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Importance of a sheep selection programme for prolificacy

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SUMMARY – The importance of a programme of genetic selection in sheep for meat is studied, whose main objective is to improve prolificacy. We use structural, technical and economic data obtained via the Programme of Technical-Economic Management which has been developed since 1993 by the livestock cooperative Carne-Aragón in collaboration with the Escuela Universitaria Politécnica of Huesca. This has allowed the use of data from more than 110 Aragonese sheep farms for 6 years (665 in total). The main breed used is the Rasa Aragonesa. Conventional statistical analyses have been carried out which relate the prolificacy of the different flocks studied to the economic results obtained, expressed in pesetas adjusted to a 1998 base, and grouped according to different feeding costs (nutritional management) and reproductive results of the farms (reproductive management). The differences, in all cases, are significant.

Key words: Meat ewes, prolificacy, animal breeding, selection criteria.

RESUME – *"Importance d'un programme de sélection ovine pour prolificité". L'étude sur l'importance de la mise en place d'un programme de sélection génétique des ovins viande, dont l'objectif est d'améliorer la prolificité, a été menée par la Coopérative Carne-Aragón avec la collaboration de l'*Escuela Universitaria Politécnica de Huesca *à partir des données technico-économiques et structurelles issues du Programme de Gestion Technico-Economique. Ce Programme, développé depuis 1993, concerne 110 élevages d'ovins viande de la race aragonaise. Des analyses statistiques conventionnelles ont été réalisées, mettant en rapport la prolificité avec les résultats économiques des différents troupeaux. Ces résultats ont été exprimés en pesetas constantes depuis 1998 et groupés en fonction des différentes dépenses d'alimentation (conduite alimentaire) et des résultats de reproduction des exploitations (conduite de la reproduction). Les différences, dans tous les cas de figure sont significatifs.*

Mots-clés : *Ovins viande, prolificité, amélioration génétique, critères de sélection.*

Introduction

The sheep farming sector in Aragón has undergone important changes in recent years which, we think, could become a future trend. Traditional extensive farming is beginning a regressive phase for various reasons, basically derived from manpower. A mixture of obligation (the impossibility of getting shepherds) and business decision (an attempt to improve the standard of living of the entrepreneur-farmer) is leading some livestock companies to redirect their productive system towards a higher level of intensification with longer periods of stabling for the animals.

We should also say that, in some cases, the farmer faces this change with a certain level of confusion, as he does not have the technical advice or enough economic information to prevent his only method of progress in this change form being by trial and error. Sometimes it is not clear to farmers, with the negative consequences on the profitability of the flock which this means, that the increase in feeding costs that stabling causes must be offset by a greater productive intensification and with the use of new, more efficient and rational systems of trough feeding, which maximize the usefulness of the feed used. Both lines of research are being developed at the moment in our Cooperative.

Referring solely to the first point, productive intensification must set, as its main objective, the kilos of carcass produced per sheep per year, given that the sale of lambs makes up around 64% of the total income of Aragonese sheep farms.

Furthermore, given the characteristics of the sheep market in our region, with the increasingly important presence of a Quality Brand which controls and differentiates the product obtained

(Ternasco de Aragón), this productive intensification cannot be brought about by increases in the carcass weight of animals which are not permitted by the quality brand regulations. If we were not producing for the quality brand we do not think it would be interesting to select on growth and conformity of the animals since we could use commercial breeding for certain markets which require bigger carcasses.

This means that the only way is to increase the numeric productivity (number of lambs sold per ewe per year), which is closely linked to the reproductive parameters of the livestock. Moreover, it is generally accepted that increases in prolificacy and fertility in ewes do not notably increase feeding costs (Castellano *et al.*, 1986).

From all that we have said we can deduce that in flocks kept in semi-intensive situations (in which the farmer contributes, at least in part, to the feeding of the animals) the improvement of the reproductive characteristic is the main objective of the selection of the race (Jurado and Espinosa, 1996).

This line of argument leads us to think that the best selection criterion to use when dealing with an increase in the production of sheep meat for its sale in the traditional market conditions of the Ternasco de Aragón, is that which is based on an increase in prolificacy, since the norms of the Quality Brand only allow the use of our autochthonous races ("Rasa", "Ojinegra", "Roya Bilbilitana") and do not allow improvement by breeding with prolific races.

Also, as Rodero and Molina (1996) say: "For a race, selection means a permanent definition of its future to adapt its present production capacities, which have been inherited from ancestral use and previous selection, to foreseeable future needs". The effectiveness of selection in creating and transmitting as far as possible genetic progress depends both on the choice of objectives related to the selection of the breeding ewes which are going to ensure the replenishment of the races, and on the refining of a coordinated programme of adapted and coherent selection methods to achieve these objectives.

