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SELECTION FOR TOTAL LITTER WEIGHT AT WEANING PER DOE AND PER YEAR IN TWO REX RABBIT STRAINS (PRELIMINARY RESULTS)

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ABSTRACT

Preliminary results of a selection experiment are presented. The selection criterion is the total litter weight at weaning per doe and per year. There are two selected rex lines (29S and 55S) and one control rex line (55T). A new cohort is born each nine or ten months. At every time, there is two cohorts ; thus generations overlap. Data from the first six cohorts is considered (162 does from line 29S, 169 does from line 55S and 102 does from line 55T). Survival rate is higher in 55S and 55T lines than in 29S line.Litter size, litter weight, interval between litters and selection criteria fall in 55T control line. Selection intensity is moderate in the selected lines. Many responses to selection (direct or correlated) are very great in relation to the mean value of the trait or in relation to the cumulative selection differential. Further analysis are needed to describe more precisely the genetic trend.

INTRODUCTION

Four years ago at the Budapest congress we described a selection experiment in two rex strains (ROCHAMBEAU et al 1988). We have proposed to select for a criterion as near as possible from the selection goal. We have not used a selection index which combine various selection criteria for it was not possible to estimate genetic correlations. Our selection goal was to improve the overall productivity of two rex strains. Usually, rex strains have a lower productivity than strains with a wild coat (ROCHAMBEAU et VRILLON 1982, VRILLON et al 1990).

Secondly we have described a management of strains with overlapping generations. Effects of overlapping generation on the prediction of genetic gain are rather complex. Consequently generations do not overlap in many selection experiments. Nevertheless most of private company strains are managed with overlapping generations. Our second aim was to increase our experience on management of strains with overlapping generations. At the same congress a spanish team have presented a very similar selection experiment (RAFAEL et al. 1988). At the current congress we will present a preliminary analysis of these two selection experiments. The spanish papers show a valuable analysis of the demography (RAMON et al 1992) and a valuable analysis of the phenotypic trend (UTRILLAS et al 1992). This paper investigate phenotypic and genetic data. Later we will study all points from the two experiments.

MATERIALS AND METHODS

1. Materials. Our rex strains come from Mexico. We have also used some bucks bought in Europe. There is two strains. The first one have a castor skin. In this strain we have a selected line (55S) and a control line (55T). The second one have a chinchilla skin. We have only a selected line (29S). We will study data of 162 does from 29S line, 169 does from 55S line and 102 does from 55T line. Does are bred between 1986 and 1991 (figure 1).

Generations overlap. In each line we have two cohorts bred with an interval of nine or ten months. When youngest does have done two or three litters we ranked does on an index. All oldest does and bucks are casted. Bucks and does from the new cohort are chosen between young rabbits bred by best ranked does. Nine or ten months later, we will breed a new cohort. At every time we have two cohorts. In selected lines we have eight reproduction groups of two bucks and seven does. Control line have four reproduction groups of the same size. Bucks stay int he groupe of their sires. Does go in another reproduction group (ROCHAMBEAU 1990).

Rabbits are reared in an isolated building, not heated and statiscally ventiled. The building has windows ; bucks and does are lighted 16 hours per day. Mating first occured at 160 days. Each breeding rabbit have an individual wire cage. Broiler rabbits are raised in collective cages in two others buildings. All rabbits are fed with the same commercial pellet. At the beginning of 1989, we stop natural mating and we use artificial insemination. Technical process was described earlier (VRILLON et al 1990).

Performance traits collected from does are birth litter size (BLS), weaning litter size (WLS), weaning litter weight (WLW), time interval between two litters (LTI).

Doe management utilize an half intensive breeding schedule. Mating occurs ten days post partum. Diagnostic of pregnancy through abdominal palpation follows fourteen days after. Weaning occurs at 30 days.

