PRODUCTIVITY AND BODY COMPOSITION OF RABBIT DOES SUBJECTED TO THREE BREEDING SYSTEMS

Theau-Clément M.[1]*, Weissman D.[2], Davoust C.[2], Galliot P.[3], Souchet C.[3], Bignon L.[3], Fortun-Lamothe L

[1]INRA, UR631 SAGA, F-31326 Castanet-Tolosan, France
[2]INZO, Rue de l'Eglise, BP 50019, 02407 Chierry Cedex, France
[3]ITAVI, 28, rue du Rocher 75008, Paris, France
[1]INRA, UMR1289 TANDEM, F-31326 Castanet-Tolosan, France
* Corresponding author: Michele.Theau-Clement@toulouse.inra.fr

ABSTRACT

The aim of this study was to compare 3 rabbit breeding systems on the performance of 332 females and offspring during 4 consecutive cycles. An intensive system (group 35; reproduction rhythm: RR=35 days, first insemination AI_1= 20.6 weeks, weaning age: WA=32 days) was compared to a semi-intensive system (group 42; RR=42 days, AI_1=19.6 weeks, WA=35 days), and an extensive one (group 49; RR=49 days, AI_1=16.6 weeks, WA=30 days). The productivity measured at 28 days (3.5, 4.2 and 4.6 kg/AI, respectively for groups 35, 42 and 49), at 63 days *post partum* (30, 38 and 42 kg/female for 4 cycles), and the total body energy were significantly increased (45.4, 46.8 and 49.5MJ, for groups 35, 42 and 49, respectively) when the reproductive rhythm decreased (P<0.001). Before and after weaning, kit mortality decreased when the reproduction rhythm decreased (11.4, 7.3, and 1.9 % and 18.3, 15.3 and 10.6 %, for groups 35, 42 and 49, respectively, P<0.05). The yearly productivity by doe was 79, 83, and 78 kg, respectively. But only an analysis of economical, environmental and social performance will allow comparing the sustainability of these 3 production systems.

Key words: Rabbit, Breeding system, Productivity, Body composition, Growth.

INTRODUCTION

In rabbit farms, a cycled production schedule leads to better potential management and planning of all the tasks of farming, supply channels and removal (animals and inputs) that are programmed in advance. Females are usually inseminated for the first time at the age of 19.6 weeks and then every 42 days (42 day reproduction rythm). In order to improve the sustainability of rabbit breeding, a reflection is underway on the design of alternative breeding systems including the current constraints: a single batch, crawl space of at least 3 days and renewal of reproductive does by adoption of 1 day old females.
The objective of this study was to compare three breeding systems on rabbit does productivity and body composition, and kit growth, recorded over on four successive reproductive cycles.

MATERIALS AND METHODS

Animals and experimental design

The experiment was performed at the ITAVI experimental farm (Rambouillet, France) using 332 Hyplus rabbit does (Hypharm, Roussay, France). Females were randomly allocated in 3 independent rooms according to their weight at 13 weeks and subjected to one of the three systems described in Table 1.

Table 1: Characteristics of the 3 breeding systems

Breeding system	Reproduction rhythm (days)	Age at 1st insemination (weeks)	Age at weaning (days)	Slaughter age (days)
35	35	20,6	32	63
42	42	19,6	35	70
49	49	16,6	30	70

Does were placed under a constant 8 h light/day (between 8 a.m. and 16 p.m.), except for 7 days before each artificial insemination (AI), when a light stimulation was applied (sudden change from 8hL:16hD to

16hL:8hD, light extinction at 24h). The return to the initial illumination (8h) occurred gradually over 4 days from the day of AI). Females were fed *ad libitum,* except young females and unfertilized ones which were fed 150-160 g/d and fed *ad libitum* for 6 d before AI. No biostimulation, or hormonal treatment were used to induce sexual receptivity.

