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Original article

Evaluation of the reproductive performance of eight rabbit breeds on experimental farms

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Abstract – The reproduction traits of 544 does from eight breeds were evaluated and compared to a control strain (INRA 9077) on three experimental farms, one of which used artificial insemination. The founders came from 110 French, Swiss and Italian breeders. These breeds were the following, in the order of decreasing body weight at amting: Argenté de Champagne, INRA 9077, Thuringer, Vienna White, Fauve de Bourgogne, Belgian Hare, Chinchilla, English and Himalayan. The overall reproductive performances of these eight breeds were lower than the control but differed markedly in the components of productivity. The three small-sized breeds had low prolificacy but good fertility and the survival rate between birth and weaning (within weaned litters) was as high as in the control. The Fauve de Bourgogne and Argenté de Champagne were the most productive among the medium-sized breeds. The least productive breeds were the Belgian Hare, in spite of its good prolificacy, because of the low survival rate of the young rabbits, and the Vienna White, because of poor fertility and the low rate of weaned litters. In spite of its poor fertility, the Thuringer had an intermediate productivity, due to good viability of the young rabbits. The recording of production data on the original farms would make it possible to better understand these results in order to improve them.

rabbit / reproduction / breed

Résumé – **Évaluation des performances de reproduction de 8 races de lapin en élevages expérimentaux.** Les performances de reproduction de 544 lapines de 8 races ont été évaluées en présence d'une souche témoin (INRA 9077) dans 3 élevages expérimentaux, dont un en insémination artificielle. Les fondateurs provenaient de 110 élevages, français, suisses et italiens. Par ordre décroissant de poids à la saillie, ces races sont : Argenté de Champagne, INRA 9077, Chamois de Thuringe, Blanc de Vienne, Fauve de Bourgogne, Lièvre Belge, Chinchilla, Papillon Anglais et Russe. Ces 8 races ont globalement des performances de reproduction inférieures au témoin, mais diffèrent sensiblement au niveau des composantes de la productivité. Les 3 races de petit format ont une faible prolificité mais une bonne fertilité et un taux de mortalité naissance-sevrage dans les portées sevrées équivalent au témoin. Le Fauve de Bourgogne et l'Argenté de

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Champagne sont les plus productives des races de format moyen. Les moins productives sont le Lièvre Belge, malgré sa bonne prolificité, à cause de la faible survie des lapereaux, et le Blanc de Vienne, du fait d'une fertilité médiocre et d'un faible taux de sevrage des portées. Malgré sa mauvaise fertilité, le Chamois de Thuringe a une productivité intermédiaire, grâce à la bonne viabilité des lapereaux. Un recueil de données zootechniques chez les éleveurs permettrait de mieux comprendre ces résultats en vue de les améliorer.

lapin / reproduction / race

1. INTRODUCTION

The French Federation of Rabbit Breeders (Fédération Française de Cuniculture) currently registers 56 rabbit breeds [8]. At the European level, national federations of rabbit breeders, members of the "European Association of Poultry, Pigeon and Rabbit Breeders", have undertaken the considerable task of describing and standardising the external characteristics of the rabbits of a number of European breeds [7]. Some of them have been created recently or are just used as pets, as in the case of the dwarf breeds, for instance. However, most of them constituted the livestock of meat rabbit breeders until the 1950's [1]. After that time, news strains, descending from a small number of breeds, were selected, generally on the basis of reproductive performance. They gradually supplanted these breeds to constitute the livestock of intensive rabbit farming. Some of these breeds were used to form strains of sires for terminal crossing (Fauve de Bourgogne, Flemish Giant, Argenté de Champagne, etc.). An interest in a wider range of these breeds has arisen over the last few years. Thanks to the breeders who have preserved these breeds, these animals still exist and are available. With the exception of some breeders, however, selection is focused on external appearance to meet the breed standard for the purpose of exhibitions. Their breeding practices have led them to attach no importance to reproductive performances of the does: to produce exhibition rabbits, they prefer litters with few big kits, planned at the beginning of the year. Therefore, these breeds run the risk of gradually loosing their zootechnical interest. Moreover, very little information is available concerning their zootechnical performances since on-farm recording has not been developed. This was the motivation behind the European RESGEN CT95-60 programme's inventory and characterisation of the European Rabbit genetic resources [2]. The zootechnical characteristics of eight breeds were evaluated on experimental farms within the framework of this programme, and were compared to a control strain. The present article deals with their reproductive performances.