Selection criteria (SC), for the n^{th} litter of a doe is :

$$SC_n = WLW_n \frac{365}{LTI_n}$$

The criterion was discussed earlier (ROCHAMBEAU et al 1988). Index used data of the doe, of its sisters, and of its mothers. Data were corrected before for parity. After the 5^{th} cohort, we have choosen a new index. It is a BLUP with an animal model :

$$Y_{ijklm} = YS_i + BB_j + PS_k + a_l + p_l + e_{ijklm}$$

YS_i is the year-season in which the litter was born (fixed). There are 22 levels.

BB_j is the line of the buck, which is the father of the litter (fixed). For experimental purpose we have used some bucks of another line to breed some litters. There are two levels. PS_k is the parity state of does (fixed). There are nine levels (one to eight, and more than eight). a_l is the additive value of the doe (random). p_l is the permanent non genetic effect of the doe (random). e_{ijklm} is the temporary environmental effect on the doe. y_{ijklm} is the selection criterion for the k^{th} litter of the l^{th} doe, made in the i^{th} year-season. A BLUP needs two more parameters : heritability and repetability. We have choosen the estimation we had (ROCHAMBEAU et al 1988) : $h_2 = 0{,}08$ and $r = 0{,}15$.

2. Demographical analysis. We use classic demographic parameters (VU TIEN KHANG 1983). If S_t is the number of alive does at age t, and S_1 is the number of alive does at the first mating, the survival rate (SR) is equal to :

$$SR = \frac{S_t}{S_1}$$

The root of the table is 100. To study the reproductive life of does, we define (ROCHAMBEAU et al 1989) :

- NFD which is the number of alive does at first mating,
- NED which is the number of effective does. An effective doe is a doe with at least one litter alive at weaning,
- NUD which is the number of useful does. An usefuel doe is a doe with at least one effective son (NUD_s) or ones effective daughter (NUD_d). For each useful doe, we define the number of effective sons (NES) and the number of effective daughter (NEF).

3. Genetical analysis. Let S_i^k be the selection differential for the pathway k of the ith cohort. The cumulative selection differential for the 6th cohort CS_6 is :

$$CS_6^k = \frac{3}{2} S_1^k + S_2^k + S_3^k + S_4^k + \frac{1}{2} S_5^k$$

We are doing a selection only in two of the four pathways which are father-son, father-daugter, mother-son (MS), mother-daughter (MD).

The cumulative selection differential for the 6th cohort (CS_6) is :

$$CS_6 = \frac{CS_6^{MS} + CS_6^{MD}}{4}$$

This way to estimate selection differential is not the best one (JAMES 1977), but is is a good rough estimate for a preliminary analysis. To study performance traits of the does, we use this model :

$$y_{ijklm} = \mu + BS_i + PS_j + LC_{kl} + e_{ijklm}$$

where μ is the overall mean. BS_i is the season in which litter was born (fixed). There are four levels. PS_j is the parity state of the doe (fixed). There are four levels (one to three, and more than three). LC_{kl} is the effect of the lth cohort from the kth line (fixed). There is six cohorts and three lines (1 = 29S, 2 = 55S, 3 = 55T) . Thus we have 16 levels. y_{ijklm} is the data of the jth litter of the mth doe born at the ith season. The doe come from the lth cohort of the kth line. We have done the analysis for the five traits (SC, BLS, WLS, WLW, LTI).

We have estimated the response to selection by two ways. For exemple for line 55S (k = 2). We use line 55T (k = 3) as a control and we have :

$$SR1 = PSR_6 - PSR_1$$

where $PSR_6 = LC_{26} - LC_{36}$
$PSR_1 = LC_{21} - LC_{31}$

We make also a regression of the PSR_l on l .

$$SR2 = PSR_6 - PSR_1$$

where PSR_6 and PSR_1 are values estimated by the regression equation for l = 6 and l = 1. We test the regression coefficient to 0 by a student test. In all tables, P_c is the critical probability. We have same data for line 29S , by using line 55T as a control line.

Statistical analysis was made with PROC GLM from SAS software.

