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# A resource-limited breeding programme for reproductive characters in the breed "Rasa Aragonesa"

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**SUMMARY** - A selection scheme to improve reproductive traits in the Rasa Aragonesa breed is presented. Implementation of this scheme will be carried out by the producers cooperative "Carne Aragón SCL" in conjunction with technical support from regional and national Agricultural Research Institutions. The selection scheme is based on records from commercial flocks, using AI (Artificial Insemination) and BLUP animal model predictions of genetic merits as selection criteria. A threshold model is assumed and compared to linear models. Genetic evaluations using linear models were found to produce similar ranking of animals as those obtained with non-linear models.

**Key words:** Animal breeding, reproductive traits, Rasa Aragonesas sheep breed.

***RESUME*** *- "Un programme de sélection avec des ressources limitées pour les caractères reproductifs chez la race "Rasa Aragonesa". On présente un protocole pour développer un programme de sélection pour les caractères reproductifs du cheptel ovin de la race Aragonesa. Ce programme sera réalisé par la coopérative Carne Aragón SCL, en collaboration avec les services de recherche agronomique de la Diputación General de Aragón et l'Institut National de Recherches Agronomiques (INIA). Le schéma de sélection est basé sur la connexion de troupeaux moyennant l'insémination artificielle et la sélection de reproducteurs selon leur mérite génétique obtenu moyennant la méthodologie BLUP modèle animal. Un modèle à seuil a été utilisé et par la suite comparé avec un modèle linéaire. Le classement des animaux selon leur mérite génétique obtenu avec un modèle linéaire est comparable à celui obtenu moyennant un modèle non linéaire.*

***Mots-clés :*** *Amélioration génétique, caractères reproductifs, race ovine Rasa Aragonesa.*

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## Introduction

The breed "Rasa Aragonesa" is mainly located in the Autonomous Community of Aragón, situated in the Northeast of Spain. This region is characterized by a dry climatology, scarce rains, high summer temperatures and large semi-arid zones.

As a rule, the owner of the herd takes care of the animals, something that implies certain differences with the management of other Spanish breeds. This favours the development of a genetic improvement programme because the farmer is the first to obtain a profit from it. Most of the flocks have a territorial base.

It is generally accepted that the nourishment of the animals accounts for the largest part of the costs which integrate the economy of a flock. Also in a semi-extensive situation (when a certain degree of supplementation is needed), greater benefits depend on the number of lambs obtained per ewe and year. Economic studies demonstrate that the increases in prolificacy and fertility of the ewes do not imply a greater expense in nourishment (Castellano *et al.*, 1986). Consequently it is possible to assess that, when the nourishment is not a limiting factor, the increase in the numerical productivity is an appropriate genetic selection objective for this breed.

In this work we present a genetic improvement programme for reproductive traits in the "Rasa Aragonesa" breed. This programme is carried out by a cooperative of farmers (Carne Aragón, SCL)

(AC), and therefore it is probably one of the few genetic selection programmes in sheep in Spain that is carried out under private initiative.

The technical support in reproduction and others matters is carried out by the Regional Government of Aragón (DGPA), while the National Institute of Agriculture Research (INIA) takes care of questions related to genetic selection.

Since the programme depends on a private company, the resources have to be necessarily limited and always based on economic criteria. This is a private programme with no contributions of any public organization and the costs depend on credits to be returned with due interests. This programme uses the resources that the regional administration provides to all the farmers, whether or not included in the programme, just like in official programmes prior to this.

The programme was initiated officially in January, 1996, although some preliminary works were done previously. We report here these works, the first steps taken and their results.

## Performance characteristics

The improvement programme involves 40 flocks, which supposes a total of 25,423 ewes with registered lambings. There are 73,806 controlled lambings, including historical data obtained in previous years.

The age at the first lambing is 553.78±124.3 days. The interval between lambings is estimated at 272.3±80.5 days. The average number of days-open is of 126.59±85.23. This indicates that there is a certain variability between the managing systems in the flocks, and although the majority have a rate of three lambings every two years, this is not strict. There are also flocks that are limited to one lamb per year.

According to the data analysed the mean prolificacy of the animals involved in the selection programme is of 1.3 lambs per lambing, with extreme values in the herds of 1.7 and 1.1. The mean fertility is 1.11 lambings per ewe and year, oscillating between 1.28 and 1.09. (Valdemoros, 1996). The artificial insemination (AI) carried out by technical personnel of the Cooperative, presents an average fertility of 0.53 pregnancies per insemination. The fecundity is close to 0.8 lambings per ewe and the prolificacy to 1.5 lambs at lambing (Bru, 1995).