2. MATERIALS AND METHODS

Eight rabbit breeds were chosen for their economic importance in France and in Europe and for their recognised or supposed zootechnical value. They comprised five medium-sized breeds: Argenté de Champagne (AC), Vienna White (VW), Thuringer (TH), Fauve de Bourgogne (FB), Belgian Hare (BH) and three small-sized breeds: Chinchilla (CH), English (EN) and Himalayan (HI). They were evaluated on three experimental farms: at the INRA centre in Toulouse, France (T: all eight breeds), at the CEZ (Centre d'Enseignement Zootechnique) in Rambouillet, France (R: CH and HI breeds) and at the "Facultad de Veterinaria" in Zaragoza, Spain (Z: AC and FB breeds). The recorded animals descended from a representative sample of males and females, bought from a total of 110 farms in France, Switzerland and Italy (Tab. I).

On each experimental farm, the rabbit does were compared to does from a control

Table I. Characteristics of the founder animals.

Breed	Acronym	Country[1]	Founders[2]	Breeders	Sires[3]	Dams[3]
Control	C77	F	25	1	18	24
English	EN	F, CH	38	13	23	35
Himalayan	HI	F, CH	28	11	13	13
Chinchilla	CH	F, CH	33	12	9	12
Fauve de Bourgogne	FB	F, I	60	25	41	42
Thuringer	TH	F, I, CH	51	15	20	22
Vienna White	VW	F, CH	33	14	18	19
Belgian Hare	BH	F, I	29	11	17	21
Argenté de Champagne	AC	F, CH	29	9	12	16

[1] F: France, CH: Switzerland, I: Italy; [2] number of purchased animals used to produce offspring to be evaluated; [3] number of parents of the founder animals.

strain, the INRA 9077 strain (called here C77), descending from the New-Zealand White breed and maintained without selection for 30 generations. They were housed in standard wire cages (with a plastic grating in T and Z). They were bred at the age of about 18 weeks and fed a commercial diet ad libitum. Young rabbits were weaned at the age of 35 days. In T, the does were artificially inseminated with fresh semen from the bucks of the same breed, with a cycled production system, at a three-week interval between successive batches. In R, the does were mated to bucks from the same breed, 10 to 12 days after kindling. In Z, they were mated at weaning, to bucks from their breed (except C77 does, mated to AC or FB bucks). The does were weighed at mating or at insemination and palpated 10 to 12 days later for gestation diagnosis. The traits recorded were the following: the number of rabbits born, dead or alive, the total weight of those born alive (except in Z), the number of rabbits weaned and the total litter weight at weaning.

The traits analysed are given in Table II. A variance analysis was performed (GLM procedure of SAS) including the fixed effects of the breed, farm, year-quarter within farm, and mating number (for fertility traits) or litter number (for litter traits) with five levels (1, 2, 3, 4, 5 or more). No interaction effect was included in the model since a preliminary analysis did not reveal significant interactions between the fixed effects.

3. RESULTS (Tab. II)

The farm, mating number (or litter number) and year-quarter significantly influenced nearly all of the variables. Regardless of the data considered, whether it was the whole data set or only C77 data, common to all farms, differences between farms in relation to fertility and prolificacy were revealed, with lower values on the T farm.

3.1. Doe weight

Our results were in general agreement with the classification of the breeds into medium and small body-sized breeds. Two exceptions were the Belgian Hare, found to be relatively light, and the Chinchilla, relatively heavy, due to its Swiss origin where this breed is known to be heavier than in France.

3.2. Fertility

For both the positive palpation rate and the kindling rate, the small body-sized

Table II. Fertility and prolificacy of the does, weight and growth rate of their litter until weaning Record number (italics) and least-square means.