RESULTS AND DISCUSSION

1. Demographical analysis. Figure 1 shows number of does born each month from the three lines. Experiment was planned with one new cohort each eight month. Interval between two cohorts is often greater (from 7 to 13 months). Till the 4th cohort, cohorts were separated. We had between two and five months without one birth. Next, we have changed managment : we have always some bitrths to keep all wire cages with one doe.

Figure 2 shows survival rate of the three lines. Castor lines have a better survival rate than chinchilla line. In 1982 it was contrary (ROCHAMBEAU et VRILLON 1982), and survival rate was lower at the same age. ROUSTAN et al (1986) have studied survival of some meat line. At 360 days of age, survival rate is lower than 30 %.

2. Genetical analysis. Table 1 gives data of the first cohort. One can see that line 55T is better than line 55S which is better than line 29S. Percentage of litters with zero rabbit at weaning is greater in line 29S (17 %) than in lines 55S and 55T (6 - 7 %). On the contrary line 29S have a smaller interval between two litters. Coefficient of variation of selection criterion is greater than 50 %. Table 2 presents numbers of effective and useful does for the first five cohorts. 90 % of does of 55 lines are effective. Percentage is lower (81 %) in 29S line. However these values are good, and fitness of these lines is regular in relation to a strain selected for growth rate, by ROCHAMBEAU et al (1989). Percentage of useful does is lower in control line than in selected lines. Nevertheless percentage of useful does is around 40 %, therefore selection intensity will be moderate. NUD_s is very similar in the three lines as a consequence of mating plan.Table 3 provides numbers of effective daughters and effective sons produced by useful does of the first five cohorts. As a consequence of small litter size of rex lines, number of effective daughters is lower than 2 (1,97 for line 55S, and 1,67 for line 29S). In a meat line this number is around 2,5.Table 4 deals with cumulative selection differentials for the 6th cohort. For line 55T, they are around zero as expected. For selected lines they are small. For example cumulative selection differential after 2,5 generations is equal to 2,5 σ_p in a selection for post weaning growth rate (ROCHAMBEAU et al 1989). On the contrary in a selection for litters size at weaning (MATHERON et POUJARDIEU 1984) cumulative selection differential after 2,5 generations is equal to 0,75 σ_p.

Table 5 shows that all effects of the model are very significant. Selection criterion decreases slightly in control line (Table 6 and figure 4). Direct response to selection is positive in 55S line and negative in the 29S line. Nevertheless the two estimations of direct response to selection are very different. Coefficients of regression are not significant. Many response to selection are very great in relation to mean value of the trait or in relation to cumulative selection differentials. Further analysis are needed ; we plan to study genetic trend with an animal model. Secondly litter size at birth and at weaning go down steadily in control line (Table 6 and figure 3). Artificial insemination makes clear a part of the fall. In spite of that birth litter size remains steady in the selected lines. Then correlated response to selection on this trait is positive. Coefficients of regression are not significant, but tendancy is clear. The two estimations in selected lines show the same trend. Weaning litter size goes down regularly in selected lines. However despite the fact that coefficients of regression are not significant, correlated response to selection on this trait is positive. Next weaning litter weight falls steadily in the control line as a consequence of the fall of weaning litter size (Table 6 and figure 4). Correlated response to selection is positive in selected lines.

Coefficient of regression is almost significant for the 29S line. Line 55S differs from line 29S. Correlated responses to selection are very different and smaller. Finally, interval between litters deacreases dramatically for lines 55S and 55T (Table 6 and figure 4). With regard to interval between litters, line 29S is different from lines 55S and 55T. Interval between litters remains steady. We start to use artificial insemination at the beginning of 1989. As a result, intervals between litters change differently in lines 55 and in line 29S (VRILLON et al 1990). Is line 55T a good control for line 29S ? Change in interval between litters explains the negative direct response to selection in line 29S. Why interval between litters drops in lines 55 and levels off in line 29S ?