The heritability of the character prolificacy in the first lambing, oscillates between 0.07 and 0.21, and between 0.15 and 0.17 if a second lambing is included (Occon, 1988). The repeatability, according to the same author, oscillates between 0.11 and 0.16. In this studies we will take as work values 0.05 for the heritability and 0.10 for the repeatability.

The prolificacy is influenced by the age of the ewes. It takes a value of 1.3 in the first lambing, rises to 1.45 in the ninth lambing and decreases to 1.40 in the next ones (Fig. 1). Previous studies show that the effects year of lambing, lambing season (Fig. 2) and herd have a clear influence in prolificacy.

The reinstatement of ewes in this breed is done according to the information provided based on the genetic value of the ewes estimated using the prolificacy of successive lambings of a same ewe. In the pedigree records we have 3,246 dams and 4,508 ewes with known dams, which amounts to a reinstatement of 1.38 daughters per mother. This scarce number of ewes with known maternity is due to the fact that most of the herds have been recently incorporated to the production control. Until now the paternity was not controlled, but from now on the daughters of inseminated ewes will be recorded.

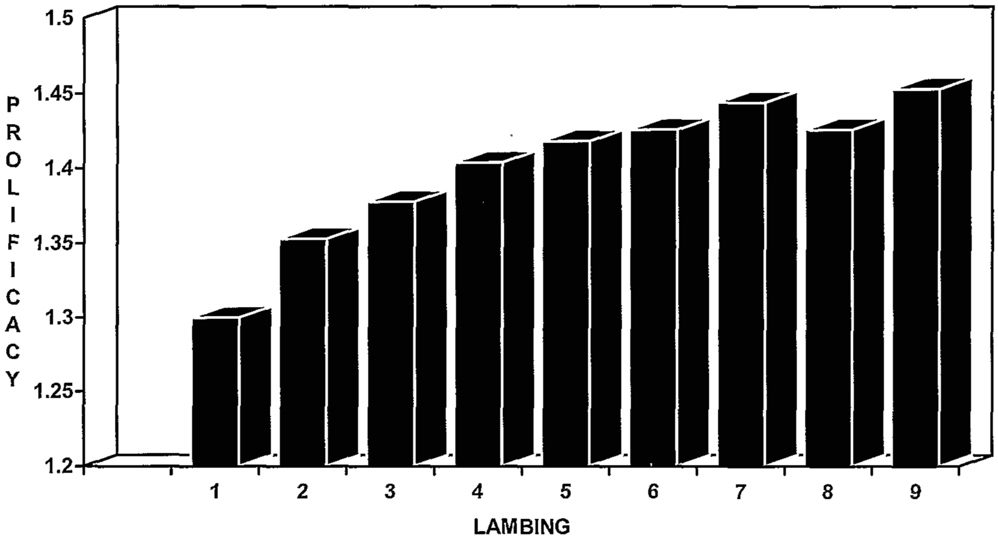

Fig. 1. Average prolificacy according to the lambing number.

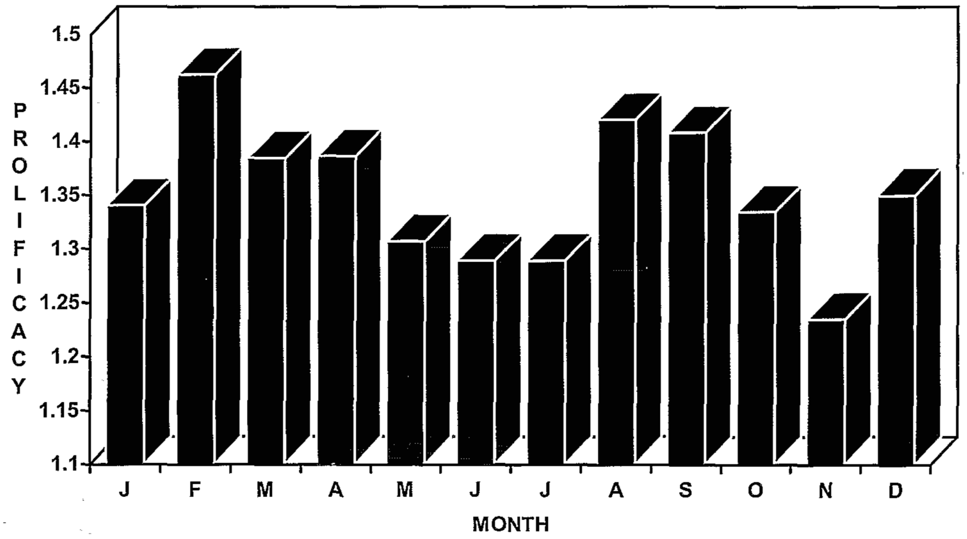

Fig. 2. Average prolificacy according to the month.