	σ_E	C77	AC	BH	CH	EN	FB	HI	TH	VW
Does mated or inseminated		*149*	*67*	*33*	*97*	*74*	*78*	*117*	*21*	*57*
Does having littered		*126*	*43*	*25*	*59*	*65*	*59*	*88*	*12*	*36*
Mating or AI		*661*	*257*	*184*	*385*	*381*	*352*	*443*	*104*	*346*
Doe weight at mating (g)	444	4240^{b}	4554^{a}	3453^{f}	3645^{e}	2946^{g}	4048^{d}	2900^{g}	4223^{bc}	4143^{c}
Fertility at palpation (%)	45.7	71.9^{a}	57.3^{b}	57.5^{b}	63.3^{b}	74.3^{a}	64.0^{b}	70.7^{a}	37.5^{c}	46.2^{c}
Kidding rate (%)	45.8	68.5^{a}	50.0^{b}	52.4^{b}	56.2^{b}	68.5^{a}	53.7^{b}	63.5^{a}	35.3^{c}	42.7^{c}
Litters born		*434*	*96*	*67*	*191*	*205*	*152*	*256*	*21*	*89*
Total born per litter	2.59	8.29^{a}	6.58^{bc}	7.20^{b}	5.73^{d}	6.07^{cd}	6.44^{c}	5.51^{d}	6.84^{b}	7.01^{b}
Born alive per litter	3.00	7.27^{a}	5.16^{bcd}	5.44^{bc}	4.96^{c}	4.85^{cd}	5.17^{bc}	4.39^{d}	5.91^{bc}	6.00^{b}
Stillborn per litter	1.66	1.02^{ab}	1.42^{bc}	1.75^{c}	0.78^{a}	1.22^{b}	1.27^{b}	1.12^{b}	0.93^{ab}	1.01^{ab}
Total litter weight at birth (g)	169	610^{a}	512^{b}	497^{b}	429^{c}	369^{d}	434^{c}	357^{d}	495^{bc}	461^{bc}
Av. rabbit weight at birth (g)	15	83^{a}	82^{a}	85^{a}	80^{a}	69^{b}	71^{b}	73^{b}	83^{a}	74^{b}
Litters weaned		*367*	*64*	*37*	*141*	*113*	*95*	*176*	*16*	*46*
% litters weaned[1]	38.2	86.3^{a}	87.0^{ab}	63.0^{c}	74.6^{bc}	63.3^{c}	78.6^{ab}	76.7^{b}	90.5^{ab}	61.0^{c}
Rabbits weaned per litter	2.14	6.81^{a}	4.77^{bc}	3.98^{c}	4.63^{c}	4.59^{c}	5.30^{b}	4.62^{c}	5.13^{bc}	5.12^{bc}
Litter weight at weaning (g)	1632	5824^{a}	4402^{b}	3399^{d}	3508^{cd}	2960^{d}	3807^{bc}	3209^{d}	4727^{b}	3777^{cd}
Individual weight at weaning (g)	171	876^{b}	975^{a}	874^{b}	757^{c}	669^{d}	763^{c}	712^{d}	893^{ab}	753^{c}
Growth from birth to weaning ($g \cdot day^{-1}$)	7.9	22.9^{b}	26.2^{a}	22.6^{bc}	18.9^{d}	17.0^{d}	20.6^{bcd}	17.5^{d}	22.5^{abd}	19.8^{cd}
Young mortality from birth to weaning (%)[2]	33.1	9.5^{a}	23.1^{b}	38.5^{c}	19.1^{b}	17.2^{ab}	18.2^{ab}	10.1^{a}	24.0^{bc}	24.4^{bc}

[1] Calculated on the set of litters with at least one rabbit born alive (1317 litters); [2] calculated on the set of litters with at least one rabbit at weaning (1055 litters); within a line, means with different subscripts are significantly different ($P < 0.05$); σ_E: residual standard deviation of the trait.

breeds EN and HI were not different from the control, while the others had a significantly lower fertility rate, particularly the Thuringer (–33 points) and the Vienna White (–26 points).

3.3. Litter size

In all the breeds studied, the litter size at birth was significantly lower than in the control, by –1 to –2.8 rabbits per litter. The least prolific breeds were the small-sized breeds (–2.2 total born for EN and –2.8 for HI) and Chinchilla (–2.6), while the medium-sized breeds were quite close to each other and displayed intermediate values. The LB (–1.1), VW (–1.3) and TH (–1.4) were the closest to the control, the AC (–1.7) and FB (–1.9) differed the most. The ranking of the breeds was about the same for the number of kits born alive. The number of stillborn, however, was particularly high for the BH (+0.75) and the AC (+0.40). In all breeds except the Himalayan, the mortality rate between birth and weaning was higher than in the control strain, by

+7 to +15 points, particularly in the BH (+29 points). The percentage of litters weaned was also lower than in the control, estimated at 84.5%. It was dramatically low in the VW, BH and EN breeds. Due to the reasons mentioned above, the gap with the control increased when considering the number of kits at weaning, ranging from –1.5 for the FB to –2.8 for the BH.