Finally, this paper present an analysis of phenotypic trends in three lines of rex. In 1989 we have renounced to natural mating and we have choosen artificial insemination. After that litter sizes go down steadily in control line 55T. As a result litter weight and selection criterion plunge slightly. The fall of all traits is smaller in selected line 55S than in control line. Line 29S is different from line 55S in interval between litters as a result of which the selection criterion decreases more than in control line. Further analysis are needed to describe genetic trends.

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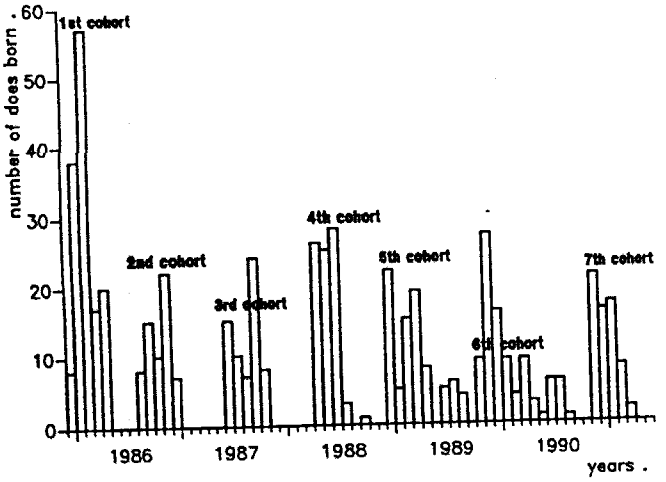

