OPTIMIZATION OF A SELECTION SCHEME FOR MILK COMPOSITION AND YIELD IN MILKING EWES : Example of the Lacaune Breed

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SUMMARY

Management of the genetic improvement of milking ewes depends on the obvious fact that they are both dairy animals and sheep. This paper deals with the Lacaune breed situation in France. It points out the way to build the selection scheme,on two particular aspects:the need to rationalize and simplify milk recording both for milk composition and milk yield,and the concurrent use of AI and natural mating,within the scope of a pyramidal management of the population. We sum up the main results of studies on these differents aspects in this paper. In the course of the last twenty years,phenotypic and genetic improvement for the nucleus and base flocks agrees with these theorical studies.

Key words : dairy ewes, milk composition, milk recording, optimization, selection scheme.

INTRODUCTION

In France, there is a population of 650,000 milking ewes of the Lacaune Breed which are bred by 3,200 farmers.They are located in a small area in the southern Massif Central mountains.Their milk is valued for production of high quality sheep milk cheeses, the most famous being Roquefort Cheese.

Cooperative selection of these Lacaune milking ewes began in the 1960s, and in 1970, the objective was to approach more closely the methods used in dairy cattle selection (progeny testing bulls only on AI).Today,however,we are moving toward a more specific selection program for ewes.They are milk producers, and therefore, genetic progress has to take into account the intensification of on-farm production and increasing milk production per head; and being sheep, their selection scheme has to be adapted to this specificity.

In this paper, we will present the optimization of this selection scheme as it was carried out between 1960 and 1985, and the results observed during this period.

I. STUDIES ON TECHNICAL AND ECONOMIC RATIONALIZATION IN A SELECTION SCHEME FOR DAIRY EWES:

In the current state of technology, with its biological and zootechnical constraints, AI on sheep is carried out with fresh semen after induced oestrus during a very short mating period (6).Compared to natural mating, it cannot multiply the number of ram progeny more than 15 times.Under these conditions, the development of a selection scheme was possible only by pyramidal organization of the animal population with, on the one hand selection breeders of the nucleus flock, and on the other hand user breeders of the base flock.

The main results of the various rationalization studies done on such a pyramidal selection program, most often using Lacaune Breed demographic and genetic parameters, can be summmarized as follows (5,9,22):

Nucleus flock

In order to maximize the annual genetic progress of the nucleus flock, it is necessary to progeny test, wathever the reproduction method (AI or natural mating), a great number of males.In natural mating, 60-70p.cent of adults ewes are mated with progeny tested rams in order to produce 20 to 30 daughters; and with AI, the optimal situation would be mating 50p.cent ewes with progeny tested rams to produce 30 to 40 daughters.Conversely to that of dairy cattle, the organization of the selection nucleus flock here is not greatly modified when moving from natural mating to AI.

During the first stage of selection which lasts approximately ten years, the mean genetic level of replacement ewes fluctuates, and then afterwards growth becomes stable with an expected genetic improvement of 2 p.cent.

Base flock

All genetic progress created in the nucleus flock spreads to the base flock : at the equilibrium, the annual genetic gain is the same as that obtained in the nucleus.

Nevertheless, this equilibrium is reached more or less rapidly, depending on the diffusion rate (either by natural mating or AI) of the rams, from the nucleus towards the base flock.

In the long run, the gap between the average genetic value of the nucleus and that of the base flock is a function of the diffusion rate and the selection rate of males born in the nucleus and used in the base flock. This gap, measured in years, can reach a century if the diffusion rate is near 10 p.cent. However, with a 100 p.cent diffusion rate, the gap can be limited to only 5 to 10 years.

Overall benefit of the selection scheme

The benefit of such a selection scheme on the whole population directly depends on the diffusion rate towards the base flock. Without diffusion, there is no progress in the base population, and the genetic selection scheme is not profitable. Costs are too high : on the one hand, recording costs which are 2 to 3 times those spent on dairy cows (divised by the profit margin per head), and on the other hand, proportional maintenance costs of the numerous progeny tested and selected males. These results demonstrate that if genetic progress rapidly spread to the base flock, state subsidies would be needed for breeders of the nucleus flock.

II. ADAPTING SELECTION TOOLS TO SHEEP

Designing selection tools specifically adapted to sheep has concerned two main areas : the rationalization and simplication of milk recording, and collective management of a large pool of males used for either natural mating or AI.

Rationalization and simplification of milk recording

This double objective is necessary because fixed costs of milk recording are too high when using A-type recording (a monthly recording of the 2 daily milkings), which is considered an international reference.

Consequently, A-type recording was limited to breeders actively working in the nucleus flock, i.e. who accepted the constraints of systematic paternity control and of a high percentage of females mated with males on progeny testing.We have otherwise developed a very simplified B-type recording which is used by user breeders of base flock who wish to practice intra-flock selection of their ewes and buy rams selected in the nucleus (10).