## Resources involved

The selection program includes the following elements:

(i) Control of production. The production control is based on a document that fills the own farmer which reflects the ewes lambed each day and the circumstances of the lambing. Every three months these documents are sent to the DGPA and supplied to the program in magnetic support. In the INIA the information is purified and data and pedigree files are created. At this time this database (without purifying) contains 28,074 ewes with lambing dates and 82,470 lambing.

(ii) Reproduction. The development of the reproductive techniques used in the program is carried out by DGPA. The sires used to connect herds and to be tested (see the paragraph Selection Plan) are located in the regional animal selection and reproduction center (CENSYRA) in Movera (Zaragoza), which is under the Regional Government. In the CENSYRA males are trained for ejaculation in artificial vaginas; extraction of semen, dose preparation, dose freezing, etc., are made there.

- The IA is made by technical personnel of the same Cooperative using the doses supplied by the CENSYRA. The process includes a series of controls, selection of the ewes to be inseminated, sponges set, insemination and pregnancy diagnosis. The inseminated ewes must be young and in good health. The inseminations are made throughout the year.
- The selection scheme has been programmed to include about 4,000 inseminations per year. During the first year these inseminations are directed to connect herds and later will be used to test both males and the diffusion of the obtained improvement.

(iii) Genetic. Elaboration of the information to obtain the genetic evaluation of the animals is carried out in the Area of Animal Genetic Improvement of the INIA in Madrid. The methodology used is BLUP (animal model with repeated measures). These evaluations will be reflected in a catalogue of sires (through which possible improved males will be detected), as well as in a document that will incorporate the reproductive record of each ewe and their genetic evaluation. This document will provide the farmers with information to select their reinstatement ewes.

The necessary informative programs for such methodology have been developed in the INIA of Madrid.

## Selection plan

The selection plan proposed for this population is shown in Fig. 3.

Taking into account the limited number of AI, it has been decided to design a classic selection scheme in which herds are connected through reference males, which besides will be used to transfer the genetic progress.

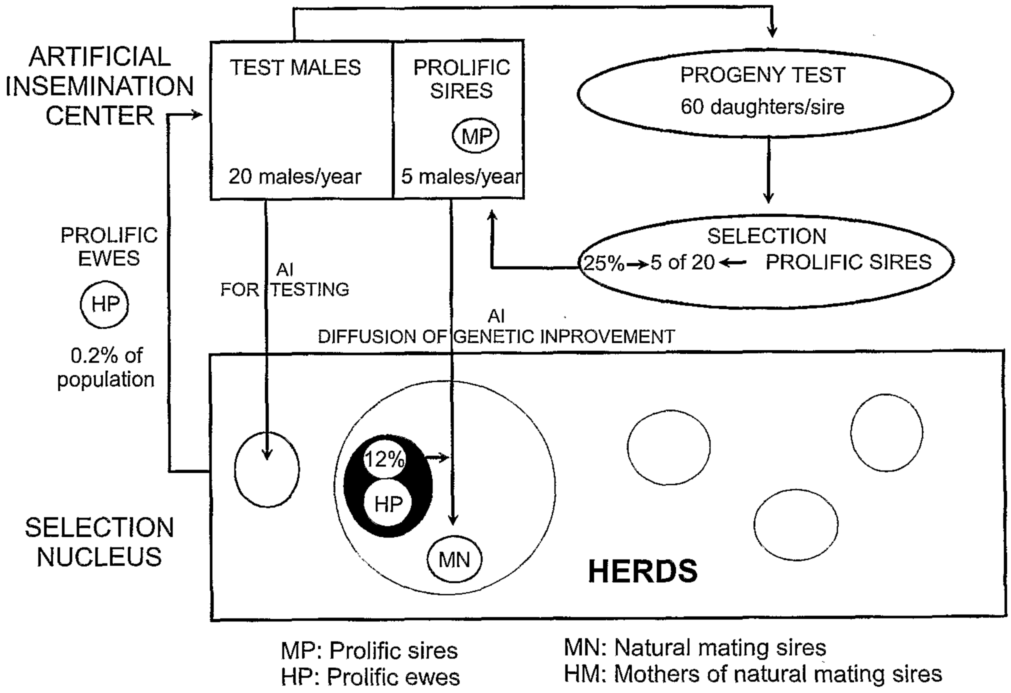

Fig. 3. Selection scheme for prolificacy.