Figure 1 : Number of does born each month

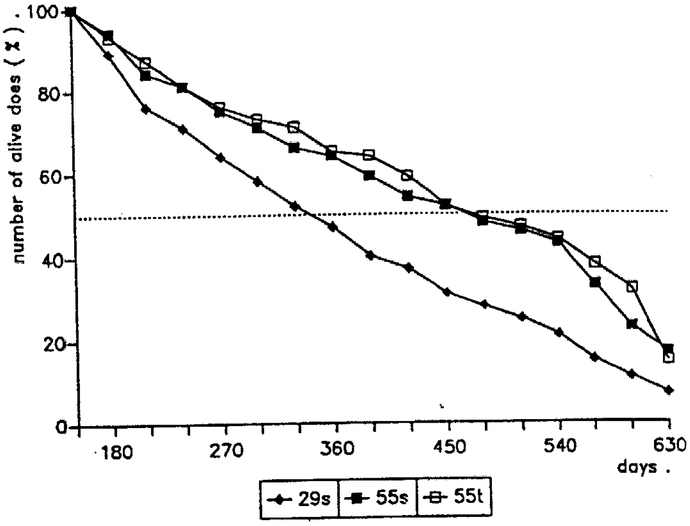

Figure 2 : Survival rate

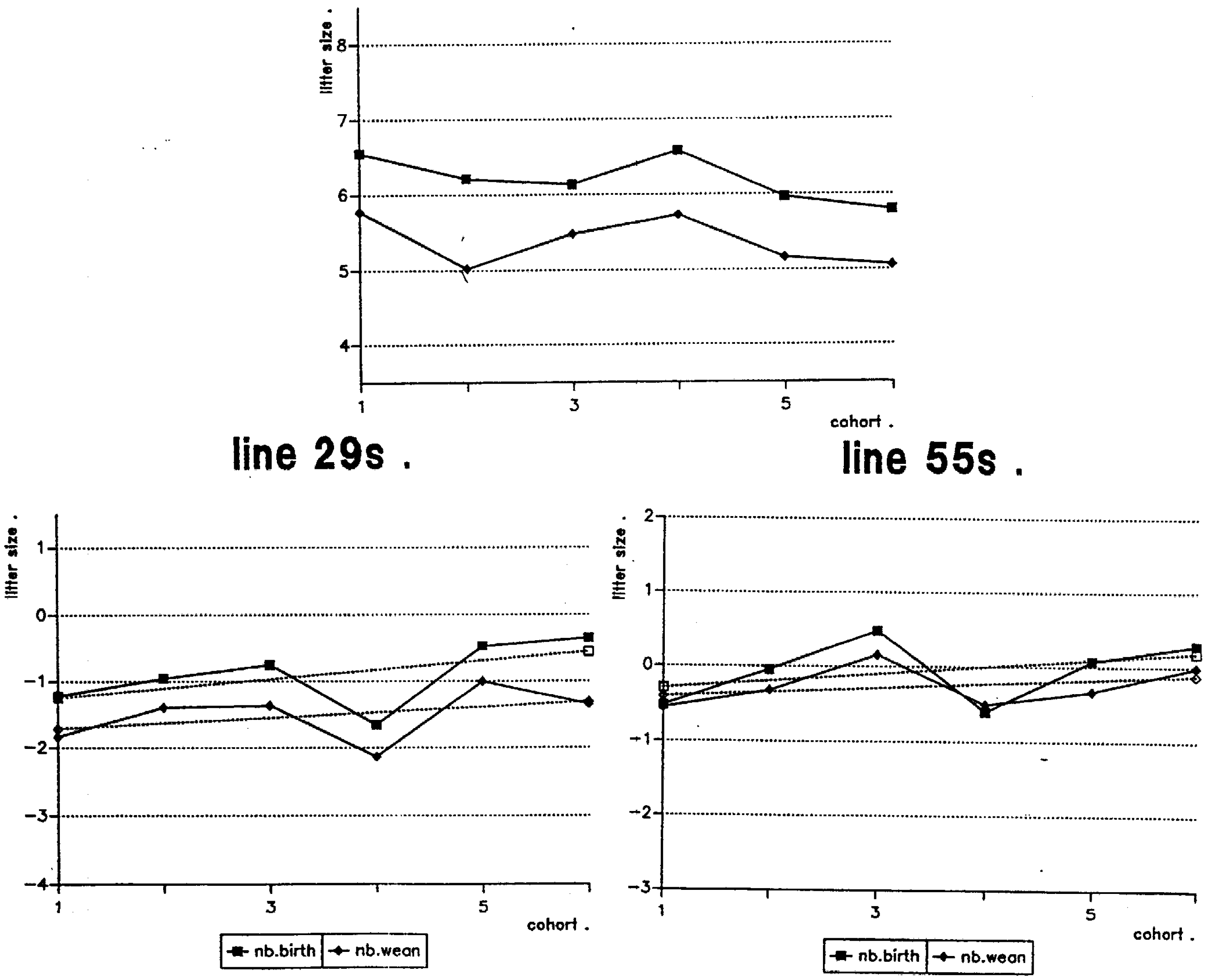

Figure 3 : Birth and weaning litter sizes (line 55T in the upper part ; selected lines in the lower part)