Inseminations were performed using heterospermic pools from bucks from a commercial breed (PS40, Hypharm). Litters were standardized to 8 kits for nulliparous, 9 for primiparous and 10 for multiparous, after removing non-viable (low weight) or surplus kits. Fostering was performed within room and natural (free) nursing was allowed. Does and kits were fed commercial diets during the whole experiment. After insemination, does of groups 42 and 49 were fed a diet that meet nutritional requirements of pregnant does (Lapety «maternité», Inzo, DE : 2.500 kcal/kg, CP: 16.5%). During pregnancy and before d 25 of lactation, does of group 35 were fed a diet for lactating (Lapety «lactation», Inzo, DE: 2.600 kcal/kg, CP: 17.2%). All the does from d 25 of lactation to weaning and all the kits from d 25 to d 49 of age were fed a lower energy diet ("Stabiconfort"; Sanders, DE: 2.300kcal/kg, CP: 15.2%). The Stabiwhite (Sanders, DE: 2.445 kcal/kg, CP: 15.5%) was given to all the kits from d 49 to slaughter. Kits were feed restricted only when digestive problems occurred. Does were culled only for sanitary reasons. A sample of females was used to measure body composition at the 1st (n=63) and the 4th AI (n=73, only fertile females at each previous cycle), using the method of Nicodemus *et al.* (2009).

Registered parameters and statistical analysis

The weight of does at AI, fertility (kindling rate, considered as Bernoulli variable: range 0-1), litter size at birth (total born, born alive, still born), and after fostering at d 21 and d 28, at weaning, the average weight of kits and productivity (weight of kits/AI, kg) at d 28 and at weaning and doe body composition (total energy, MJ/animal) were measured. An analysis of variance was conducted taking into account the fixed effect of the breeding system (3 levels: 35, 42 and 49 d), the parity at the moment of insemination (3 levels: nulliparous, primiparous, and multiparous of the 3th and 4th cycle) and the interaction. As kits were not identified at weaning, the individual weight at d 63 was analysed using the single effect of the breeding system. The mortality of reproductive does were analysed using a Chi square test.

RESULTS AND DISCUSSION

Does mortality. For groups 35, 42 and 49 respectively, 94, 108 and 90 does were introduced in each room at the 1st AI. Just before the 4th AI 10, 15 and 15 were added to replace those that died or were culled. After the 4th AI, mortality did not significantly differ according to breeding system (19.2, 20.3 and 20.0 % for groups 35, 42 and 49, respectively). Tables 2 and 3 give the results of variance analysis (least-square means).

Weight and body composition of does. The weight of does at insemination was significantly lower for group 35 (4159 *vs*. 4304 and 4261g for groups 42 and 49, respectively, Table 2). In general, the weight of does increased with parity. An interaction between the breeding system and parity was observed. The weights of nulliparous does, were significantly lighter in group 49 (subclass means of 3489 *vs.* 3709 and 3698 g respectively in groups 35 and 42, P<0.001). On the other hand, the mean weights at AI were lower for primiparous and multiparous does in group 35 (4307 *vs.* 4516 and 4514g and 4461, 4698 and 4782g respectively in groups 42 and 49). At the 4th AI, the total energy of doe's bodies was the lowest in group 35 compared to the 2 other groups (Figure 1b). This could likely be the consequence of an energy deficit associated with intensive reproductive rhythm (Fortun-Lamothe, 2003).

Reproductive performance. The average fertility was 74.2 %. For the 4 reproductive cycles, the fertility was lowest in group 35 compared to the two other groups (65.9 *vs*. 76.6 and 80.0 %, respectively). This result is in agreement with the results of Theau-Clément *et al.* (1990), Blocher and Franchet (1990) and Theau-Clément *et al.* (2000). Figure 1a highlights the interaction breeding system*parity; for multiparous does, the kindling rate significantly decreased for group 35 throughout the experiment (48.2 *vs*. 78.2 and 90.1 % for groups 42 and 49), which could be linked to their lower body condition.

Table 2: Influence of breeding system and parity of does on their reproductive performance.

	Number	AI weight (g)	Fertility (%)	Total born	Born alive	Still born	Litter size at 28d	Litter size at weaning	Total energy (MJ)
Average	*1065*	4189	74.2	10.6	10.0	0.6	8.3	8.1	47.98
R^2		0.624	0.05	0.166	0.142	0.018	0.558	0.533	0.763
Breeeding system		P<0.001	P<0.001	P=0.016	P=0.014	NS	P<0.001	P<0.001	P<0.001
35	*338*	4159^{a}	65.9^{a}	10.3^{a}	9.7^{a}	0.7	8.1^{a}	7.8^{a}	45.4^{a}
42	*401*	4304^{b}	76.6^{b}	10.9^{b}	10.3^{b}	0.7	8.4^{b}	8.1^{b}	46.8^{ab}
49	*326*	4261^{b}	80.0^{b}	11.1^{b}	10.5^{b}	0.7	8.9^{c}	8.8^{c}	49.5^{b}
Parity		P<0.001	NS	P<0.001	P<0.001	P=0.002	P<0.001	P<0.001	P<0.001
Nulliparous	*416*	3632^{a}	77.78	8.9^{a}	8.5^{a}	0.4^{a}	6.9^{a}	6.4^{a}	34.77^{a}
Primiparous	*327*	4446^{b}	72.58	11.4^{b}	11.0^{b}	0.6^{a}	8.7^{b}	8.5^{b}	-
Multiparous	*322*	4646^{c}	72.16	11.9^{c}	11.0^{b}	1.0^{b}	9.8^{c}	9.8^{c}	59.72^{b}
Breed. syst.*parity		P<0.001	P<0.001	NS	NS	NS	P<0.001	P<0.001	P<0.001

