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SELECTION, DIFFUSION AND PERFORMANCES OF SIX SPANISH LINES OF MEAT RABBIT

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SUMMARY - The Unit of Rabbit Science and the Department of Animal Science are two Spanish institutions involved in rabbit genetic improvement since 1976. They develop specialised lines, maternal and paternal, for using in three way crossing schemes. The number of maternal lines are four and they are named, line A, line V, line Prat and line H. The paternal lines are two: Line R and line Caldes. The details of their selection programmes are explained, including the nucleus of selection owned by farmers. These nucleus are considered as crucial in the diffusion and use of the lines in crossbreeding. Finally, non comparative data of the reproductive and growth performance of the lines are given.

Key words: rabbit, Spanish lines, performance, selection.

RESUMÉ - L'Umité de Cuniculture et le Departement de Science Animal sont deux Institus liés à l'amèlioration génétique du lapin dès 1976. Ils ont developpé des souches specialisées, femelle et mâle, qui sont employées dans un schéma de croisement à trois voies. Les lignées maternels sont quatre: lignée A, lignée H, lignée Prat et lignée V. Lse souches mâle sont deux: lignée R and lignée Caldes. On explique les programmes de sélection et la création de Noyaux de sélection propieté des eleveurs. L'existence de ces Noyaux est cruciale pour la diffusion et pour l'utilisation des souches in croisements. On releve les performances zootechniques non comparables des souches pour caractères numériques et de croissance

Mots-clés: Lapin, Souches espagnoles, performance, sélection.

INTRODUCTION

The production of rabbit meat is relatively important in Spain and reached 99800 Tm in 1994. It means that, after Italy and France, Spain is the third producer of rabbit meat in Europe. The Spanish rabbit production is evolving to farms of more than two hundred does and it is compulsory to increase productivity, because production costs and sale prices are very close. Nowadays, the use of more productive animals is increasing (Rosell, 1996). In this sense, the demand of crossbred does and the use of males from specialised paternal lines is becoming higher and higher. In order to cope with the needs of the Spanish rabbit production two public institutions, the Unit of Rabbit Science (Barcelona, I.R.T.A.) and the Department of Animal Science (Valencia, U.P.V.), work since 1976 in the development of new lines of rabbits under the scope of their use in a three way scheme of crossbreeding. Consequently the efforts have been focused on the foundation and selection of *maternal* and *paternal lines*. Specialised maternal lines are devoted to produce *crossbred does* by crossing two of them. Paternal lines supply the sires to be mated to the crossbred does. The aim of this paper is to show the details of the foundation, selection, diffusion and performances of both types of lines developed by the institutions cited before.

MATERIAL AND METHODS

Table 1 shows the lines to be described in this paper, pointing the year of foundation, the type of line, the origin and the institution that develops each line.

Table 1. Spanish lines of rabbits to produce meat

Line	Foundation	Type	Origin	Institution
Caldes	1976	Paternal	New Zealand White	IRTA
A	1976	Maternal	New Zealand White	UPV
R	1976-1981	Paternal	Californian and others	UPV
V	1981	Maternal	Synthetic	UPV
Prat	1992	Maternal	Synthetic	IRTA
H	1996	Maternal	Heterogeneous population	UPV

Methods of selection

It is necessary to distinguish between the methods of selection according to the aptitude of the lines. Line R is being selected since its foundation by individual selection on the criterion of daily gain between weaning (28 d.) and slaughter (63 d.) .The main objective is to improve feed efficiency because of its negative and important genetic correlation between growth rate and conversion index (Blasco, 1989). After foundation of line Caldes the initial objective was to develop a mixed line with acceptable performances in growth and reproduction. Line Caldes was selected from 1976 to 1992 for litter weaning weight and post-weaning daily gain following an independent culling level method of selection (Rafel *et al.*, 1990). Since 1992 the method of selection is the same than for line R. Relevant features of this kind of selection are a short generation interval (around 6 months) and a yearly direct genetic response that ranges around 2.5% of the average of the trait (Estany *et al.*, 1992). Correlated responses are: an improvement of feed efficiency (Feki *et al.*, 1996), an increased daily feed consumption, an increased intestinal content and a diminished dressing percentage and maturity at fixed slaughter weight (Feki *et al.*,1994).

