# EFFECTS OF A MODULATION OF THREE RABBIT BREEDING SYSTEMS ON REPRODUCTIVE PERFORMANCE AND KIT GROWTH

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## ABSTRACT

The aim of this study was to test on 292 rabbit does during 2 reproductive cycles (5th and 6th insemination), the consequences of a modulation of breeding practices. Three rabbit breeding systems were defined (35, 42 and 49) varying in reproductive rhythm (35, 42 or 49 days, respectively), age at weaning (32, 35 or 30 days, respectively) and age at slaughter (63, 70 or 70 days, respectively). Females were allocated to four groups in which the system changed (from the 1st to the 4th AI=initial system) to another (from the 5th to the 6th AI=modulation), before returning to the initial system (7th AI). Does of group 35-42-35 were inseminated from $AI_1$ to $AI_4$ every 35 days and for 2 following cycles every 42 days, before returning to a 35 system before the 7th AI. Does of group 42-35-42 were inseminated from $AI_1$ to $AI_4$ every 42 days and for the 2 following cycles every 35 days, before returning to a 42 system before the 7th AI. Does of group 42-49-42 were inseminated from $AI_1$ to $AI_4$ every 42 days and for the 2 following cycles every 49 days, before returning to a 42 system before the 7th AI. Does of group 49-42-49 were inseminated from $AI_1$ to $AI_4$ every 49 days and for the 2 following cycles every 42 days, before returning to a 49 system before the 7th AI. Because of poor reproductive performance in the 35 system (despite a high growth of kits before weaning due to a more energetic diet of does), a sudden change from a 35 system to a 42 one significantly increased productivity at 63 days from 4.23 to 6.92 kg/AI. Conversely, the 42 system was not very sensitive to an intensification (group 42-35-42) or an extensification (42-49-42) of one week. Similarly, an intensification of one week of the 49 system (group 49-42-49) did not influence the productivity of rabbits. The consequences of a return to the initial system were weak but deserve to be tested over a longer period.

**Key words**: Rabbit, breeding system, flexibility, reproductive performance, growth.

## INTRODUCTION

In rabbit farms, females are usually inseminated for the first time at the age of 19.6 weeks and then every 42 days (42 days reproduction rythm). But the market demand for rabbit meat evolves during the year (drop during the summer period) and the physiological capacities of females evolve over the time (lower performance in primiparous, reduction of feed intake during periods of high heat). It is therefore necessary to consider the possibilities for modulation of breeding systems firstly to adapt meat production to consumer demand and secondly to adapt the practices to the animal potential.

This study aimed to test on 2 reproductive cycles, the consequences of a modulation of breeding systems on productivity. Both extensification and intensification of breeding systems have been tested on multiparous and their ability to return to their original system.

## MATERIALS AND METHODS

### Animals and experimental design

The experiment was performed at the ITAVI experimental farm (Rambouillet, France) in three independent pairs of rooms (reproduction/fattening). A total of 292 Hyplus rabbits (Hypharm, Roussay, France) were distributed in 3 original groups (35, 42 and 49) according to their weight at 13 weeks (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 |

During the experiment, does were subjected to different successive breeding systems according to Table 2. For group 42, at the 5th artificial insemination (AI), females were divided in 2 subgroups (taking into account their weight and parity) to apply different successive breeding systems.

**Table 2:** Experimental design

| | Breeding system | | |
|---|---|---|---|
| Group | From $AI_1$ to $AI_4$ | $AI_5$ and $AI_6$ | $AI_7$ |
| 35-42-35 | 35 | 42 | 35 |
| 42-35-42 | 42 | 35 | 42 |
| 42-49-42 | 42 | 49 | 42 |
| 49-42-49 | 49 | 42 | 49 |

At the moment of the introduction in the rooms, the does were placed under a constant 8h light/day (between 8h a.m. and 16h p.m.). Seven days before each insemination, a light stimulation was applied (sudden change from 8hL:16hD to 16hL:8hD, light extinction at 24h). The day of artificial insemination, the return to the initial illumination (8h) occurred gradually over 4 days (between d 0 and d 3: -2h/day) after AI in all groups. Nevertheless, an exception was made because an application of 2 different breeding systems in a same room, no light stimulation was done from the 5th AI of groups 42-35-42 and 42-49-42. A nutritional flushing was practiced in young females: 150-160g restricted, they were fed *ad libitum* for 6 days before AI. No biostimulation, or hormonal treatment have been used to induce receptivity.