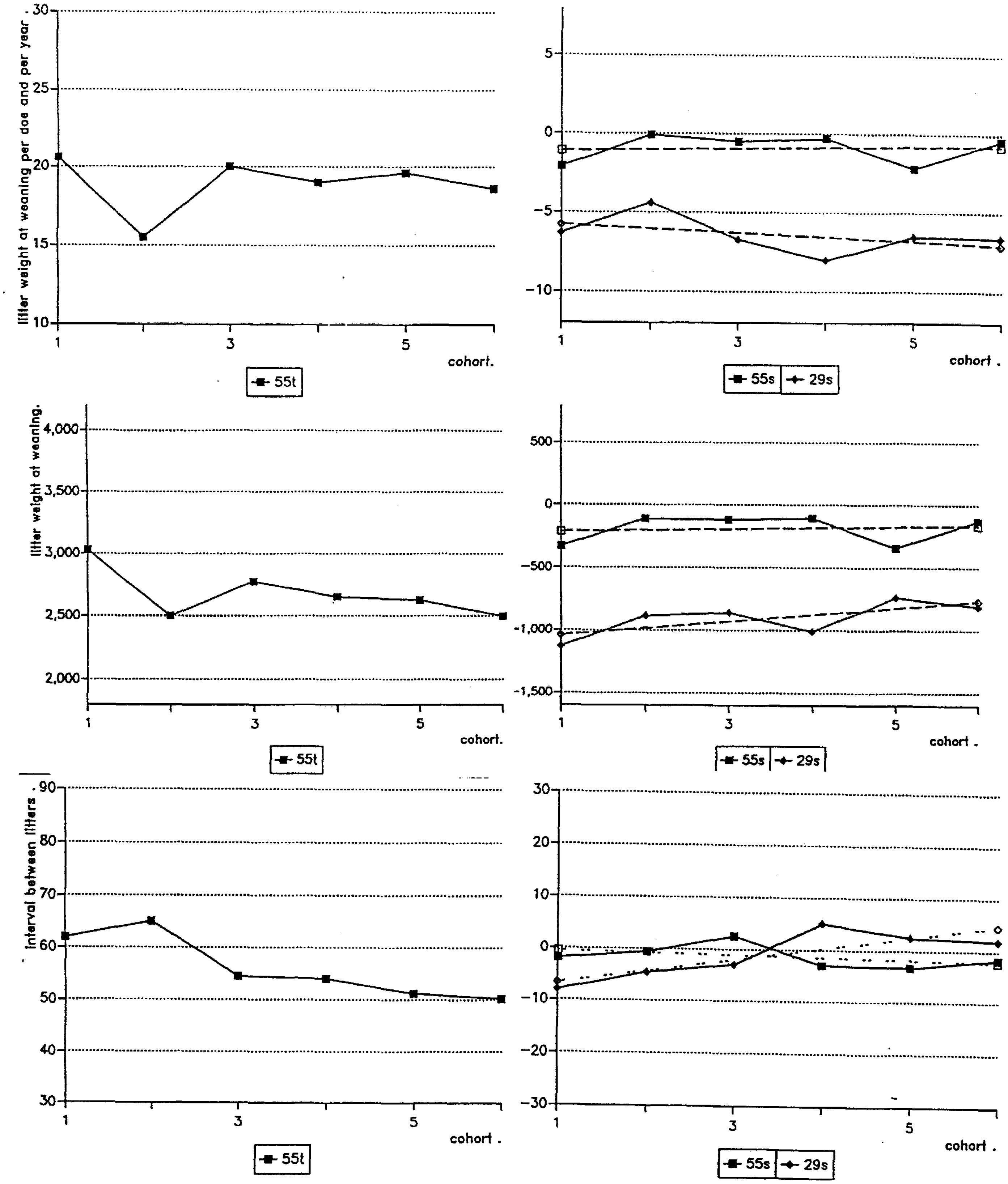

Figure 4 : Selection criterion, weaning litter weight and interval between litters.
(line 55 in the left-hand side, selected lines in the right-hand side)

TABLE 1 : DATA OF THE 1[st] COHORT

Trait \ Line	295			55S			55T		
	N	Mean	STD	N	Mean	STD	N	Mean	STD
BLS	228	5,28	2,28	229	5,9	2,66	167	6,5	2,1
WLS	228	3,82	2,34	229	5,1	2,50	167	5,7	2,3
WLW	228	1847	1120	229	2642	1183	167	3002	1139
LTI	228	53,5	27,4	229	60,0	31,4	167	62,3	30,8
SC	228	13,9	9,6	229	18,2	10,6	167	20,5	11,1

TABLE 2 : NUMBER OF DOES ALIVE AT THE FIRST MATING (NFD), NUMBER OF EFFECTIVE DOES (NED), NUMBER OF USEFUL DOES (NUD_S and NUD_S) FOR THE THREE LINES