Selection methods in maternal lines are more complicated than in sire lines. This complexity is due to the fact that males do not express themselves the litter size traits and the values of the heritabilities of reproduction traits. So it is necessary to consider as many own and relative records as possible in the genetic evaluation of the does and bucks. In addition, the generation interval is longer than in the case of the selection of sire lines and, consequently, it could be necessary to take account some environmental and physiological effects into the models of evaluation (Armero *et al.,* 1996). The oldest one is the line A, nowadays in the 25th generation. The objective is to improve litter size at weaning. The criterion of selection of the offspring is the estimated genetic value of the mating. For the evaluation of a doe or buck a family index is computed that has a maximum of four items :

-average litter size at weaning of the individual to be evaluated if it is a doe
-average litter size at weaning of the dam
-average litter size at weaning of the full sisters
-average litter size at weaning of maternal and or paternal half sisters

The family index has the flexibility of computing the coefficients of each of the four items for the does and bucks that have offspring as a function of the number and structure of the allowable records (Baselga *et al.,* 1984).

The objective in lines V and Prat is also litter size at weaning and the selection is carried out in a similar way to the line A. The mean difference is the method of estimating the additive values of the breeding animals. In this case a BLUP method is used (Henderson, 1975) that is applied under a mixed model that explain litter size at weaning considering the next *fixed effects*:

- the physiological state of the doe that takes into account if the doe is primiparous or not and in this last case if it has sucklings or not at the moment of conceiving the litter that is being analysed and the litter size at weaning of the previous litter.
- the year season in which the parity took place,

and the next *random effects*:

- the additive value of the doe
- the permanent non additive effect of the doe
- the residual effect

The BLUP applied for line V is actually a reduced BLUP that evaluates the individuals of the last generation considering the previous one as the founding generation (Estany *et al.*, 1989). On the other hand, the line Prat is selected through a complete BLUP that uses all the records and relationships between animals since the foundation of the line (Gómez *et al.*, 1996). Simulation studies with real data have shown similar efficiencies for the three alternatives for selecting litter size. The loss of response due to select on an Family Index or a Reduced BLUP, instead of a complete BLUP is around a 8% (Armero *et al.*, 1996). Estimated responses in these lines are between 0.05-0.10 weaned per litter and generation (Estany *et al.*, 1989 ;Gómez *et al.*, 1996). These values are lower than expected from theoretical considerations.

The foundation of line H deserves some comments. It lays on the detection of does named hyperprolific, screening a large population of commercial rabbits, spread in different Spanish farms of a size between 150 and 2200 does. A doe was sorted as hyperprolific if it had a parity with 17 or more young born alive of if its accumulated number of born alive along all its parities allowed its classification in the group of the best 1% (García-Ximénez *et al.*, 1996). A first step of the process was to obtain male progeny from mating 20 hyperprolific does and the best 9 bucks coming from different nucleus of line V. In the second step, a new and larger set of hyperprolific females was mated to the males obtained in the first step to produce the founding generation of the line H (*generation 0)*. In order to circumvent time and disease problems, hysterectomies were performed in the first step and embryo vitrification in the second step. After thawing and transferring these embryos, a set of 474 rabbits of the generation 0 were allowable for maintaining the line and for studies of comparison of the line H with the line V and crossbred does AxV. The comparison was successful for line H (Cifre *et al.*, 1998a, b). After three generations without selecction we are getting the generation H4 from the best matings of H3. Individual genetic values have been calculated using a BLUP method, similar to the line V, but the selection trait is number born alive per litter.

Diffusion

The use of these lines in a three way crossbreeding scheme is recommended. Males (great sires) of one maternal line are mated to females (great dams) of other maternal line to produce the crossbred does for replacement. The crossbred does are mated to males (sires) of the paternal lines or inseminated with semen coming from this type of sires. An original aspect of the Spanish programme is the chosen way to spread the genetic achievements to the farmers. According to this aspect two points should be emphasised. First, the constitution of nucleus of selection, owned by the farmers and managed by the UPV or the IRTA. These nucleus replicate the selection method that is carried out on the maternal lines A, V and Prat. Now, there are eight nucleus of this type, in addition to the original nucleus of the above cited Spanish public institutions. Second, the crossbred does are produced in the farms that get the great dams from the nearest nucleus. The great sires and the final sires are supplied directly by the original nucleus or indirectly through multiplication of their stock in the farms of the replicated nucleus. This procedure allows to convert in a big extent the multiplication in selection, to reduce the cost of the breeding stock sold to the farmers, to reduce the health and adaptation problems derived of the introduction of foreign animals into the farms and to improve the communication between breeding companies and farmers.