Inseminations were performed using heterospermic pools of bucks from a commercial breed (PS40, Hyplus, Hypharm, Roussay, France). The litters were homogenised to 8 for nulliparous, 9 for primiparous and 10 for multiparous, after removing non-viable (low weight) or surplus. Adoptions were performed within room and free suckling was applied. Does and kits were fed with commercial diets during the whole experiment. After insemination, does of groups 42 and 49 were fed a diet that meet the nutritional requirements of pregnant does (Lapety «maternité», Inzo, DE : 2500 kcal/kg, CP: 16.5%). Does of group 35 were fed a diet for lactating does from parturition to d25 of lactation (Lapety «lactation», Inzo, DE: 2600 kcal/kg, CP: 17.2%). All the does from d25 of lactation to weaning and all the kits from d25 to d49 of age were fed a lower energy diet ("Stabiconfort"; Sanders, DE: 2300kcal/kg, CP: 15.2%). The Stabiwhite (Sanders, DE: 2445 kcal/kg, CP: 15.5%) was given to all the kits from d49 to slaughter. Females were fed *ad libitum* but the future reproductive does and unfertilized ones received a restricted feeding (150-160g /d) except the 6 days before insemination. They were eliminated only for sanitary reasons. Kits were feed restricted only when digestive problems occurred.

**Registered parameters and statistical analysis**

To avoid possible interactions with parity, the analysis of reproductive performance only concerns multiparous does. The weight of does at the moment of insemination, fertility (kindling rate, considered as Bernoulli variable: range 0-1), litter size at birth (born alive), at 28 days, at weaning, the average weight of kits at these moments and productivity (weight of kits/AI, kg) at 28 days and at weaning were analysed using an analysis of variance. The model includes the fixed and combined effect of the group and the breeding system (12 levels: as presented in table 2). The weight at 28 days and the individual weights at 63 days were not registered at the 7th AI. Because no identification of kits was done at weaning, it was not possible to select individual weights coming only from multiparous does. Consequently, this calculation concerns all females (nulliparous, primiparous and multiparous). Table 3 gives the results of variance analysis (least square means).

## RESULTS AND DISCUSSION

The analysis concerned 1005 inseminations and evidenced a significant influence of the breeding system for all traits (Table 3).

*Average weight of does at AI*. Considering only the initial breeding system (from the 1st to 4th AI), the weight of does at the moment of insemination was significantly lower when a 35 system was applied. A change from a 35 to a 42 system significantly increased the weight at AI (from 4461 to 4818g) without any effect when returning to the initial one. A sudden change from 42 to 35 system had no significant effect on the weight of does at insemination but a return to a 42 one, increases the weight at AI. In contrast, a change from a 42 to a 49 system increases the weight of does without any significant effect when returning to the original one.

*Reproductive performance*. Considering only the original breeding system, in multiparous does, the lowest fertility was obtained for a 35 system and the highest for the 49 one (48.2 vs. 78.2 vs. 90.1 %, respectively for 35, 42 and 49 systems). This result is in agreement with the conclusions of Theau-Clément *et al.* (1990), Blocher and Franchet (1990) and Theau-Clément *et al.* (2000). A change from a 35 to a 42 system significantly increased fertility without any effect when returning to the original one. In contrast, a sudden change from a 42 to a 35 system or from a 42 to a 49 one had no effect on fertility even when returning to the original one. In the same way, a change from a 49 to a 42 system, as well as a return to the original system has no effect on fertility. The poor reproductive performance of the 35 system can be related to the weak weight at insemination and could be a consequence of an energy deficit as evidenced in a previous communication (Theau-Clément *et al*., 2012).

At birth (after standardization), at 28 days and weaning, in multiparous, the litter size did not vary according to the original breeding system. Successive changes applied on groups 35-42-35 or 42-35-42 had no significant impact on litter size at birth (born alive). Nevertheless, a surprising and important decrease of the number of born alive was observed for groups 42-49-42 after a return to the original reproduction rhythm, probably due to a depressive summer effect.