	NFD		NED		NUD_D		NUD_S	
	N	%	N	%	N	%	N	%
295	200	100	162	81	69	43	40	25
55S	191	100	169	88	64	38	37	22
55T	113	100	102	90	59	58	29	28

TABLE 3 : NUMBER OF EFFICIENT DAUGHTERS (NED) AND SONS (NES) PRODUCED BY THE USEFUL DOES OF THE FIRST FIVE COHORTS

		N	Means	STD	COV
29S	NES	93	0,69	0,91	0,06
	NED	93	1,67	1,27	
55S	NES	86	0,74	0,94	0,07
	NED	86	1,97	1,54	
55T	NES	85	0,56	0,76	- 0,04
	NED	85	1,49	1,05	

TABLE 4 : SELECTION DIFFERENTIALS FOR SELECTION CRITERIA (SC), BIRTH LITTER SIZE (BLS), WEANING LITTER SIZE (WLS), WEANING LITTER WEIGHT (WLW) AND INTERNAL BETWEEN LITTERS (LTI)

	29S					55S					55T				
	SC	BLS	WLS	WLW	LTI	SC	BLS	WLS	WLW	LTI	SC	BLS	WLS	WLW	LTI
CS_6^{MS}	10,6	2,2	2,6	1276	- 2,5	14,3	2,3	2,6	1450	- 9,0	5,9	0,8	1,4	728	- 8,0
CS_6^{MD}	14,5	2,2	3,1	1543	- 4,1	14,7	3,6	3,3	1649	- 7,0	- 1,7	- 0,5	- 1,2	-605	- 21,2
CS_6	6,3	1,1	1,4	705	- 1,7	7,3	1,2	1,5	775	- 4,0	1,1	0,1	- 0,1	31	- 7,3
$\frac{CS_6}{\sigma_p}$	0,66	0,48	0,61	0,63	0,06	0,69	0,44	0,60	0,66	0,13	0,10	0,10	- 0,04	0,03	0,23

TABLE 5 : ANALYSIS OF VARIANCE FOR SELECTION CRITERIA (SC), BIRTH LITTER SIZE (BLS), WEANING LITTER SIZE (WLS), WEANING LITTER WEIGHT (WLW) AND INTERVAL BETWEEN LITTERS (LTI). F IS THE VALUE OF THE TEST AND P_c IS THE CRITICAL PROBABILITY

		SC	BLS	WLS	WLW	LTI
Litter season	F	9	3,7	5,2	6,0	4,7
	P_c	.0001	.01	.001	.0005	.003
Number of litter	F	20	36	21	38	88
	P_c	.0001	.0001	.0001	.0001	.0001
Line (cohort)	F	14	5,0	12	20	7,6
	P_c	.0001	.0001	.0001	.0001	.0001

TABLE 6 : RESPONSE TO SELECTION FOR SELECTION CRITERIA (SC), BIRTH LITTER SIZE (BLS), WEANING LITTER SIZE (WLS), WEANING LITTER WEIGHT (WLW) AND INTERVAL BERTWEEN LITTER (LTI)

			SC	BLS	WLS	WLW	LTI
Least square means for each strain and for the I[st] and the 6[th] cohort	29S	1	14,3	5,33	3,93	1899	53,9
		6	12,0	5,44	3,71	1687	52,1
	55S	1	18,5	6,03	5,22	2696	60,0
		6	18,2	6,07	5,05	2369	48,5
	55T	1	20,6	6,55	5,77	3028	61,9
		6	18,6	5,79	5,06	2496	50,2
29S	SR1		- 0,3	+ 0,87	+ 0,49	+ 320	+ 9,9
	SR2		- 1,40	+ 0,69	+ 0,41	+ 271	+ 9,8
	P_c		0,41	0,27	0,46	0,11	0,03
55S	SR1		+ 1,70	+ 0,80	+ 0,54	+ 205	- 0,2
	SR2		+ 0,34	+ 0,47	+ 0,28	+ 49	- 1,9
	P_c		0,80	0,19	0,44	0,77	0,54