A simpler version of the A-type recording method has also been studied, the goal first being limited to milk yield.This topic has been thoroughly studied with dairy cattle; it has been well-known that whatever simplification method proposed, it is more precise to eliminate one of the two monthly milking recordings than to reduce or space apart the recordings (of the two milkings) during lactation (2,15).Using this guide, the alternate AM-PM recording method has been proposed for dairy cattle (18), and the present solution for this species is to propose multiplicative adjustement coefficients according to the milking interval, or to a combination of milking interval and days in production (20,21).The purpose of these coefficients is to reduce the bias of the monthly control of a single milking. In 1970, an original approach was offered, the AC milk recording, for dairy sheep (11).Adjustment coefficients are calculated simply for each recording x flock by the ratio of milk produced by the entire flock during the 2 milkings on the test day and the sum of the individual recordings during the only recorded milking.Accounting for the species 'seasonality, these multiplicative coefficients calculated at each recording x flock are implicitly adjusted for mean effects of milking intervals, days in production, herd and their interactions: after this adjustment, there is no more bias, and loss of precision is negligible compared to A-type recording (2,11).This AC-type recording for milk yield has been extented to the Lacaune nucleus since 1977.

With the milk yield per lactation having been highly increased since 1960, it appeared necessary in the 1980s to take milk composition into consideration as a selection goal.In order to tackle this new stage, an experimental A-type recording was tried from 1979 to 1981 (2 milking records per day, milk yield and composition) on 6798 ewes from the nucleus, with the intention to set up a study file (2).We first redefined the main selection goal, taking into account the use of the milk (cheese): the average useful yield per lactation with economic weighting factors of 1 and 1.85 for fat yield and protein yield respectively (2). Then, for this new goal we perfected a punctual qualitative recording method to complement the AC milk recording. For this purpose, we verified the existence of a period in the middle of lactation when samplings (F p.cent, P p.cent) are closest to the annual content, as in dairy cattle (7,13). We then used the seasonality of sheep milk production : it is possible to sample each ewe's milk content 2 or 3 times a lactation, with only 3 successive monthly recordings by flock.In this way, we get what we call ponctual content.After having considered secondary selection goals of this in-season milk production, analogously to studies on lactation prediction (1,8), we perfected a method for standardizing ponctual content measurements taking into account for each ewe, lactation rank, day of the first qualitative recording during lactation, milking persistance and lactation length (2).

This gives an unbiased estimation of the annual content. This information, combined with the AC milk recording, allowed us to very precisely measure the average useful yield. The lack of precision with regard to this criterion is about that as observed with the AM-PM milk recording, for instance in dairy cattle. Testing each ram on 36 daughters instead of 35 is sufficiant to get the same expected annual genetic progress as that attained with the classical A-type recording. Since 1985, the official recording practice regarding the Lacaune nucleus is both quantitative (AC method with 7 to 8 monthly recordings of the morning milking per herd and per year) and qualitative (3 punctual recordings of the 7 to 8 monthly records).

Breeding centers for young rams and artificial insemination centers

Breeding centers for young rams were created as early as 1960; then AI centers were organized in 1970. Their role is to allow collective management of a great number of rams for each selection cycle.

In the young ram centers, the males of the nucleus flock, born from assortative mating, are grouped together from weaning to puberty.

If AI were used alone, one could expect an annual genetic gain 30-35 p.cent higher than with natural mating (5). Nevertheless, extended use of AI on sheep is slowed down for economic and zootechnical reasons. Consequently, it is important to judiciously combine AI and natural mating : financial availabilities have to be exploited in order to direct AI primarily toward progeny testing and assortative mating in the nucleus flock, provided that the diffusion of genetic progress by natural mating toward the base flock is organized. The determining role of the young ram breeding center appears one more time. It has to furnish the majority of the males used in the whole population.

III. RESULTS OBSERVED ON DAIRY LACAUNE FROM 1960 TO 1983

Current organization of the selection scheme

In 1983, the 3264 breeders of the "Rayon de Roquefort", milking about 650,000 ewes, are divided as follows :

- 324 breeders using A-type recording, whose 105,000 ewes represent the selection nucleus flock (fig.1)
- 1940 breeders in the base flock, of whom 1000 are undergoing B-type recording for 230,000 ewes.

The nucleus is open, in that each year, the best breeders practicing B-simplified recording replace its less adapted breeders. In the nucleus flock, almost 65 p.cent of adult ewes are inseminated : 45 p. cent are used as mates of rams on progeny testing, and 45 p. cent are mated with selected rams. This is near the theoretical optimum, since the rams are actually judged by 30 to 40 daughters each. Ancestry selection of young males is controlled using AI : in 1983 nearly 90 p.cent of the 7000 best nucleus ewes are inseminated with elite ram semen, giving 2098 male lambs which are kept for reproduction. 1469 of them enter the 4 breeding centers.

