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Heritability and correlation of the zootechnical performance of the Algerian local rabbit

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Abstract

The improvement of rearing conditions of the local rabbit requires a characterization of zootechnical performances of breeding and growth as well as the knowledge of genetic parameters. The average weight for reproduction is 2.85 kg for females and 2.70 kg for males. The average weight at weaning is 579 g to 5 weeks, the average weight at slaughter is 1.70 kg to 13 weeks.
The study shows the heritability of relatively medium or low values:
- (0.09 to 0.22) for growth traits of the litter
- (0.17 to 0.28) for individual growth traits
- (0.04 To 0.09) for breeding traits
The correlations between breeding criteria such as the size of the litter and growth traits such as individual weights are negative (-0.20, -0.45). The correlation between the weight of the litter and individual weight at weaning and slaughter is negative (-0.30, -0.47). The correlations between weight at different ages and of ADG are all positive and very significant.

Keywords: Heritability, local rabbit, Growth, Breeding, Correlation.

Introduction

The local rabbit is of small size with average breeding performance whose coefficient of variation is high. This population is described as very heterogeneous ***(MeftiKorteby, 2012)***. Its numerical productivity is low due to high mortality in the nest. Between 10 and 11 weeks of age, which coincides with the normative age of slaughter abroad, the local rabbit has a low weight of 1.20 kg to 1.30 kg. This weight leads to very light carcasses not accepted by consumers. It is more than necessary to extend the rearing period to 13 weeks to provide heavier carcasses. This extension of the rearing period is not economically attractive due to the deterioration of zootechnical indices.

Between 1985 and 1988, Algeria opted for importing foreign selected strains of rabbits whose performance is much higher than the local's. These exotic animals are not adapted to local conditions and therefore brought about high mortality rates. According to ***Berchiche, 1992***, the ignorance of the animal to the environmental conditions specific to Algeria, is the cause of this problem.

All Algerian scientists decide to integrate the local rabbit in rational farms, due to its adaptation. Leaving the animal as it is while improving the environment alone is insufficient. Selection is the best way to populate the hutches with a performing animal which is also adapted to the environment.

Materials and Methods

The study was conducted at the Technical Institute of farms (ITELV Baba Ali Algiers). The data collected relate to seven consecutive years from 1998 to 2004. The rabbits belonging to the local population of Algeria. The total number of nullipara rabbits with an average age of 160 days installed in maternity is 1,120. The number of males aged on average of 170 days is 230. The total number of weaned rabbits is 7,264.

The hutch is 250m². Maternity is $120m^2$. It contains 90 hutches for females and 12 hutches for males, all flat deck. The fattening compartment is $72m^2$, consisting of 114 Californian collective cages.

The reproduction is natural, with a sex ratio of 1/5. The rate of reproduction is semi-intensive. Pregnancy diagnosis is performed by abdominal palpation at 14 days after mating. Weaning and identification of young rabbits are practiced at 35 days.

Breeding is enclosed with rotary mating in the family, as described by (***Chevalet and Matheron, 1976***).

The feed distributed is a mixed pellet, composed of dehydrated alfalfa (44%), bran of big sized granules (21%), barley (20%); soybean meal (8%), maize (4%) and a vitamin mineral supplement (3%).

Studied parameters

Heritability (h^2)
$h^2 = 2\, b_{xy} = 2\ (SP / sqx)$
$SP = \Sigma x.y - [(\Sigma x \Sigma y) / n]$
$Sq_x = \Sigma\ [X^2\ (\Sigma X)^2] / n$
X: Performance of the parents.
Y: Performance of the descendants.
n: number of animals

- Phenotypic correlations

$$r_{xy} = \frac{\sum xy - \frac{\sum x \cdot \sum y}{n}}{\sqrt{\left(\sum x^2 - \frac{(\sum x)^2}{n}\right)\left(\sum y^2 - \frac{(\sum y)^2}{n}\right)}}$$
.

x: first criterion
y: second criterion

Statistics

The mean, standard deviations, the minimum and maximum values, the correlations are calculated by the SPSS software (version 21). A test ANOVA one way, was used to compare between same class averages.

Results and Discussion

Under semi-controlled conditions, the local rabbit is of small size (***MeftiKorteby and al. 2010***). The average age of entry into reproduction is 163 days which has a large variation from 130 days to 210 days, with a high coefficient of variation of 21%. The frequency of rabbits that come into normative reproductive age is 40%, or 135 days.

The weight of does at first mating is 2.65 kg. Actual weight at mating corresponds to 80% of adult weight, proof that the local females reproduce at a late age, since the theoretical weight for reproduction is set at 75% of the adult body weight. For the same size, the weight of starting reproduction is 2.15 kg for the local breed in Morocco (***Barkok and Jaouzi 2002***). The elimination of the first litter as replacement animals may be considered in order to reduce the age gap and normalize weight when preparing for reproduction.

The average weight of the does at mating is 2.85 kg, with a coefficient of variation between 11% and 14%. These important changes may be due to genetic or individual heterogeneity in the age of entry into reproduction and different parity orders. The single band system and the natural reproduction mode do not allow the use of rabbits at an ideal and generalized age, which is 5 months.

