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Relation between littersize (number weaned) and later body weight gain in the New Zealand White rabbit

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Introduction

For an economic meat production with rabbits the prolificacy as well as daily gain are very important traits. If prolificacy is characterized by the number of offspring weaned per doe and year then this trait is composed of the number of young weaned per litter and the number of litters per year. Since in a fully synchronized reproduction management with post partum artificial insemination the number of inseminations per year is fixed by 11 thus the remaining factors are conception rate (around 0.7) and littersize. In every case the number of young weaned per litter is extremely important. If we want to slaughter 10 000 animals a year then with 11 inseminations per year, a conception rate of 0.7 and 7 young weaned per litter we need 186 does, whereas with 8 young weaned we need only 163 does. This reduction in the number of breeding animals reduces in the same proportion the number of cages needed and the food maintenance requirement. The food needed for an offspring (additional requirement of the doe and direct requirement of the young) is not reduced, it might even be slightly increased. In addition there is a tendency that animals being raised in large litters have a lower weight at weaning and even at 8 or 12 weeks of age than animals raised in small litters. Thus the reduction of cost due to fewer cages (housing costs) and to reduced maintenance are to be compared with the higher direct food requirement for animals weaned and the somewhat lower weight at 8 and 12 weeks of age.

The daily gain up to the usual slaughter weight is the second important component of the economic efficiency. If the wanted slaughter weight is reached one week earlier the requirement for housing facilities is lowered by 1/9 and the requirement for maintenance food by 1/8 assuming a fattening period of 8 weeks after weaning and a break in the use of the housing for one week (for cleaning etc.).
If the wanted slaughter weight is reached later because of large litter size, the advantage of large litters is reduced. In an integrated production scheme these components must be considered. The latter can be done by deriving economic weights (marginal profits) and by taking into account the genetic and phenotypic correlations between the traits.

In this investigation the emphasis is on the phenotypic relation between the size of the litter the animal comes from and the later daily gain. This phenotypic relationship is of importance for the optimization of the management e.g. for evaluating the advantages and disadvantages of exchanging newborn animals between litters in order to standardise littersize.

Material, Methods and Results

The data were collected in a nucleus breeding farm over a six year period of time. Only data from purebred New Zealand White were utilized. This decreases the value of the results somewhat, since in the production tier crossbreds are usually used.

The breeding animals are kept in flat decks with single cages and slatted floor. The reproduction management is characterized by age at first insemination of 110 days, synchronized post partum artificial insemination and weaning at an age of 27 days.

The average performance with respect to reproduction is shown in Tab. 1.

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Tab. 1: Reproductive performance (altogether 5692 inseminations)

	$\hat{\mu}$	$\hat{\sigma}$
conception rate	0.65	
Performance per litter born		
littersize	8.60	3.1
born alive	7.64	3.5
weaned	6.11	3.4

During the fattening period till an age of 8 weeks the animals were kept in cages with a group size of 6 to 8 animals, afterwards only 4 animals are kept in one cage. The temperature was kept at 20° C, food and water were given ad lib. The food contained 600 TDN, 18 % crude protein and 14 % crude fibre.

The number of animals and the average performance are given in Table 2.

Tab. 2: Number of animals and average performance

		number	$\hat{\mu}$	$\hat{\sigma}$
weight at 8 weeks	male	758	1766 g	308 g
	female	3290	1702 g	285 g
weight at 12 weeks	male	677	2770 g	316 g
	female	3064	2718 g	324 g
daily gain 8-12 weeks	male	666	38 g	5.9 g
	female	2979	39 g	6.4 g

For the data analysis the method of least squares and the Henderson Method III was used.

In the analysis of the data the size of the litter the animal was raised was treated as factor variable and in some analyses as regressor variable. Besides the size of the litter other factors were also taken into account as the following statistical model indicates:

$$y = \mu + \text{week of birth} + \text{sex} + \text{length of suckling period} + b_1 \text{ age} + b_2 \text{ age of the dam} + (\text{number weaned}) + e$$

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For all three traits more than 2400 observations could be used in the analysis.

Results about the statistical significance and about the estimated effects are given in Tab. 3 and Tab. 4.