Since the average life of a ewe is approximately 8 years, they will be renewed at a rate of 12% per year.

The scheme consists of 40 herds and a center of Artificial Insemination (CIA). Each year 20 6-month old lambs, intended to be the sons of the better breeding males, (prolific males of AI) (MP) and of the 2 per thousand ewes with the greater genetic merits (HP), will be introduced in the CIA. These lambs will be trained for artificial ejaculation in artificial vaginas and will inseminate a given number of ewes of the herds, to obtain approximately 60 daughters per male, these daughters will be scattered if possible at least in four different herds in order to assess connection of all the herds.

Evaluation of animals (sires and ewes) will be done periodically with BLUP methodology (as described below). Once a year the top 25% of males with the best genetic merit will be selected (males declared as prolific (MP)). These prolific males will stay in the CIA a whole a year, in order to spread good genetic qualities to the whole population.

The small number of improved males will prevent a substantial diffusion of the genetic improvement achieved in the CIA. Farmers are expected to use, in their own heards, in a massive way the sons of these prolific males (MP) and of the better ewes of each herd (HM). These natural mating males(MN) will be used during two years.

## Theoretical selection response

To evaluate the possible selection response under this scheme we used the techniques described by Elsen and Mocquot (1974) and Hill (1974) based on the identification of the groups of animals in which genetic progress is detected and on their evolution through the time. The following groups of males and females will be identified: four groups of males in the CIA with ages of 1 to 4 years and a group of 3 year-old females, to be the mothers of futures sires (HP).

Among the herds six groups of males will be identified. The 4-year-old males are the MP and their sons (to be used with 1 and 2 years in the 5th and 6th years of the program) are the MN. Also we will identify eight groups of females with ages of 1 to 8 years. In this case the 3 year old females are the selections in each herd (HM).

Figure 4 shows the expected genetic progress per year for four of the groups above, prolific males (MP), natural mating sires (MN), prolific females (HP), and mothers of natural mating sires (HM), expressed in units of selection intensity (i). This genetic progress has been estimated for 10 year of selection plus three previous without selection, the last genetic evaluation being done in year 12.

The greater genetic progress is concentrated in the MP and HP, because these are the real drivers of the plan. Responses in MN and HM are consequence of it. The other groups of animals present different degrees of genetic progress which are always smaller. At the end of the program (year 13), the genetic value of the population would be equal to that reached if, from then onwards the matings were at random. All groups would then gradually approach that same genetic merit. This value would be of 6.92 and is the same that would be obtained through the classic formulation from Dickerson and Hazel (1944) and Rendel and Robertson (1950). However, with the proposed method we can follow the evolution of the groups we might be interested in.

This progress has been calculated on the underlying scale and means an increase of 0.595 units ($R=ih^2_s=6.92x0.086=0.595$). This increase in the visible scale amounts to an incidence of 51%. Assuming an initial incidence of 30%, and 10 years of selection it is possible to reach an average prolificacy of 1.51 in the selection nucleus.

## Genetic evaluation of animals

One of the essential conditions for a correct application of the linear models is that the analysed trait presents normal distribution. The linear model is a technique sufficiently "healthy" to be valid even if the character studied does not adjust faithfully to the normal distribution. Thus, it is considered acceptable to ignore the discontinuous nature of a character if at least it presents 6 classes and their distribution is not clearly asymmetrical or shows curtosis. Nevertheless, in the trait "prolificacy in sheep", it is not possible to ignore their discrete nature and the clear asymmetry of the distribution.