Performance

To illustrate the performance level of these lines, data of A23 (line A generation 23), R13, V20 and H2 and lines Caldes and Prat, recorded between August of 1996 and November of 1997 will be analysed. The traits considered have been weaning weight, slaughter weight, post-weaning daily gain and litter size traits. Animal models have been used for all traits. Other random effects were considered: non-genetic dam effect for growth traits and non-genetic doe effect for the reproductive traits. Year-season was a fixed effect for all traits. For growth traits other considered fixed effect was parity order (1, 2 and higher), and litter size at birth as a covariate. For reproductive traits, a combination of parity order and lactation state called physiological state was considered. Because of the descriptive nature of this paper, the only results to be shown will be the least square means for year-season, parity order and physiological state.

RESULTS AND DISCUSSION

Breeding conditions of the selected lines were different. It is not possible to compare straightforward the different figures. Moreover, concerning growth traits, ages at weaning and at slaughter were different between institutions (28 and 63 d. in U.P.V. and 32 and 60 d in I.R.T.A.). Weaning and slaughter weights were clearly affected by this fact. Differences in the length of fattening period also influenced the values of daily gain. The least square means for weaning weight, slaughter weight and post-weaning daily gain by parity order, by line and by season are given in Tables 2, 3 and 4. Data are adjusted by litter size at birth. In U.P.V. , paternal line R, selected on daily gain, showed the heaviest values at weaning (+66 g) and at slaughter (+420 g), and daily gain was higher than the average of other three lines (+10.1 g/d). In I.R.T.A., paternal line Caldes also shows the highest values in weaning weight (+46 g), slaughter weight (+368 g) and daily gain (+12 g/d). Previous comparison between lines R and Caldes, breed in the same conditions, were favourable to the line R for growth rate (Ramon *et al.*, 1996). These paternal lines are widely used by rabbit breeders in Spain in natural mating or in artificial insemination.

Reproductive performances of the lines are showed on Tables 5, 6, 7 and 8. Line H, founded with hyperprolific criteria, showed the highest litter size in U.P.V. and line R the lowest. Reproductive performances of paternal line C have been not reduced by the selection for daily gain since 1992. However, line R has lost reproductive efficiency along generations. Reproductive performances of Spanish maternal lines are competitive with other European lines(Brun and Poujardieu, 1998; Brun *et al.*, 1998). Reports of technical and economic management programs in Spain show an increasing total born in commercial farms since 1993, laid on the use of selected lines (Ramon *et al.*, 1998). The major interest of these lines is not their use as pure breed but their contribution to crossbreed schemes taking profit of heterosis. A crossbrreding experiment is in process using five of these lines (A, Caldes, Prat, R and V). The main objective is to optimise the composition and the direction of the cross between maternal lines to produce the best crossbred doe. A second aim is the study of the performances of the young rabbits sired by males from paternal lines.

Table 2. Least square means (and standard errors) for weaning weight by parity order (PO), season (AE) and line.

		Line A	Line C	Line H	Line P	Line R	Line V
PO[1]	1	490 a[2] (7.0)	634 a (6.5)	500 a (7.8)	602 a (5.2)	558 a (12)	498 a (9.5)
	2	569 b (7.1)	757 b (6.7)	551 b (7.1)	699 b (5.0)	633 b (12)	544 c (9.5)
	3	586 c (8.0)	757 b (6.2)	552 b (6.9)	710 c (4.9)	612 b (16)	528 b (9.3)
AE	1	534 a (13)	727 b (6.7)		641 a (5.3)	579 (18)	514 a (9.7)
	2	556 bc (7.1)	706 a (6.8)	542 b (7.0)	683 b (5.5)	612 (19)	523 a (10)
	3	558 c (6.5)	727 b (7.2)	540 b (7.0)	682 b (5.3)	609 (14)	536 b (9.3)
	4	546 ab (8.0)	705 a (7.0)	521 a (8.0)	675 b (5.1)	603 (12)	520 a (9.3)

[1] PO: 1=first parity, 2=second parity, 3=next parities; AE: 1=summer, 2=autumn, 3=winter, 4=spring.
[2] Least square means within column and effect that do not share a common letter differ (P<0.05)

Table 3. Least square means (and standard errors) for slaughter weight by parity order (PO), season (AE) and line.