For this reason Carne-Aragón S.C.L. has been developing a selection scheme for the Rasa Aragonesa race since 1994, whose objective is an increase in numeric productivity, and the selection criterion is the prolificacy of ewes per birth. The model used for genetic evaluation is the animal model with repeated measurements and includes the following effects: flock-year, lambing season, lambing number, period between lambing, covering mode, genetic value, and the fixed effect. The programme uses the BLUP animal model methodology and foresees reaching a mean prolificacy in the selection nucleus of 1.51 (Fantova *et al.*, 1998). The selection nucleus is made up of 61 flocks spread through the three Aragonese provinces, with a total of 36,000 sheep, 72 sires have been used for artificial insemination, having 727 daughters ear marked and with registered and controlled births. Also, 5 catalogues of breeding sheep have been published (Valdemoros *et al.*, 1999).

Prolificacy is a very important economic factor, although there is an increase in lamb mortality and, as Analla and Seradilla (1996) show for the "Segureña" race, it brings about a decrease in the weaning weight and in the sale-slaughter weight. This decrease can however be tolerated in the market, since it means a very small reduction in the carcass weight, if a carcass yield of 50% is assumed.

From all we have said, the aim of the study we are presenting is to relate prolificacy with the economic results obtained on our sheep farms. To do this we group them depending on their different feeding costs (nutritional management) and the reproductive results (reproductive management) in order to clarify the options which farmers have when they take their business management decisions.

Materials and methods

We have used the data obtained with the Technical-Economic Management Programme in meat ewe farms which, since 1993 and in the Autonomous Community of Aragón, has been developed by the livestock cooperative for commercializing sheep meat Carne-Aragón S.C.L. and the Escuela Universitaria Politécnica de Huesca of the University of Zaragoza.

The number of farms studied has varied during the six years of operation, with a mean of 110 for the period 1993-1998 (last economic year with data available), spread through the three Aragonese

provinces, and in the majority of the regions in them. This means more than 55,000 breeding ewes have been analysed each year, the majority being of the "Rasa" race.

Although there are biases inherent to this type of study, heightened in this case since the majority of the farms are members of the Cooperative mentioned, we can say that the large scale of the survey allows us to find farms which are representative of the different geographical areas, farming systems, sizes, types of management-handling (reproductive, nutritional, etc.) and levels of intensification which exist. Furthermore, this limitation has been more than offset by the fact that the cooperation given by Carne-Aragón has allowed us to obtain high quality, reliable data to calculate the results, since the information at a farm level has been gathered by the veterinarian who deals with the technical and sanitary aspects of the farm. We have also had real data for the sales of lambs and the purchases of raw materials and materials prepared via the Cooperative.

The fundamental differences between this Management Programme and others, apart from its continuous tracking, are: the separation of the sheep farming activity from other agricultural and livestock business activities which the farms may have, the evaluation of home-grown feed (including that used by grazing), and the evaluation of family manpower.

With the information obtained via the Programme we have calculated the technical and economic results and various indices for each farm. These indices are divided into four groups: structural characteristics, level of intensification, technical results and economic results (including indices related to costs, income, productivity and profitability). Once this information is prepared it is given to the farmer along with the mean for the area and the general mean.

The economic results which appear in this study are expressed in pesetas indexed to 1998 (according to the average Consumer Price Index published by the National Statistics Institute).

Then we have grouped the farms depending on their prolificacy (above or below the mean) and on their different feeding costs. Once organized the data has been analysed by conventional statistical methods for comparing means.

Results and discussion

As a preliminary step we will now describe the sample studied. The mean structural and technical characteristics of the farms are shown in Table 1. The average size of these in this period was 501 breeding ewes of more than 12 months old, a figure which no doubt reflects a high level of specialization in sheep farming activity. As they are handled by 1.34 Man Power Units (MPU), the level of labour intensification is 374 ewes/MPU.

Regarding the technical characteristics, the mean number of lambs sold per ewe per year is 1.1, a figure obtained with a fertility of 1.08 births per female present per year and a prolificacy of 1.31 lambs born (live or dead) per birth. The level of miscarriages is 3.88%, and lamb mortality is 9.60%. If we consider the evolution of the technical characteristics through the period studied we note that there is little variation in the reproductive indices and in the number of lambs sold per ewe per year.

The total income per ewe per year (Table 2) amounts to 16,151 ptas, indexed to 1998, of which 63.8% is from the sale of lambs (including home use, payment in kind, and variation of stocks), and 29.9% is from subsidies, and finally of relatively very little importance: wool, ewes sacrificed, animals sold live, and difference in inventory of breeding animals.