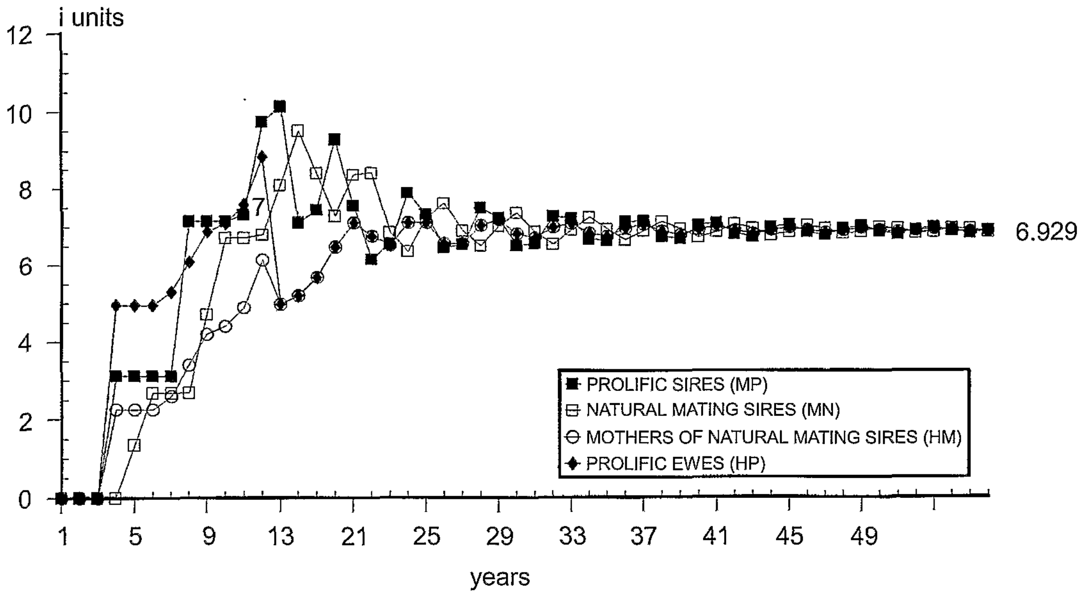

Fig. 4. Theoretical genetic response (10 years of selection).

The BLUP methodology is generally accepted as the most efficient and versatile method to obtain a classification of animals by genetic merit. With the adequate conditions, the BLUP leads to unbiased predictions with minimal variance. On the other hand, there are considerable theoretical reserves on the validity of its application to discrete characters. Gianola (1980), among others, points out some of these difficulties:

(i) The values are often arbitrary assigned to each class.

(ii) The variance in the visible scale is not constant and depends on the genetic value of the selection candidates.

(iii) The genetic variance depends on the incidence of the trait in the population.

(iv) In the visible scale there is non-additive genetic variance, as it is pointed out above.

The literature about the methods that try to take into account these difficulties is not scarce, (Berger and Freeman, 1978; Quaas and van Vleck, 1980). In many cases these modifications make the evaluations worse instead of improving them.

Accepting the threshold model, some non-linear methods have been developed which circumvent these difficulties, (Gianola and Foulley, 1983; Harville and Mee, 1984). Unfortunately they generate tremendous computational problems.

Two alternatives are possible:

(i) To apply non-linear methods in spite of the computational difficulties.

(ii) To ignore the discrete nature of the character, apply the methodology BLUP and to contrast the consequences.

There is evidence that, if the purpose is exclusively to obtain a genetic ranking of animals, the utilization of linear models in which the discrete nature of the traits is ignored leads to results similar to those obtained with more sophisticated methods, (Toro *et al.*, 1986; Olesen *et al.*, 1994). The Gibbs sampling in Bayesian models inference, (Hoeschele and Tier, 1995; Sorensen *et al.*, 1995), accounts for the lack of normality of the distribution of the character and permits to obtain estimations of variance components and of the real genetic progress.

The genetic model to be used is:

$$y_{ijklm} = \mu + RA_i + E_j + Dp_k + Ed_l + U_m + Ep_m + \varepsilon_{(ijklm)}$$

where:

$y_{ijklm}$ is the prolificacy of the ewe
$RA_i$ is the joint effect herd-year (176 levels)
$E_j$ is the seasonal effects (12 levels)
$Dp_k$ is the open-days effect (3 levels)
$Ed_l$ is age effect (10 levels)
$U_m$ is the genetic value of ewe (26,058 animal)
$Ep_m$ is the permanent effect
$\varepsilon_{(ijklm)}$ is the residual effect

## Current situation of the scheme

At this time we have a purified database with records of 26,058 ewes, of which 4,491 have known mother (most of the herds have incorporated recently to the program and do not have historical information). In 1994 and 1995 inseminations were made with 7 sires with the exclusive purpose of connecting herds. Now there are 156 daughters of these males (average 22 daughters by sire). 14 herds could be considered as connected.

A first genetic evaluation has been carried out in order to detect mothers of futures sires. In 1996, 20 males were chosen to be tested. At the beginning of 1998 their genetic evaluations will be obtained. All the artificial inseminations are done with this purpose.

The scheme will try to test 20 males each year with a sufficient number of daughters to obtain at least 60% reliability. Under these conditions we will be able eventually to declare breeding sires.

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