3.4. Rabbit weight

The average rabbit weight at birth was quite similar to the control for the AC, BH, CH and TH breeds, and significantly lower in the small body-sized breeds (EN: –14 g and HI: –10 g) as well as in FB (–11 g) and VW (–8 g). At weaning, the AC rabbits were significantly heavier than the control ones (+96 g) due to a higher growth rate (+3.3 $g \cdot d^{-1}$); the TH rabbits weighed the same as the control ones and all the others were significantly lighter. Only the small breeds and the VW breed showed a growth rate lower than the control.

4. DISCUSSION

As far as we know, this type of comparative evaluation of reproductive performances of several breeds, at several locations and in comparison to a common control, is the first one in the history of rabbit breed evaluation. Most previous works have been devoted to selected strains or crossbreeding (see Rochambeau [15] for a review), and comparative studies of European native breeds are badly lacking. Zootechnical evaluations so far have only dealt with a few breeds treated separately [5, 9–11, 13, 14] and some crossbred products of these breeds have been compared [12].

Generally speaking, the reproductive performances of the breeds studied were lower than those of the control strain, the INRA9077 strain, which had been an unselected strain for 30 generations. Preliminary analysis had shown that there were no significant interactions between breeds and farms: although the average performances varied between experimental farms, the difference with the control strain was observed on all of the farms and the ranking of the breeds was not modified. The least square means for the control strain are in good agreement with those previously observed by Brun [3] (called A in his paper). For all these reasons, we can consider that the results are representative of the potential of the breeds.

The more extensive the production conditions were, the better the performances: the extensive Z farm performed the best. The intensive T farm, with artificial insemination, had the worst performance. The poorer than usual performances of the T farm may also have resulted from sanitary problems, due to the gathering in one place of animals from many breeds and herds.

Obviously, these breeds are not usually bred in wire cages with a semi-intensive reproduction rhythm. Most often, they are housed in wooden or cement cages, usually in open-air hutches, and follow an extensive reproduction rhythm. The high proportion of litters that entirely disappeared before weaning may be indicative of the non-adaptation of these breeds to wire cages together with a semi-intensive reproduction rhythm.

Aside from this general observation, this study revealed specific features of some breeds. The small body-sized breeds exhibited a high fertility level, similar to that of the control strain, as already shown by Hulot and Matheron [9] for the Himalayan breed. Mortality rates of the young rabbits within the weaned litters were as low as in the control. However, their prolificacy was low, in agreement with the observations of Brun and Rouvier [4] on the Himalayan breed. The medium-sized breeds displayed different patterns from each other, depending on the trait considered. In the Belgian Hare, litter size at birth was close to that of the control but the mortality of the young at birth and during the suckling period, was very high. The Vienna White and Thuringer

showed the lowest fertility rate. The Vienna White also showed a low proportion of litters weaned while the Thuringer showed a fairly high viability of the young. Finally, Fauve de Bourgogne and Argenté de Champagne were the most productive among the medium-sized breeds. Argenté de Champagne is the only breed in which the individual rabbit weight was higher than the control, either at weaning (+100 g) or at an adult stage. This breed displayed a high growth rate of the young rabbits during suckling, in agreement with the results of Chevallier et al. [5]. Conversely, the rabbit weight of the Fauve de Bourgogne, Thuringer and Vienna White was significantly lower than that of the control.

These results from reproductive performances led to several questions. What is the relative contribution of breeding conditions and genetic potential of the breed in the determination of the results? Does selection for conformity to a breed standard, without considering reproductive performances, account for these low reproductive performances, particularly for medium sized-breeds? Are some breeds not endangered due to their low fertility level, namely the Vienna White and Thuringer breeds?

5. CONCLUSION

These results will be used to complete a database, created within the framework of the RESGEN programme. Its objective was to record not only the external features of the breeds, but also their genetic and zootechnical characteristics ([6], www.brg.prd.fr, www.tiho-hannover.de/einricht/zucht/eaap/index.htm). These reproduction results have to be put together with those concerning growth until slaughter and carcass traits [2]. The latter show interesting implications for meat production, which justify the utilisation of some of these breeds in the formation of specialised sire breeds. But it is necessary to know more about the relative contribution of breeding conditions and breed genetic potential in the determination of the overall poor reproductive performance obtained under our conditions. A first step would be to verify the results under the usual breeding conditions, by setting up a simple performance recording system at the original farms. Based on these data, breeder organisations could then decide whether a genetic programme is necessary to correct the main defects. We feel that this is an important condition to ensure the preservation of these original genetic resources and their valorisation within innovative production systems.

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