The mean total costs per ewe per year amounts to 14,100 ptas, of which 45.2% is for feed, and 42.4% for the farmer's own and employees' manpower (including the agrarian social security). That is to say, these two costs represent 87.6% of the Total Costs of the farm. This gives us a sheep activity margin/ewe of 2,051 ptas indexed to 1998.

As relatively important costs, in the total feed cost (6,374 ptas/ewe per year) are included: bought feed (51.6%), home-grown trough feed (30.1%), forage rent (10.2%) and estimated grazing in own meadows (8.1%). Within bought feed concentrated lamb feed is included (1,494 ptas/ewe per year).

We can see then that nowadays Aragonese sheep farms are not economically profitable with their

livestock productions and depend to a large extent on the subsidies they receive. So the subsidy for loss of income fits its name and does just this, its function largely being to pay solely family manpower, this being the main purpose of the economic activity carried out by the farmers.

Table 1. Structural and technical characteristics of the farms studied

	1993	1994	1995	1996	1997	1998	Mean
No. Farms	96	95	115	117	115	117	110
Structural Data							
No. ewes	442.0	460.4	478.3	524.7	539.4	561.5	501.0
Man Power Units (MPU)	1.31	1.33	1.36	1.36	1.35	1.33	1.34
% family MPU	90	87	87	90	91	88	89
Ewe nb/MPU	338.2	345.9	352.3	386.3	399.2	421.9	374.1
Technical Data							
Fertility	1.12	1.09	1.08	1.01	1.11	1.08	1.08
Prolificacy	1.31	1.30	1.33	1.30	1.31	1.30	1.31
% Double births	28.00	27.61	29.93	27.84	28.79	27.93	28.35
% Triple or more births	1.44	1.14	1.37	1.14	1.23	1.10	1.24
Fecundity	1.47	1.43	1.44	1.31	1.45	1.42	1.42
Lamb mortality (%)	9.27	9.21	9.62	9.80	9.68	10.02	9.60
% Miscarriages	5.42	4.11	4.14	3.95	3.17	2.50	3.88
Lambs sold per ewe	1.15	1.12	1.13	1.05	1.12	1.08	1.11

Table 2. Economic results of the farms studied (data in ptas indexed to 1998)

	1993	1994	1995	1996	1997	1998	Mean
No. Farms	96	95	115	117	115	117	110
Income/ewe							
Sale of lambs	9740	10661	10315	10514	11101	9535	10311
Subsidies	5822	4836	5662	4102	3752	4856	4838
Others	963	1076	1393	578	1012	987	1002
Total income	16525	16573	17370	15194	15865	15378	16151
Costs/ewe							
Total feeding	7714	6336	6207	5927	6108	5954	6374
Manpower	7036	6797	6198	5609	5298	4909	5974
Animals sold live	746	497	666	271	522	497	533
Health+Reproduction	427	458	430	451	498	476	456
General costs	451	512	630	550	537	654	556
Interests	348	321	216	170	103	85	207
Total costs	16722	14921	14347	12978	13066	12575	14100
Sheep activity margin/ewe	–197	1652	3023	2216	2799	2803	2051

We think that an abolition of this subsidy would mean a forced redirection of the sector towards a greater increase in the productivity of our flocks, if one wants to maintain this important farming activity in our region. In this context, possible in the not-too-distant future, programmes for the genetic improvement of the prolificacy of the race "Rasa Aragonesa" will undoubtedly play an important role.

To analyse the importance that an increase in prolificacy has on the economic results of the farms studied, we do a first classification of the 665 farms depending on if their prolificacy figures are above or below the total mean (1.31 lambs born / birth). We see that the productivity per head is 2,528 and 1,625 ptas respectively (Table 3), the differences being statistically important (t test). So, the 328 farms with a prolificacy figure above the mean manage to get 903 ptas more per ewe per year, that is to say 452,403 ptas more per farm.

Table 3. Comparison of economic results per ewe depending on the prolificacy

	No. cases	Sheep activity margin/ewe		Standard deviation
Prolificacy < 1.31	337	1625		3486
			p<0.001	
Prolificacy > 1.31	328	2528		3584

In Table 4 we can see how the farms with a prolificacy figure above the mean (1.43 lambs born per birth) sell 0.25 lambs per ewe per year more (significant correlation of 0.51 between both variables) than those with a figure below the mean (1.19) lambs born per birth, and so have greater incomes from the sale of lambs and total incomes (correlations significant with the prolificacy of 0.55 and 0.51 respectively).

