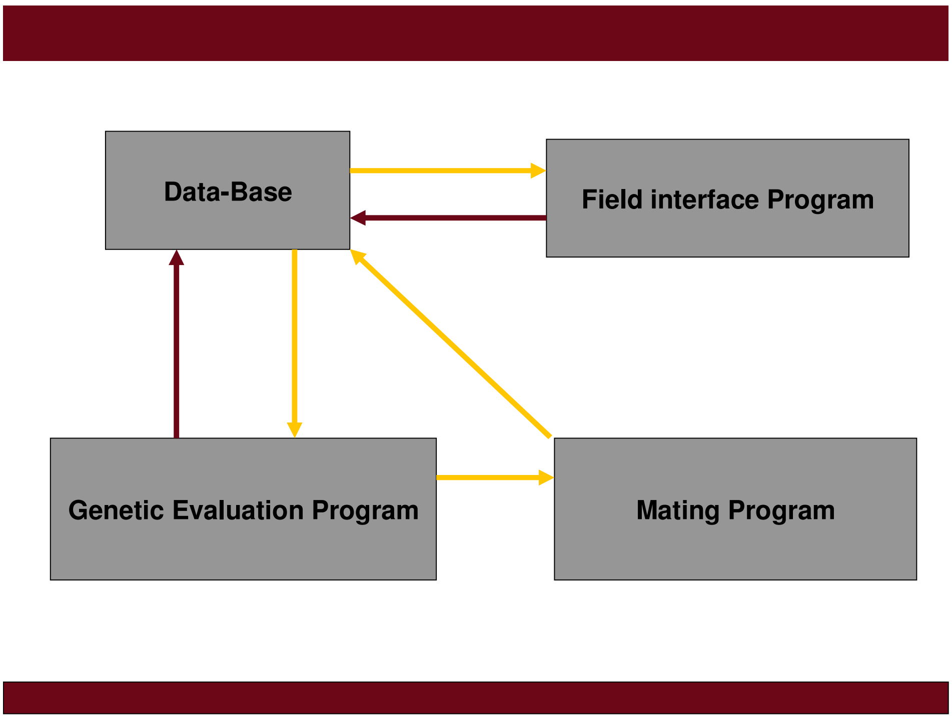

Figure 4. The data flow in the information system to evaluate animals and monitor the population.

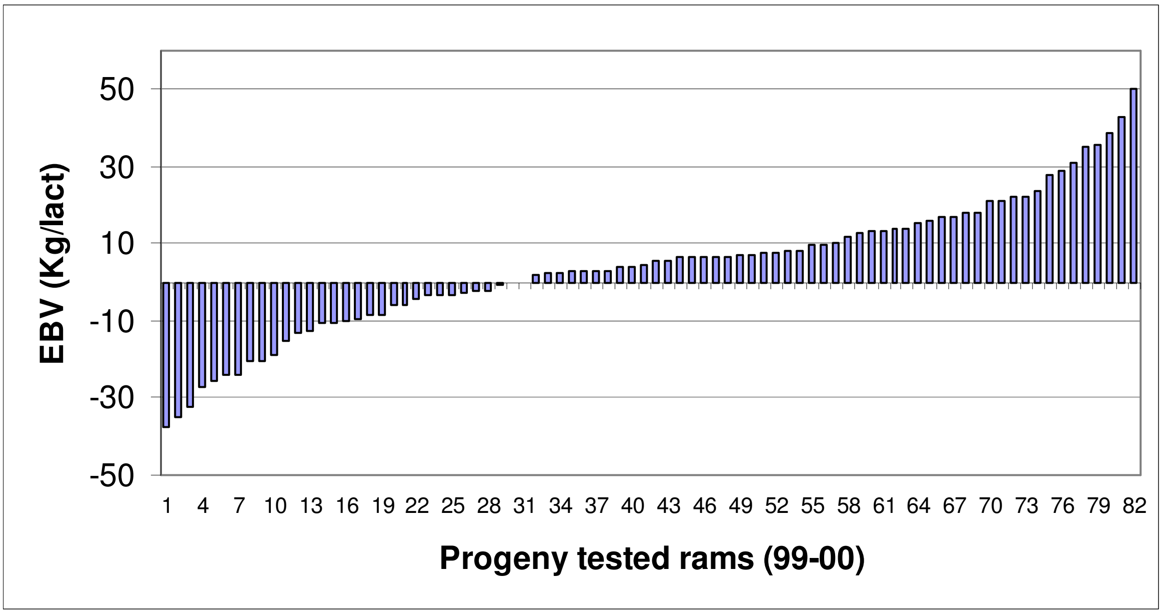

Figure 5. Distribution of EBV for the 82 rams progeny tested in 1999 and 2000.

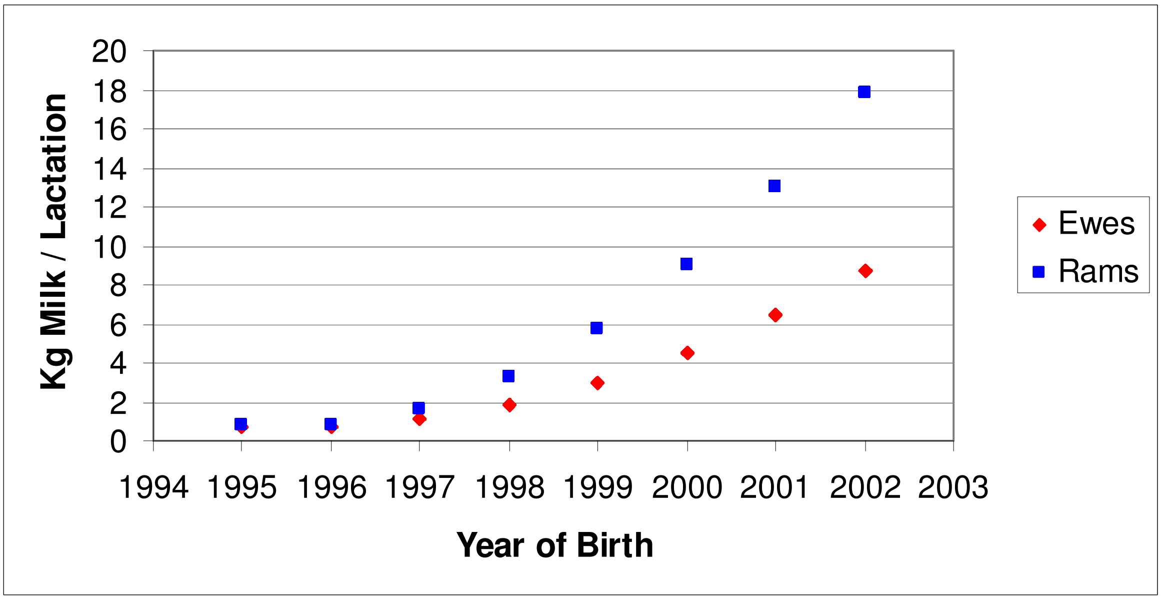

Figure 6. Relationship between EBV of animals born in the nucleus by year of birth.

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