The increase in weight between that of entry and that of reproduction is 10 and 11%. The local rabbit continues to grow throughout its period of reproduction and in proportion to the order of parity.

The weight of the doe at the time of giving birth is 2.80 kg. It decreases in accordance to the observation of ***Milistis*** and al. 1999 ***MeftiKorteby and al. 2010***. The decrease in weight between parturition and mating is 52 grams on average. Loss rates vary between 2% and 6%, but the frequent value to local rabbits is 3%. This weight reduction can have several causes. According ***Paregi Bini et al. 1990*** feed intake increased by 25% to 50% during the first three weeks of gestation; resulting in increased body fat stores. The situation is reversed at 21 days of gestation; the energy balance becomes progressively negative (***Milistis and al.1999***), facing increased gestation needs (***Forthun Lamothe and Lebas 1994***). This worsens the situation even more and also the decrease in food consumption during the last week of gestation (***Xiccato and al., 1999***), a phenomenon encountered practically by all breeding females in gestation, of different species. According to the same author, the female refuses to eat food on the day of giving birth, which could also explain the weight loss.

Table 1: Number of sire and dam families and progeny total per generation based on available records on different zootechnical criterions

N° Génération	Number of			Mean weight (g)				Litter size	
	Sires	Dams	Progeny	1 day	35 days	70 days	91 days	Born	Weaning
First	30	150	651	47.27±12.51	640±154	1.357±244	1.740±332	6.73±2.78	4.34±2.76
Second	32	160	584	46.66±12.06	585±117	1.358±271	1.757±331	7.15±2.34	4.65±2.08

During lactation, ingestion of the rabbit increases rapidly after birth (60% to 75%). It is well known that milk production results in very high energy expenditure compared to the energy value of the milk of the doe and the number of rabbits fed. Certainly this is particularly important if the size of the litter alive is big. According to ***Piles et al. 2005***, the increase in consumption is insufficient to cover maintenance requirements and milk production resulting in mobilization of body reserves. This situation can be worse if the diet is unbalanced and that the animal has very high needs.

These results are approved on the local population and conversely demonstrated when the dam loses its litter. In fact, it gains weight, metabolism of milk production is diverted to the deposition of body reserves. According to ***Forthun Lamothe, 2005***, the energy of reproduction is 80% from food and 20% from mobilization of body reserves, which increases the energy deficit when females are simultaneously pregnant and lactating. The quality of feeds can play an important role on subsequent reproductive performance of rabbits. We must think on the formulation of a more concentrated nutrient feed where rabbits can cover their needs by consuming a moderate amount of food.

The weight of the breeding buck is very heterogeneous; it varies between 2.06 kg and 3.02 kg, with a coefficient of variation between 10% and 18%. Age at start of reproduction and weight can be much more manageable than in females. The weight of the female does not change the number or weight of reproductive traits.

The size of the litter is 7.22 young rabbits / litter, which classes the local rabbit in the category of medium prolificacy. This criterion discretely changes from year to year; it ranges from 6.34 to 7.55. The heterogeneity within the same year is due to inter individual differences or differences of litter order.

Table 2: Study of correlations breeding criteria

Critères	TBL	DN	LSW	D. b-w	LBW	BW	WW
Liter size	+0.77**	+0.18**	+0.50**	+0.35**	+0.70*	-0.42**	-0.20**
Mean weight of a born	+0.25**	-0.45**	+0.13	-0.49**	-0.30**	-	+0.32**
Mean weight of weaned	-0.50**	-0.65**	-0.71**	-0.54**	-0.47**	+0.32**	-
Female Weight at mating	+0.04**	-0.15**	+0.09**	-0.15**	+0.06**	+0.11**	+0.19**

TBL: Total born live:LSW: liter size of weaning, LBW:litter born Weight, DN: Death number
D.b-w: death birth-weaning, BW: a born weight, WW: weaned weight.

- *Significativecorrélation *at P≤ 5%.*
- *Significativecorrélation * *at P≤ 1%.*

The average stillbirth rate is 15.55%; varying between 11.82% and 21.68% this parameter happens to be controlled by improving the individual weight of the young rabbits at birth and improving farming conditions, including winter temperature changes. It has been noticed that the young rabbits in the nest are sensitive to cold, which is one of the causes of nest mortality. However, growing animals are more tolerant of the cold than high temperatures.

The size of the litter of 6.77 is highly correlated with the size of the litter born and weaned litter size (r = 0.77** and r = 0.5**). The rabbits in the big sized litters are weaned the most despite being the most affected by mortality, hence the importance of choosing prolificacy at birth. Numerical productivity is 12.64 rabbits / mother hutch; it oscillates between 10-15 / years.

The weight of the litter born is 336.67g. The weight of weaned litter is between 2,258g to 2,453g by ***Berchiche and Kadi, 2002*** and 3298.5g by ***Mefti Korteby et al. 2014***. The average weight of an individual born is 49.40g and 46.63g. It seems light compared to other races. However, selecting the size of the litter results in increased litter weight (r = + 0.70 **), but a significant decrease in the weight of a rabbit born (r = -0.42 **) and a rabbit weaned (r = -0.2) (Table 3). This criterion is positively correlated to the size and weight of the litter, but negatively to mortality. The size of the litter weaned is 4.85. The individual weight at weaning is 578.58g. The correlations showed that increased weight at weaning is related to the decline in birth-weaning mortality (r = -0.54 **).