Table 4. Classification of farms depending on their prolificacy

	Prolificacy < 1.310	Prolificacy > 1.310
No. Farms	337	328
No. ewes/MPU	377.6	372.3
Fertility	1.05	1.11
Prolificacy	1.19	1.43
% Miscarriages	3.9	3.7
% Lamb mortality	8.7	10.5
Lambs sold per ewe per year	0.98	1.23
Price of lamb	8715	8896
Income per lambs/ewe	8553	10909
Total income/ewe	13829	16491
Concentrated feed cost/ewe	1238	1586
Trough feed cost/ewe	2967	3962
Grazing cost/ewe	1033	1088
Total feeding cost/ewe	5240	6636
Total costs/ewe	12204	13963
Sheep activity margin/ewe	1625	2528

As an expression of greater productive intensification they also have greater fertility and greater mortality rate of lambs, although with non-significant correlations with respect to the prolificacy. They have greater total costs (r^2 = 0.41), above all those derived from nutrition (r^2 = 0.50) due to the need for greater quantities of feed in troughs for the breeding ewes (r^2 = 0.41) and a greater consumption of concentrated feed for lambs (r^2 = 0.38).

Finally, we see that an increase in the prolificacy of 9.2% above the mean (1.43 vs 1.31) produces an increase of 23% in the sheep activity margin per ewe per year, again above the mean figure (2,528 vs 2,501 ptas).

Taking into account that the differences between flocks is basically due to the management-handling and nutrition supplied by each farmer, the productivity of the race being perfectly adapted to the supply of nutrients form each farm (De la Fuente *et al.*, 1996), we now group the farms depending on the different nutritional management methods and stabling periods, indirectly defined by the feeding cost per sheep.

So we classify the farms in 3 different groups: (i) feeding costs of less than 4,500 ptas/ewe, which basically groups the flocks farmed very extensively (24% of the total) with a short stabling period and little feed via trough; (ii) feeding costs of between 4,500 and 7,000 ptas/ewe, which is the largest group (51%) and is made up of semi-extensive farms which tend to stable and supplement animals in lactation; and (iii) feeding costs of more than 7,000 ptas/ewe which includes farms (25%) which stable and supplement the animals for periods longer than that which is for lactation.

Once the three groups have been defined we make another subdivision among them depending on if their prolificacy is above or below the mean (Table 5).

Table 5. Comparison of economic results per ewe depending on the feeding cost and the prolificacy

Feeding cost per ewe	Prolificacy	No. cases	Sheep activity margin/ewe		Standard deviation
< 4500	< 1.31	116	2419	p < 0.05	3673
	> 1.31	46	3826		3636
4500-7000	< 1.31	177	1801	p < 0.001	3003
	> 1.31	162	2963		2899
> 7000	< 1.31	44	–1178	p < 0.001	3474
	> 1.31	120	1444		4102

As one can see, the best economic results are in all cases from the groups which reach a higher prolificacy level, the differences being significant. The increases in the Sheep Activity Margin per ewe per year are 1,407, 1,162 and 2,622 ptas, for the extensive, semi-extensive and intensive groups respectively.

Coinciding with the results obtained by Pardos (1997), the more extensive groups show better productivity per head, since some intensive farms have problems in offsetting the increase in costs, above all nutritional costs, by productive intensification.

From all the farms which underwent Technical Economic Management Control 33 took part in the Selection Scheme for prolificacy developed by Carne-Aragón and published by Valdemoros *et al.* (1999). The results obtained up until now are shown in Table 6. One can see that there is a high correlation between prolificacy and the Farm Flock Effect which causes the differences in this characteristic, something which still does not occur in the genetic value, as there is still much progress to be done.

Conclusions

The increase in the prolificacy of the flocks studied allows the improvement of economic results per head. Although there is an increase in lamb mortality and total costs, basically those to do with feeding (supplements for the mother in lactation and concentrated feed for lambs), the increase produced in the total income is able to offset this. An increase in prolificacy of 9.2% above the mean (1.43 vs 1.31) causes an increase of 23.3% in the sheep activity margin per ewe per year, also above the mean (2,528 vs 2,051 ptas).

Within each "system" defined depending on the nutritional costs per sheep per year, the level of productivity achieved determines its economic viability. The economic results per sheep are always better in those farms which have a higher level of prolificacy, independently of the "system" which they belong to.

There are no differences between farms in the genetic effect of the prolificacy characteristic. Nevertheless, there are differences in the flock effect, that is to say depending on the management-handling itself on the farm, which is really the factor which determines the phenotypic differences.

Table 6. Genetic value and farm flock effect

	GVF * 100[†]	FFE * 100[††]
No. farms	33	33
Maximum	–0.7	–11.6
Minimum	+0.58	+44.9
Mean	–0.066	+11.9
Standard deviation	+0.28	+12.5
Correlation with the prolificacy	–0.226	0.863

[†] Genetic Value of a particular farm.
[††] Farm Flock Effect, that is to say, effect of the management on the prolificacy of a particular farm.

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