At 28 days, the different changes in breeding systems did not greatly influence the litter size. Only for group 42-49-42, a significant drop of litter size was observed after changing the system (from 9.88 to 9.00 kits, consequence of the same summer effect) despite the standardization of litter size at birth to 10 kits. Except for group 49-42-49, the litter size at weaning (age varying according to the system) tended to decrease after the 1st change of system and except for groups 42-35-42 and 42-49-42, the number of weaned remained at the same level after returning to the original system.

*Young growth*. For the original system (from the 1st to 4th AI), the average weight of kits at 28 days was higher for the 35 system. It was probably the consequence of the more energetic diet given to this group, to meet the higher nutritional needs of does using a more intensive reproduction rhythm. This could explain the drop of the weaning weight of kits of group 35-42-35 when changing from a 35 to a

42 system (724 *vs*. 647 g). But the reverse was not demonstrated for group 42-35-42 from a 42 to a 35 system. The different ages of kits explained the differences of weight at weaning between groups.

**Table 3**: Influence of a change of breeding system on reproductive performance and young growth.

| | *Number* | AI weight (g) | Fertility (%) | Born alive | Litter size at 28 d | Litter size at weaning | Weight at 28 d (g) | Weaning weight (g) | Productivity at 28 d (kg/AI) | Productivity at weaning (kg/AI) |
|---|---|---|---|---|---|---|---|---|---|---|
| *Average* | *1005* | 4785 | 80.8 | 10.75 | 9.70 | 9.58 | 659 | 867 | 3875 | 6.59 |
| $R^2$ | | 0.096 | 0.094 | 0.025 | 0.079 | 0.053 | 0.151 | 0.523 | 0.473 | 0.099 |
| Breeding system | | P<0.001 | P<0.001 | P=0.023 | P<0.001 | P<0.001 | P<0.001 | P<0.001 | P<0.001 | P<0.001 |
| Group 35-42-35 | | | | | | | | | | |
| 35$^{(1)}$ | *112* | 4461$^{a}$ | 48.2$^{a}$ | 10.41$^{a}$ | 9.65$^{bcd}$ | 9.62$^{cd}$ | 724$^{d}$ | 911$^{d}$ | 3.37$^{a}$ | 4.23$^{a}$ |
| 42$^{(2)}$ | *136* | 4818$^{bcd}$ | 85.3$^{bc}$ | 10.61$^{a}$ | 9.40$^{b}$ | 9.28$^{ab}$ | 647$^{ab}$ | 892$^{d}$ | 5.04$^{b}$ | 6.92$^{c}$ |
| 35$^{(3)}$ | *67* | 4725$^{bc}$ | 82.1$^{bc}$ | 10.42$^{a}$ | 9.85$^{d}$ | 9.59$^{bcd}$ | - | 826$^{bc}$ | - | 6.38$^{bc}$ |
| Group 42-35-42 | | | | | | | | | | |
| 42$^{(1)}$ | *119* | 4698$^{b}$ | 78.2$^{b}$ | 11.24$^{a}$ | 9.88$^{d}$ | 9.85$^{d}$ | 661$^{bc}$ | 882$^{d}$ | 5.10$^{b}$ | 6.79$^{c}$ |
| 35$^{(2)}$ | *85* | 4801$^{bcd}$ | 87.1$^{bc}$ | 10.40$^{a}$ | 9.66$^{cd}$ | 9.45$^{bc}$ | 667$^{c}$ | 850$^{c}$ | 5.39$^{bc}$ | 6.71$^{c}$ |
| 42$^{(3)}$ | *40* | 4969$^{e}$ | 80.0$^{bc}$ | 11.75$^{a}$ | 10.00$^{d}$ | 9.44$^{bc}$ | - | 888$^{d}$ | - | 6.68$^{c}$ |
| Group 42-49-42 | | | | | | | | | | |
| 42$^{(1)}$ | *119* | 4698$^{b}$ | 78.2$^{b}$ | 11.24$^{a}$ | 9.88$^{d}$ | 9.85$^{d}$ | 661$^{bc}$ | 882$^{d}$ | 5.10$^{b}$ | 6.79$^{c}$ |
| 49$^{(2)}$ | *89* | 4889$^{de}$ | 83.2$^{bc}$ | 10.40$^{a}$ | 9.49$^{bc}$ | 9.45$^{bc}$ | 642$^{ab}$ | 718$^{a}$ | 4.85$^{b}$ | 5.39$^{b}$ |
| 42$^{(3)}$ | *45* | 4867$^{ce}$ | 82.2$^{bc}$ | 8.89$^{b}$ | 9.00$^{a}$ | 8.89$^{a}$ | - | 1064$^{f}$ | - | 7.35$^{cd}$ |
| Group 49-42-49 | | | | | | | | | | |
| 49$^{(1)}$ | *91* | 4782$^{bcd}$ | 90.1$^{c}$ | 11.30$^{a}$ | 9.85$^{d}$ | 9.82$^{d}$ | 669$^{c}$ | 804$^{b}$ | 5.93$^{c}$ | 7.10$^{c}$ |
| 42$^{(2)}$ | *147* | 4934$^{e}$ | 89.1$^{c}$ | 11.19$^{a}$ | 9.77$^{d}$ | 9.72$^{cd}$ | 632$^{ab}$ | 976$^{e}$ | 5.41$^{bc}$ | 8.32$^{d}$ |
| 49$^{(3)}$ | *74* | 4828$^{b}$ | 86.5$^{bc}$ | 10.64$^{c}$ | 10.00$^{d}$ | 9.83$^{d}$ | - | 726$^{a}$ | - | 6.18$^{bc}$ |