Tab. 3: Summary of the significant factors on body weight gain

	weight at week 8	weight at week 12	daily gain
week of birth	xx	xx	xx
sex	xx	xx	
length of suckling period	xx	xx	x
age at weighing (week 8)	xx	xx	xx
lenght of the interval (week 8 -12)		xx	xx
age of the dam			

x - $p < 0.05$; xx - $p < 0.01$

Tab. 4: Estimated effects of littersize on the traits characterizing growth

		weight a week 8 (g)	weight at week 12 (g)	daily gai (g/Tag
Mean value		1715	2753	39.
Standarddeviation		182	250	5.
Difference male - female		82±11	71±16	-0.4±0.
effect of the number of animals weaned				
Difference between 6 and 7 animals		4.8	-14.5	-1.2
Difference between 7 and 8 animals		-7.9	-0.3	-0.0
Difference between 8 and 9 animals		25.1	21.2	-0.0
Difference between 9 and 10 animals		36.0	55.1	0.6
Difference between 10 and 11 animals		62.3	71.5	0.4
Standarderror of the Difference		11-25	15-34	0.32-0.7
Regression linear	b	-21.7±3.0	-22.0±4.1	0.08±0.0
Regr. linear + quad. + cub.	b_1	-264.24	-155.41	3.4
	b_2	32.49	22.25	-0.2
	b_3	-1.39	-1.12	0.00

By fitting a polynomial regression, one gets difference between the littersizes considered in Tab. 4 of 7.7, 10.0, 19.0, 34.7 and 57.1 g, i.e. that animals, which were raised in litters of 11 animals weaned, are on average 57 g lighter than animals coming from litters of 10 animals weaned.

If the various traits are regarded as traits of equal standing we can calculate phenotypic correlations.

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The following model was used:

y = week of birth + sex + length of suckling period
+ b_1 age + b_2 age of dam + e

Tab. 5: Phenotypic correlation between the growth traits (calculated from the residuals with 2164 df)

	weight at 8 weeks	weight at 12 weeks	daily gain	offspring weaned	offspri born
weight at 8 weeks	1.	0.84	0.19	-0.14	-0.1
weight at 12 weeks		1.	0.69	-0.10	-0.1
daily gain 8 - 12 weeks			1.	0.01	-0.0
offspring weaned				1.	0.4
offspring born					1.

Discussion

As can be seen from the correlation and from the regression the littersize (number of animal weaned) has an influence on both the weight at 8 weeks and the weight at 12 weeks. On the other hand the influence on the daily gain is very low. Similar results were obtained by Heckmann and Mehner (1970) and by Rouvier et al. (1973).

If we look at the crucial weight at an age of about 12 weeks then we observe that by increasing the littersize by one young the average weight is decreased by 22 g. With daily gains of nearly 40 g this points out that animals coming from litters of 11 young weaned need about 3 to 4 days longer than animals coming from litters of 7 in order to reach the same weight. From an economic point of view the larger litter may, however, still more than compensate the lower body weight.

The results have consequences for the selection work. If the selection is done without considering the littersize the animal was raised in, then there is no fair comparison, thus decreasing the efficiency of selection. In addition, since the littersize is strongly correlated with the number born alive, there is the danger that mainly animals from small litters are selected and used for breeding thus resulting in a correlated selection response for lower prolificacy.

Another aspect is of interest for the management. As can be inferred from the results of the weight at 12 weeks, the influence of littersize on weight is non-linear. Littersizes between 6 and 8 young weaned seemed to have only small effects whereas littersizes varying between 8 and 11 show much larger effects. This becomes clear if the relationship is estimated by a polynomial regression. Standardizing litters then not only leads to more equal weights of animals of the same age but also leads to higher weights altogether, since the average weight at a littersize of 8 to 9 animals is higher than the average of litters with 11 animals and 6 animals.

References

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Summary

For meat production in rabbits there are several traits of economic importance, like high prolificacy, large body weight gains and high feed efficiency. In practice there are some difficulties, since there seems to exist an antagonism between the size of the litter and the weight of the young at an age of 8 or 12 weeks. With records from a breeding scheme the question was investigated using data from a purebred strain of New Zealand White. For the latter the results must be interpreted cautiously since in practice not purebreds but crossbreds are usually used. The main results are: There is essentially no correlation between number of animals weaned and daily gain between 8 and 12 weeks, but there is a negative correlation between number weaned and weight at 8 or 12 weeks of age. Increasing the litter size by one reduces the average weight by more than 20 g, however, there is a significant curvilinear relationship, i.e. increasing litter size from 10 to 11 has a much more drastic effect than an increase from 6 to 7.