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# SELECTION FOR LITTER WEIGHT AT 56 DAYS WITH OVERLAPPING GENERATIONS IN A WHITE SYNTHETIC STRAIN OF RABBITS

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## I. INTRODUCTION

In Spain, rabbit farming is concentrated in the northeastern Autonomous Communities of Catalonia and Valencia. Catalonia stands out as the first rabbit meat producer in Spain with production, consumption and slaughtering numbers higher than 7000 tons of carcases (1983), and produces 40 % of the rabbit meat marketed in Spain. Farms of less than 20 cages, which often breed rabbits for home consumption and supplementary income, are not proportionally as numerous as in the rest of Spain (30 to 40 % of the animals are raised in such farms *vs* 50 to 60 % in the whole of the country), but small industrial farms (between 20 and 100 cages) have an important economic weight, especially in Catalonia where they amount to 43 % of the industrial production (*vs* 25 % in Spain) (all data provided by National Inquiry on Rabbit Farming, 1984).

Many times, these small rabbit farms have a low technical level and raise the animals in poor conditions. A way of increasing their economic viability can be found in genetic improvement, by the use of selected breeders which must have productive capabilities for growth, fertility, prolificacy, and be stress-resistant. However, animals coming from selection farms are often expensive and of dubious value, so that farmers are dissuaded from improving their flocks and prefer to do self-replacement. In 1980, the Agrarian Research Service (Servei d'Investigació Agraria) at Caldes de Montbui (Catalonia) designed an experiment with the following objectives :

1) to study the efficiency and the effects of selection for litter weight at 56 days, taken as a general criterion for meat production (in Spain, rabbits are slaughtered at 2 months of age).

2) to assess the practicability of a selection model with overlapping generations, a system that is supposed to optimizate particular management features, such as the occupation of the breeders' cages.

3) to provide the rabbit breeders with selected terminal sires.

The experiment have both theorical and practical interests : the theorical interest is to improve the knowledge about selection for a general purpose and selection with overlapping generations. The practical interest is to increase the genetic level of the Catalonian rabbit farms. Besides, if our selection method proves itself efficient and practicable, it could be applied in other selection farms.

The selection flock was made up of local New Zealand White rabbits, well known from a genetical point of view. If convincing results are obtained, the same experiment will be carried out with coloured "country" rabbits in order to prove the method with a new genetic pool. These animals are scattered in the smallest rabbit farms and have unknown productive capacities, but they may have a good ambiental resistance and, marketed as a "local" breed, they could be commercially interesting. Furthermore, this is a way of preserving a local phenotype, thus following ,a recommendation expressed during the Third World Rabbit Congress (Roma, 1984) (VALLS *et al.*, 1985).

## II. SELECTION EXPERIMENT

### 1. Population

From October 1980 to April 1981, we developed a first stock of 5 lines of 14 does and 2 bucks (New Zealand White) each, purchased from various Catalonian breeders. A 6th line of crossbred New Zealand x Californian entered the stock in 1981. The 6 lines were bred separately until May 1983, when they were crossed following a factorial mating plan in order to create a new genetically homogeneous stock, so achieved in November 1983.

### 2. Management

#### 2.1. *Management conditions*

The climate in Caldes de Montbui is mediterranean with a continental trend. The equipment is comparable to the one used in average rabbit farms. Light and air pressure are controlled. Rabbit manure is collected in deep pits. The breeders are housed individually in galvanized wire cages (females : 60x50x33 cm ; males : 70x40x33 cm) organized in flat-deck. Each cage has a feeder, an automatic dew-drop waterer and an attached subterranean nesting basket for the does' cages. Animals are fed with a commercial pelleted diet. Dried alfalfa is given once a week. The flock is managed with a fortnight rhythm, alternating a "reproductive" week (matings : Monday, Wednesday, Friday; palpations : Tuesday) and a "productive" week (weaning, controls).

### 2.2. *Breeding protocol*

The breeding flock is divided into 6 mating groups made up of 16 does and 5 bucks each. Each mating group occupies a row of cages in order to ease the management.

The does are first mated at 135-140 days of age and the bucks at 150-155 days. The post-partum lasts 10 to 11 days. A doe is mated with a buck from the same mating group and different for each mating. Pregnancy diagnostic is made 10-14 days after mating. The does are culled after the 5th parity. A buck is replaced by his own son as soon as this one is old enough to go into service. A female is allotted into a mating group different to her grand-parents groups. The mating group structure and the replacement methods should reduce the increase of the inbreeding rate during generations.

A maximum litter size of 10 kits per litter is allowed at parities 2nd or more (8 in first part) so as not to hamper the developement of rabbits from large litters. The surplus individuals are eliminated 2 days after birth.