NS: P>0.05. Within columns, means with different letters are significantly different P<0.05.

At birth, litter size was lower in group 35 (9.7 *vs*.10.3 and 10.5 born alive for groups 42 and 49, respectively). The total born number increased with parity and consequently with doe's age. At birth (after standardization), at d 28 and at weaning (age varying with the breeding system), the number of kits was the highest in group 49 (8.9 and 8.8) and the lowest in group 35 (8.1 and 7.8), but the litter size increased as parity increased. Figure 1c highlights that litter size strongly depended on parity; nulliparous does in group 49 had the highest litter size at d 28 and at weaning, whereas nulliparous does in group 35 had the lowest litter size. This result is interesting because does from group 49 had been inseminated at the most precocious at the age of 16.6 weeks

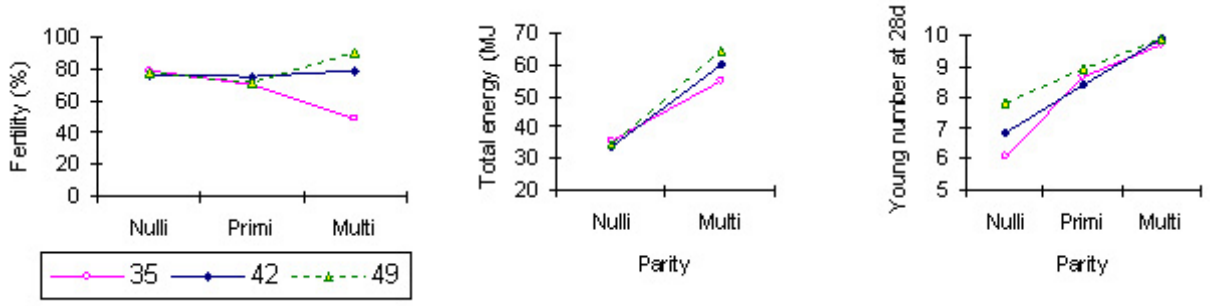

Figure 1: Fertility (1a), total energy (1b) and number of kits at d 28 (1c) according to breeding system and parity.

Kits growth. At birth, the average weight of kits did not vary according to breeding system (Table 3). The average weight of kits at d 21 and d 28 was highest in group 35 (417 *vs.* 398 *vs.* 407 g and 682 *vs.* 649 and 657 g respectively, in groups 35, 42 and 49). This result can best be explained by the more energetic diet given in group 35 to meet the high nutritional needs associated with the intensive reproduction rhythm.

At weaning, due to their older age (35 d), kits of group 42 were heavier than those of groups 35 and 49 (911 *vs.* 856 *vs.* 766g, respectively). The individual weight at d 63 decreased with the extensification of the reproductive rhythm (2284 *vs.* 2201 *vs.* 2182 g respectively for groups 35, 42 and 49). In general, during the pre-weaning period, growth rate of kits produced by nulliparous was slower than kits from older does. Nevertheless, an interaction was particularly noted at d 28, between breeding system and parity, which was more evident in primiparous and multiparous groups. The average weight of suckling rabbits was higher for group 35 (756 *vs.* 693 *vs.* 679g and 724 *vs.* 661 and 669 g, respectively, for groups 42 and 49), probably with a reflection of the energy content of the diet (Figure 2a). At the time of sale, the weight of rabbits was 2.32, 2.46 and 2.42 kg/AI, respectively, for groups 35, 42 and 49 at an age of 63 days for group 35 and 70 days for groups 42 and 49.

Table 3: Influence of breeding system and parity of does on rabbits growth and their productivity.