		Line A	Line C	Line H	Line P	Line R	Line V
PO[1]	1	1745 a[2](13)	2000 a (12)	1789 a (15)	1691 a (11)	2216 a (26)	1830 a (16)
	2	1870 b (14)	2183 b (12)	1887 b (13)	1789 b (10)	2295 b (28)	1864 b (16)
	3	1905 c (15)	2185 b (11)	1924 c (13)	1786 b (9.8)	2316 b (34)	1859 b (16)
AE	1	1738 a (26)	2099 b (12)		1700 b (11)	2171 a (40)	1722 a (17)
	2	1891 c (13)	2180 c (12)	1930 c (13)	1854 d (11)	2327 b (42)	1927 c (18)
	3	1916 d (12)	2199 c (13)	1896 b (13)	1824 c (11)	2365 b (30)	1941 c (16)
	4	1814 b (15)	2014 a (13)	1774 a (16)	1644 a (10)	2239 a (27)	1815 b (16)

[1] PO: 1=first parity, 2=second parity, 3=next parities; AE: 1=summer, 2=autumn, 3=winter, 4=spring.
[2] Least square means within column and effect that do not share a common letter differ (P<0.05)

Table 4. Least square means (and standard errors) for post-weaning daily gain by parity order (PO), season (AE) and line.

		Line A	Line C	Line H	Line P	Line R	Line V
PO[1]	1	35.7 a[2] (0.27)	49.2 a (0.27)	36.6 a (0.33)	38.7 (0.30)	47.4 (0.55)	38.0 (0.32)
	2	37.0 b (0.27)	51.3 b (0.28)	38.1 b (0.29)	38.9 (0.28)	47.3 (0.58)	37.7 (0.32)
	3	37.5 c (0.31)	51.5 b (0.26)	39.2 c (0.27)	38.5 (0.27)	48.1 (0.71)	38.0 (0.31)
AE	1	34.3 a (0.52)	49.7 b (0.28)		37.7 b (0.30)	45.5 a (0.84)	34.5 a (0.33)
	2	37.9 c (0.27)	52.5 c (0.28)	39.6 c (0.28)	41.9 d (0.32)	48.5 b (0.86)	40.1 c (0.36)
	3	38.6 d (0.25)	52.6 c (0.30)	38.7 b (0.28)	40.5 c (0.31)	49.8 b (0.63)	40.1 c (0.31)
	4	36.2 b (0.31)	48.0 a (0.29)	35.7 a (0.34)	34.8 a (0.29)	46.5 a (0.56)	37.0 b (0.30)

[1] PO: 1=first parity, 2=second parity, 3=next parities; AE: 1=summer, 2=autumn, 3=winter, 4=spring.
[2] Least square means within column and effect that do not share a common letter differ (P<0.05)

Table 5. Least square means (and standard errors) for total born by physiological state (PS), season (AE) and line.

		Line A	Line C	Line H	Line P	Line R	Line V
PS[1]	1	8.7 a[2] (0.29)	8.8 a (0.20)	10.5 a (0.41)	8.4 a (0.16)	7.9 (0.44)	9.1 a (0.30)
	2	9.9 b (0.36)	9.8 b (0.23)	11.4 b (0.35)	10.7 b (0.18)	7.9 (0.58)	11.0 b (0.33)
	4	10.0 b (0.35)	9.2 a (0.19)	10.9 ab (0.29)	10.7 b (0.14)	7.6 (0.58)	11.1 b (0.26)
AE	1	10.2 (0.67)	9.6 (0.31)		9.5 a (0.25)	8.6 (0.74)	9.7 a (0.33)
	2	9.6 (0.32)	9.6 (0.30)	10.8 (0.39)	9.7 a (0.25)	8.0 (0.74)	10.4 a (0.45)
	3	9.7 (0.25)	9.5 (0.31)	11.7 (0.29)	10.4 b (0.26)	8.2 (0.53)	11.1 ab (0.30)
	4	10.3 (0.36)	9.5 (0.31)	11.1 (0.40)	10.5 b (0.24)	8.4 (0.46)	11.6 b (0.27)

[1] PS: 1=first parity, 2=second parity, 4=next parities (In levels 2 and 4 there is an overlap between lactation and gestation); AE: 1=summer, 2=autumn, 3=winter, 4=spring
[2] Least square means (within a column) that do not share a common small letter differ (P<0.05)

Table 6. Least square means (and standard errors) for number born alive by physiological state (PS), season (AE) and line.