At 4 weeks of age, the young rabbits are weaned, tatooed, individually weighed and housed at a constant number of 7, so that the group size effect on growth rate is reduced. The individuals are weighed again 28 days after weaning (*i.e.* 1 week before selling).

## 3. Selection process

In a first stage, does are selected after their weaning litter weight to produce future breeders. In a second stage individuals kept for breeding are chosen according to their own post-weaning growth.

### 3.1. *Does indexation*

Every fortnight, the litter weaning weight are recorded and corrected for the weaning age and then centered and reduced : $W = (Lw - \overline{Lw})/\sigma$

W = Standardized litter weight at weaning.
Lw = Litter weight at weaning.

$\overline{Lw}$ = Average of weights of litters weaned at the same day.

$\sigma$ = Standard deviation of weight of litters.

This standardization of litter weight enables comparisons between litters born at different periods.

The doe is indexed on her litter performance using the classical formula :

$$\hat{G} = \frac{n.h^2}{1+r(n-1)} .(\overline{Wi} - \overline{W})$$

G = estimate of breeding value at the nth litter.
n = no. of litters recorded.
$h^2$= heritability.
r = repeatability.

$\bar{w}_i$= average of the i standardized litters weights of the doe.

$\bar{\bar{w}}$ = average of the contemporaries $\bar{w}_i$.

The contemporaries are defined as the females indexed at the same time, less the first and second parity females.

The possible future bucks are chosen among litters of the 50% best indexed females, while the possible future does come from the 80% best females. Other progenies from these females can be kept for multiplication purpose. Females at 1st and 2nd parity or from the worst 20% are not allowed to give replacements.

A female with negative index is eliminated as soon as a replacement doe is available.

3.2. *Selection of future breeders*

The individual litter weights are recorded at weaning and 28 days later. The future breeders are selected according to their own post-weaning daily gain from does chosen at indexation. A 25% of females and a 15% of males from the fortnightly progenies must be kept so that the replacement needs are fulfilled. In order to avoid inbreeding, a maximum number of 2 males and 2 females from the same litter is allowed.

**4. Discussion**

4.1. *Selection criterion for a general objective*

From an economic point of view, the breeders' objective is to increase the total selling weight of offspring born per doe and per year.

$$TSW = \sum_{i=1}^{p} \left( \sum_{j=1}^{n_i} Iw_{ij} \right)$$

TSW= Total selling weight of rabbits per doe/year.
p = Number of litters born per doe/year.
$n_i$= Number of rabbits born in the ith litter.
$Iw_{ij}$= Individual weight of the jth rabbit from the ith litter.

For instance, ROCHAMBEAU *et al.* (1988) propose the following criterion :

$$C = \frac{1}{n}\left[\sum_{i=1}^{n} \frac{W_i}{T_i}\right] \times 365$$

C = Annual productivity of the doe calculated on her n litters.
n = Number of litters produced by the doe.
$W_i$= Weaning weight of the ith litter.
$T_i$= Time interval between the (i-1)th and ith parturition.

However, there is little knowledge about the efficiency of such a criterion if directly used as a selection trait, and we do not know whether the doe or her offspring have to be so characterized. Moreover, its heritability seems to be low : 0.05 to 0.15 for the litter weight at 77 days (GARCIA, 1982). For these reasons, we wrote the 56-day litter weight as follows :

$$SLW = WLW + \left[\sum_{i=1}^{n} ADG_i\right] \times T$$

SLW = 56-day litter weight.
WLW = Litter weight at weaning
n = Litter size at 56 days of age.
T = time interval between weaning and day 56.

$ADG_i$= Average Daily Gain between weaning and day 56 for the ith rabbit.

We divided the general objective into two components : the litter weight at weaning - considered as a female trait -, and the post-weaning growth - which characterizes the progeny itself.

We project to improve the selection method, first by taking into account the fertility rate of does and bucks (no particular emphasis was placed on this trait until now), and secondly by increasing the precision of the estimates of breeding values by getting more information from relatives (sisters, half-sisters and mother) and by using genetic parameters calculated in our population.

4.2. *Overlapping generations*

The system of overlapping generations has been less developed in intensive species (poultry, pigs, rabbits) than in the extensive ones, essentially because of the complexity of calculation. In rabbit farming, it enables a full occupation of cages that makes the management of a selection flock similar to the one of a production flock. Besides, It reduces the generation interval so that the annual genetic

gain should be increased. Its main drawbacks are 1) the lesser selection pressure, given that only a few animals are selected at a time, 2) the lack of theoretical knowledge about it, especially in a complex case as ours, and 3) the heaviness of a fortnigthly indexation procedure.

4.3. *Diffusion*

We started selling animals for multiplication in March 1986 to 4 multipliers whose role is to provide bucks to commercial farms (table 1). About 5500 improved stud bucks have so been produced until now. For the moment, these animals are mated for terminal crossing and should not be used otherwise. In the future, crossing schemas involving a "country" strain or a female line could be planned.