		Average weight					Productivity	
	Number	birth (g)	21 d (g)	28 d (g)	weaning [(1)] (g)	Individual weight at 63 d (g)	28 d (kg/AI)	Weaning (kg/AI)
Average	*1065*	63.8	403	654	841	2214	3.98	4938
R^2		0.026	0.297	0.362	0.402	0.018	0.12	0.132
Breeeding system		NS	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001	P<0.001
35	*338*	64.4	417^{a}	682^{a}	856^{a}	2284^{a}	3.47^{a}	4170^{a}
42	*401*	63.5	398^{b}	649^{b}	911^{b}	2201^{b}	4.16^{b}	5592^{b}
49	*326*	63.5	407^{c}	657^{b}	766^{c}	2182^{c}	4.64^{c}	5384^{b}
Parity		P=0.007	P<0.001	P<0.001	P<0.001	-	P<0.001	P<0,001
Nulliparous	*416*	63.5^{a}	369^{a}	595^{a}	780^{a}	-	3.09^{a}	3689^{a}
Primiparous	*327*	62.4^{a}	429^{b}	710^{b}	888^{b}	-	4.38^{b}	5419^{b}
Multiparous	*322*	65.4^{b}	424^{b}	684^{c}	865^{c}	-	4.80^{c}	6038^{c}
Breed. syst.*parity		NS	P=0.003	P<0.001	P<0.001		P<0.001	P<0.001

NS: P>0.05. Within columns, means with different letters are significantly different P<0.05.
[(1)] Kits were weaned at 32, 35 or 30 day *post partum*, respectively for groups 35, 42 and 49.

Kits mortality before and after weaning decreased as the extensification of the reproduction rhythm increased (11.4, 7.3, and 1.9 % and 18.3, 15.3 and 10.6 %, for groups 35, 42 and 49, respectively, P<0.05).

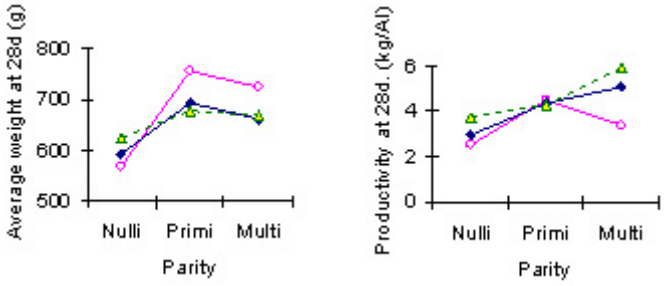

Figure 2. At d28, average weight (2a) and productivity (2b) according to breeding system and parity.

Productivity. The productivity at d 28 was the highest for group 49 (4.64 kg/AI) and the lowest for group 35 (3.47 kg/IA). This result was mainly due to the performance of nulliparous does which was significantly higher in group 49 (3.72 *vs*. 2.56 and 3.00 kg for groups 35 and 42; Fig. 2b) despite the early age of their 1st AI, than those of multiparous does being significantly higher for group 49 and lower for group 35 (5.93 *vs*.3.37 *vs*. 5.10 kg/AI). It is interesting to note the less variable and positive progression of productivity of does in group 49 during the beginning of their production cycle. At weaning, due to a variation in age, the ranking of groups was modified compared to productivity at d 28. Nevertheless at d 63, overall productivity for the 4 successive cycles was 30, 38 and 42 kg/female over 140, 168 and 196 d. Extrapolated to one full year, and assuming similar results, productivity per female at 63 days was 79, 83 and 78 kg of rabbits, respectively, for groups 35, 42 and 49. Regardless of fluctuations related to parity or age of does, under our experimental conditions, productivity per insemination increased with the more extensive reproductive rhythm. This result agrees with Theau Clément *et al.* (2000), and Castellini *et al.* (2010) and may be the consequence of a reduction in the duration of concurrent lactation and pregnancy that corresponded to a reduction in the energy deficit.

CONCLUSION

This study aimed at comparing 3 breeding systems on reproductive performance and kit growth, over 4 successive parities. Under our experimental conditions, an early 1st insemination (16.6 weeks) associated with an extensive rhythm (49 days) resulted in a higher productivity at d 28 and d 63 than the other systems. An intensive rhythm (35 days) combined with a 1st AI at 20.6 weeks led to a productivity at

d 28 and d 63 that was significantly lower than those of a semi-intensive rhythm. Consequently, the productivity by reproductive cycle increases with the extensification of breeding systems. Nevertheless, only a thorough economical, environmental and social analysis will reveal the comparative sustainability of these breeding systems.

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