The second stage of the selection scheme is the mass selection of young rams regarding their type and growth potential (3). Without forgetting the rules concerning genetic variability management (23), rams having the best origin for milk production start their progeny test at the end of their breeding center period when they are 8 or 15 months old. In 1983, 430 rams of the 2098 sons from good origine are progeny tested (fig.1). In 1983, other lambs near 1300 in number (including 400 to 500 males directly sold by the nucleus breeders) are sold as reproducers to the base breeders. The progeny test, the third step of the selection plan, is done half in natural mating, half in AI, using a connection design (5,12).

In the base flock, around 20 p.cent of adult ewes are inseminated with progeny tested rams (or rams waiting for their progeny test results) while near 60 p.cent of the need for rams is covered with the sales of young males described above. The diffusion rate (from the nucleus to the base flock) is in the neighbourhood of 80 p.cent. It reaches 100 p.cent if we consider only breeders practicing B-type recording.

In conclusion, with this pyramidal framework, AI is dominant in the nucleus, while the diffusion of the genetic gain works mainly through natural mating using young males born from assortive mating in the nucleus (fig.1).

<u>The observed results</u>

No realized genetic gain estimations have been done for milk yield in the Lacaune Breed. Nevertheless, the efficiency of the selection may be appreciated indirectly in several ways:

- The good relationship between the indexes of fathers and sons show their global accuracy. This result has been obtained several times both with the contemporary comparison method used from 1965 to 1980 (4, 16) and with the BLUP evaluation used in France since 1980 (19) for the 3 dairy species (non published results).

-The phenotypic trend of the milk yield, from 1960 to 1983, in the nucleus and in the base flocks, demonstrates the main result (fig.2). The average milk production of the nucleus Lacaune ewes increased more than twofold, from 80 liters per lactation in 1960 to 182 in 1983. Moreover, two steps are clearly observed for the nucleus: a starting step 1965-1975 with the average phenotypic progress of 4 liters per year; then an equilibrium stage from 1975, with an average annual progress of 5.4 liters. From 1975 on, there is a phenotypic progress in the base flock parallel to that in the nucleus, with a time lag of 5 to 7 years (fig.2). This results shows that selection and user breeders presently have the same rhythm of progress on account of the almost 100 p.cent diffusion rate. Even though these evolutions are only phenotypic, trends and lags are in accord with the prediction of the models presented above.

- Finally, considering the annual evolution of the BLUP-type moving base indexes (19), the annual genetic gain would be between 2 and 2.5 liters (e.g 1 to 1.5 p.cent), a result confirming that the selection is close to the optimum.

CONCLUSION

Taking account on the one hand of the negative genetic correlations between milk yield and milk composition (2), and on the other hand of the present efficiency of the dairy Lacaune selection scheme, one can easily understand that it was necessary to adjust this sheme in the 1980s. Since 1985, the punctual qualitative recording is made by hand for the dams of rams in the nucleus in order to manage the dam-son path with the new selection goal: the average useful yield.The aim is to generalize the qualitative punctual control for all the primipars of the nucleus, in order to select the 4 paths of progress for the average useful yield and content.With a practical, then financial, point of view, sheep milk recording needs to be partly automatized. We hope we may succeed in this goal before 1990.

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FIG. 1 - SELECTION SCHEME AND DIFFUSION OF MALE REPRODUCERS IN LACAUNE SHEEP BREED (YEAR 1983)

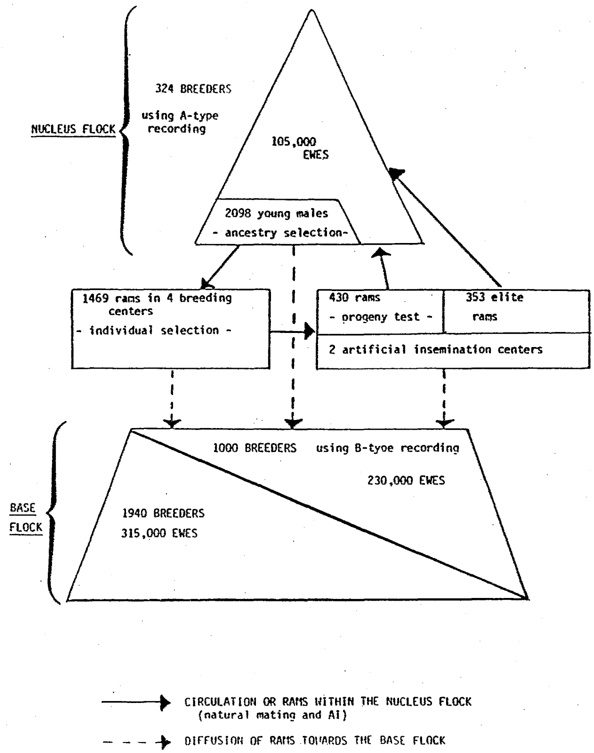

FIG. 2 - PHENOTYPIC PROGRESS OF THE MILK YIELD IN LACAUNE SHEEP BREED (1960 - 1983)