4.4. *Further developements*

The experiment has not yet been totally carried out and genetic results are still to determine. Though we can not assume the cause to be genetical more than simply zootecnical, plain results (table 2) indicate that our results (numeric productivity) are better than the average of controlled farm. Especially, the average number of weaned kits per litter is larger, even though we standardize the litter size after birth (cf. 2.2.).

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TABLE 1 - Numbers of animals sold for multiplication and estimates of stud bucks produced by multipliers.

| YEAR | 1986 | 1987 |
|---|---|---|
| Males from the selection flock | 45 | 60 |
| Females from the selection flock | 354 | 415 |
| Stud bucks from multipliers | 2500 | 3000 |

TABLE 2 - Numeric productivity in Caldes de Montbui and in other Catalonian rabbit farms.

| YEAR | 1984 | | 1985 | | 1986 | | 1987 |
|---|---|---|---|---|---|---|---|
| FARM (1) | others | Caldes | others | Caldes | others | Caldes | Caldes |
| Total number of males | 204 | 30 | 358 | 30 | 359 | 30 | 28 |
| Total number of females | 1740 | 74 | 2873 | 81 | 2721 | 88 | 82 |
| Total number of litters | 10595 | 569 | 18906 | 630 | 15493 | 660 | 672 |
| Tot.number of weaned lit. | 9653 | 536 | 17430 | 592 | 13324 | 597 | 618 |
| Aver.nbr total kits/litt. | 7.9 | 9.2 | 8.1 | 9.4 | 8.0 | 9.4 | 9.5 |
| Aver.nbr living kits/lit. | 7.4 | 8.7 | 7.6 | 8.7 | 7.5 | 8.4 | 8.9 |
| Aver.nbr weaned kits/lit. | 5.8 | 7.0 | 6.3 | 7.0 | 6.1 | 6.7 | 6.9 |

(1) the number of other farms was respectively of 21 and 24 in 1985 and 1986.In 1984, total numbers of males, females, litters and weaned litters were calculated from 10 farms while the average numbers of kits per litter (total, living and weaned) were calculated from 11 farms. No data were available for other farms in 1987 (Source : Performance Control Program - Programa de Control de Rendimientos)

TABLE 3 - Average litter weight at weaning (g.) in Caldes de Montbui

| YEAR | | 1985 | 1986 | 1987 |
|---|---|---|---|---|
| First parity | Number of litters | 167 | 193 | 165 |
| | Litter weight at weaning | 4475 | 5067 | 4783 |
| Parity > 1 | Number of litters | 377 | 437 | 506 |
| | Litter weight at weaning | 5324 | 6181 | 6055 |

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The meat productivity of small rabbit farms in Catalonia can be improved by using a multipurpose animal with capabilities for growth, fertility and prolificacy. In 1980, an experiment was designed to: (a) to study the efficiency and the effects of selection for litter weight at 56 days, taken as a general criterion for meat production, (b) to assess the practicability of a selection model with overlapping generations, a system that theoretically allows an optimization of particular management features, (c) to provide the rabbit breeders with terminal sires.

The selection flock was initially constituted from 6 local New zealand white lines. It comprises 96 does and 30 bucks. Every fortnight, the females are indexed at weaning on their litter weights (28 days). The future breeders are chosen among the progeny of the best indexed does on the basis of their own growth rate between weaning and day 56. The diffusion of genetic gain is made after a multiplication stage. In a near future, the experiment could be repeated with a synthetic coloured "country" strain.

# SELECCION PARA EL PESO TOTAL DE LA CAMADA A 56 DIAS CON GENERACIONES IMBRINCADAS EN UNA LINEA SINTETICA BLANCA DE CONEJOS.

La mejora de la produción en granjas pequeñas de conejos de carne en Cataluña puede realizarse mediante un animal de aptitud mixta frente al crecimiento, la fertilidad y la prolificidad. A tal efecto, en el año 1980 se diseñó una experiencia de selección a fin de: a) estudiar la eficacia y los efectos de la selección en el peso de la camada a los 56 días, considerado éste como el objetivo global para la produción de carne, b) evaluar las posibilidades de la selección en generaciones imbrincadas, modelo éste que teóricamente permite optimizar los diferentes aspectos de manejo, c) suministrar un macho terminal a los productores.

El lote de selección se constituyó a partir de 6 orígenes locales de raza neozelandesa blanca, y está formado por 96 hembras y 30 machos. Cada quincena, las hembras se indexan de acuerdo al peso de sus camadas al destete (28 días). Los futuros reproductores son elegidos por el crecimiento entre el destete y los 56 días entre la descendencia de las hembras mejor indexadas. El progreso genético se difunde tras una etapa de multiplicación. En un futuro próximo, la experiencia se repetirá con una línea sintética coloreada "país".