		Line A	Line C	Line H	Line P	Line R	Line V
PS[1]	1	8.0 a[2] (0.33)	8.1 a (0.23)	10.2 (0.47)	8.1 a (0.19)	7.4 (0.48)	8.5 a (0.36)
	2	9.3 b (0.41)	9.0 b (0.26)	10.7 (0.39)	10.2 b (0.20)	7.4 (0.62)	10.2 b (0.40)
	4	9.4 b (0.39)	8.3 a (0.22)	10.0 (0.33)	10.3 b (0.16)	6.6 (0.62)	10.5 b (0.31)
AE	1	9.8 (0.77)	8.9 (0.36)		9.1 a (0.29)	8.7 (0.79)	8.6 a (0.40)
	2	9.2 (0.36)	9.0 (0.35)	10.0 (0.44)	9.4 a (0.28)	7.3 (0.79)	10.0 b (0.54)
	3	9.2 (0.28)	8.9 (0.36)	11.0 (0.33)	10.1 b (0.30)	7.4 (0.57)	10.8 b (0.36)
	4	9.2 (0.41)	9.0 (0.35)	10.5 (0.45)	10.2 b (0.28)	7.6 (0.49)	10.9 b (0.32)

[1] PS: 1=first parity, 2=second parity, 4=next parities (In levels 2 and 4 there is an overlap between lactation and gestation); AE: 1=summer, 2=autumn, 3=winter, 4=spring
[2] Least square means (within a column) that do not share a common small letter differ (P<0.05)

Table 7. Least square means (and standard errors) for litter size at weaning by physiological state (PS), season (AE) and line.

		A	C	H	P	R	V
PS[1]	1	6.9 a[2] (0.31)	6.7 a (0.22)	8.6 (0.41)	7.3 a (0.20)	6.2 (0.45)	7.9 a (0.30)
	2	8.5 b (0.39)	7.8 b (0.25)	9.1 (0.34)	9.0 b (0.22)	6.0 (0.59)	8.5 b (0.34)
	4	8.7 b (0.37)	6.9 ab (0.21)	8.8 (0.29)	8.7 b (0.17)	4.6 (0.59)	8.2 b (0.26)
AE	1	8.7 (0.73)	7.5 (0.35)		8.4 a (0.30)	6.8 (0.75)	7.1 a (0.34)
	2	8.5 (0.34)	7.3 (0.33)	9.1 (0.38)	8.3 a (0.30)	6.1 (0.75)	8.0 b (0.46)
	3	8.2 (0.27)	7.5 (0.34)	9.3 (0.29)	8.9 b (0.31)	5.6 (0.54)	8.9 c (0.30)
	4	8.1 (0.39)	7.5 (0.34)	8.7 (0.40)	8.9 b (0.30)	5.9 (0.47)	9.0 c (0.27)

[1] PS: 1=first parity, 2=second parity, 4=next parities (In levels 2 and 4 there is an overlap between lactation and gestation); AE: 1=summer, 2=autumn, 3=winter, 4=spring
[2] Least square means (within a column) that do not share a common small letter differ (P<0.05)

Table 8. Least square means (and standard errors) for litter size at slaughter age by physiological state (PS), season (AE) and line.

		Line A	Line H	Line R	Line V
PS	1	6.4 a (0.31)	8.1 (0.42)	5.9 b (0.42)	7.7 a (0.30)
	2	8.0 b (0.39)	8.6 (0.35)	5.3 ab (0.55)	8.4 b (0.34)
	4	8.2 b (0.38)	8.5 (0.29)	4.2 a (0.55)	8.0 b (0.26)
AE	1	7.7 (0.73)		6.3 (0.70)	6.9 a (0.34)
	2	8.0 (0.35)	8.7 ab (0.39)	5.6 (0.70)	7.8 a (0.46)
	3	7.8 (0.27)	8.9 b (0.29)	5.2 (0.50)	8.7 b (0.30)
	4	7.8 (0.39)	8.2 a (0.40)	5.5 (0.44)	8.9 b (0.27)

[1] PS: 1=first parity, 2=second parity, 4=next parities (In levels 2 and 4 there is an overlap between lactation and gestation); AE: 1=summer, 2=autumn, 3=winter, 4=spring

[2] Least square means (within a column) that do not share a common small letter differ (P<0.05)

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