$^{(1)}$Initial breeding system, $^{(2)}$After changing the initial breeding system, $^{(3)}$Coming back to the initial breeding system
Within columns, means with different letters are significantly different P<0.05

*Productivity*. For the original system (from the 1$^{st}$ to 4$^{th}$ AI), the productivity at 28 days (kg/AI) was the highest for group 49-42-49 (5.93 kg/AI) and the lowest for group 35-42-35 (3.37 kg/IA). In the group 49-42-49, these results were due to both a high fertility and a good growth before weaning. Conversely in group 35-42-35, the low productivity was due to a low fertility despite the high growth performance reached with a more energetic diet. Only a change from a 35 system to a 42 one (35-42-35) allowed increasing the productivity at 28 days (3.37 *vs.* 5.04 kg/AI, respectively). At weaning, the productivity was highly related to the age of kits which was varying with the system (Table 1).
A change of breeding system influenced the productivity at 63 days only for the shift 35 to 42 (8.7 *vs*. 14.6 kg/AI). The other changes of breeding systems did not greatly modify the productivity (from a 42 to a 35 system: 14.4 and 14.3 kg/AI; from a 42 to a 49 system: 14.4 and 13.5 kg/AI; and from a 49 to a 42 system: 16.5 and 162 kg/AI, Figure 1).

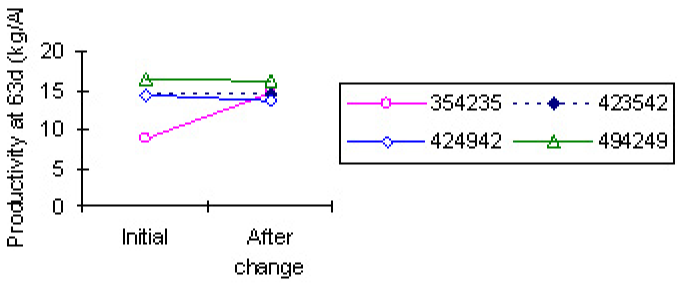


**Figure 1:** Productivity at 63 days according to the breeding system

This study confirms that in multiparous does, the productivity per insemination increases with an extensification of the 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 corresponds to a reduction in the energy deficit.

## CONCLUSION

This original study aimed to test during two reproductive cycles, the flexibility of 3 breeding systems. Results are difficult to interpret since inseminations were not contemporary and the effects of practices could be confounded with the effect of environment (temperature). But they evidence that a sudden change from a 35 system to a 42 one increases productivity at 63 days by 68 %. On the opposite, the 42 system is not very sensitive to an intensification, or an extensification of one week. Similarly, an intensification of one week of a 49 system did not influence the productivity of rabbits. But the consequences of a return to the initial system deserve to be tested over a longer period to erase possible residual effects of such reproductive cycle modulations.

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