Table 3: Correlation between growth criteria

Critères	WL 5s	WL 10s	MDG	MDC	FCR
Weight Live 13 s	+0.72**	+0.55**	+0.50**	+0.44**	-0.24*
MDG	+0.31**	+0.27**	-	+0.40*	-0.11
FCR	-0.06	-0.05**	-	+0.06	-

WL: weight live, s: week, MDG: Mean daily gain, MDC: Mean daily consumption,
FRC: Feed conversion ratio:
*Significative corrélation * at P≤ 5%.*
*Significative corrélation * *at P≤ 1%.*

The individual weight at 10 weeks of age is 1.28 kg. The slaughter age of rabbits in Algeria is 13 weeks. It is delayed by three weeks from the standards. The extension of the rearing duration by three weeks deteriorates economic technical parameters.

The slaughter weight is 1.61 kg, it oscillates between 1.55 kg and 1.75 kg. The increase in weight between weaning and 10 weeks is 2.21 times and 2.78 times from weaning to slaughter.

Growth is best expressed by the average daily gain, at 6 weeks of age, weight gain is between 16.24 g/day and 24.74 g/ day with an average of 18.83 g/day. At 10 weeks, average daily gain is 27.51g/ day; it is between 23.69 g/day and 27.86g/day, the best gains are around this age period. At 13 weeks, the average daily gain is of 25.86 g / day, it varies between 18.68 g / day and 27.50 g / day.

Consumption indexes are most effective when the animal is young. At 10 weeks of age, the consumption index is 5.64, it is between 4.64 and 5.85. At 13 weeks of age, feed consumption is 7.16, between 7.04 and 7.87. This parameter is considered too high, requiring the selection of individuals with low consumption index.

Taking a choice on the live weight at weaning comes down to choosing a high weight at slaughter the correlation is of (r = + 0.72 **). Slaughter weight has a heritability of 0.10 (Table 4), considered low. The environmental effects are much more measurable compared to genetic effects.

Weaning weight has a heritability of 0.20 much less subject to the effects of the environment than slaughter weight. Individuals selected for high weaning weight causes an indirect selection with average progress on the average daily gain by correlative effect (r = + 0.44 **), but without any influence on the consumption index (r = -0, 11).

Table 4: Heritability for traits production.

Genetic characters	Heritability
Maternal Abilities	
Female weight at matting	0.20
BirthProlificacy	0.09
Live Number / liter size	0.05
Prolificacy to 35 days	0.04
Survival rate at 70 days	0.21
Survival rate at 91 days	0.19
Litter Growth	
Birth litter weight	0.21
Live weight litter	0.22
Total litter weight at 35 days	0.19
Total litter weight at 91 days	0.09
Individual growth performance	
weight at day 1	0.28
Individual weight to 35 days	0.22
Individual weight to 70 days	0.19
Individual Weight 91 Day	0.17
Mean daily gain from 42 to 91 days	0.26
Mean daily consumption from 35 to 91 days	0.22
Feed conversion ratio from 42 to 91 days	0.25

The choice on body weight at 13 weeks of age seems more effective than the choice of the average daily gain, the correlation (r = + 0.50 **), this weight is correlated with the average daily consumption is (r = + 0.44) (Table 2).

The size of the litter born has a heritability of 0.09 which confirms the values found by ***Rastogi et al. 2000*** h^2 = 0.09 to 0.12 and ***Rochambeau, 2001*** [0 to 0.15], lower than the value found by ***Blascoet al.1996*** and ***Ling-ru Chu and al. 2004***, of 0.29. The criterion of choice in maternal line is the prolificacy despite its low heritability.

The size of the weaned litter is strongly influenced by environmental conditions, it has a low heritability of 0.04, which supports the values found by ***Blasco.and al.1993***, ***Rostagi and al.2000***, ***Piles et and al.2005*** and ***Nofal and al. 2008***. The improvement of farming conditions in maternal nutrition, animal health can lead to an increase in this parameter.

Heritability of litter weight is 0.26 (***Argente et al 1999***), in our case, it is 0.21. Weaning weight and slaughter have in our conditions low heritability, 0.22 and 0.17, respectively, should theoretically be average values between 0.2 and 0.4.

These calculated genetic parameters are essential to effectively implement selection methods to estimate the genetic progress.

Conclusion

The local population is best suited to Algerian breeding conditions. Conducted in semi-intensive and semi rational, has low growth performance and average performance of reproduction. The main causes of mediocre performance are either genetic or effects of the environment, principally feeding which is one of the limiting factors of externalizing potential.

The coefficients of variation are high, from which emanates the idea of creating specialized lines (descendants) in the same population.

Selection is chosen as a method of improving genetics so as to achieve genetic progress. The prediction of direct or indirect genetic progress requires knowledge of heritability and correlation.

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