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THE EFFECTS OF CHANGING THE REMATING INTERVAL ACCORDING TO THE PREVIOUS LITTER SIZE ON THE REPRODUCTIVE PERFORMANCE OF THE DOE RABBIT.

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Summary

The reproductive response of 35 Gigante de España does was studied being subjeted to reproductive rhythms conditioned by the prolificity of each parturition. The does acceptance rate was seen to decrease when the remating interval was prolonged (87.19% for the intensive rhythm dropping until 73.08% during the extensive rhythm) whereas the pregnancy and fertility rates grew (52.94%, 79.33%, 82.46% and 85.33% positive pregnancies during the intensive, semi-intensive, extensive and weaning rhtyhm, respectively, and the fertility was 52.94%, 76.00%, 80.70% and 83.33%). Fertility of second mattings was high in the intensive rhythm (84.38%). Prolificity was also higher when the real interval between parturitions was increased, obtaining 6.97 total pups per litter for the intensive rhythm, 8.20 for the semi-intensive, 8.65% for the extensive and 8.66 for the weaning rhythm ($P<0.01$). Prolificity of delayed parturitions due to refuse or non pregnancy also tended to increase when the remating interval became greater. The effect of the reproductive rhythm on the litter size at weaning was not significative. The season, inbreeding and age of the does have also been studied and only the age modified significantly the prolificity and the litter size at weaning.

Key words: Remating interval, reproductive response.

Introduction

In 1968 BEL, PRUD'HON and BENHACINA observed during an experimental period of 6-8 months and on a little group of 10 does, that 90% accepted mating 0-1 days post-partum independent to the number of litter previous. The higher receptivity of the post-partum mated does was acompanied by a lesser fertility and prolificity than the does remated in semi-intensive or extensive intervals after parturition have later been proved (PRUD'HON et al., 1969).

These behaviour differences dependent on the reproductive rhythm applied to the does have been confirmed in numerous subsequent experiments (GIAVARINI et al., 1980, SURDEAU et al., 1980, PERRIER et al., 1982, PARTRIDGE et al., 1984, MARTINEZ et al., 1987, LAMMERS and PETERSEN, 1988, LAMB et al., 1991), although sometimes the different prolificity of the reproductive rhythms does not exist in practice (MARTIN, 1977, COLIN et al., 1980, SZENDRO et al., 1984, YAMANI et al., 1992a) or are only found when the extensive rhythm was included (MENDEZ et al., 1986a).

The discussion about the productivity of early or later remating intervals has occupied some of the name autors, whitout reaching an unanimous conclusion because the higher annual litter number of the intensive rhythm doesn't always give a higher total number of young obtained annualy per doe.

In these conditions, farmers from traditional rabbit producing countries, Italia, France and España, have used both the intensive or semi-intensive rhythms during the past decade, but dropped the first when they began managing reproductive groups, a higher number of females compared to the number of maternal cages or, likewise, artificial insemination, being common nowadays to programme remating 7 or 11 days post-partum on weekly organised farms.

Despite the basic reproductive rhythm used on rabbit farms or in experiments on this topic, there are some does that refuse the buck or do not conceive within the corresponding rhythm and they are delayed respected to their groupmates. The results of these "second matings" have scarcely been studied but, in every case, the fertility and prolificity improve when the interval parturition-fertile mating increases (PRUD'HON et al., 1969, SURDEAU et al., 1984, MAERTENS and OKERMAN, 1988, BLOCHER and FRANCHET, 1990). However, we don't know of any studies where the consecuencies of modifying the mating time of each parturition according to the circunstances are analysed, phenomena wich is practiced on some farms, the south Mediterranean included (BARKOK, 1992). HENAF and PONSOT (1987) indicated that fertility improved on rabbit farms which change the mating time regarded to those that used a fixed rhythm.

To investigate the effect on productive performances of the modification of the remating interval in terms of prolificity of each previous parturition was planed for the present experiment.

Material and methods

Animals

342 productive cycles from a total of 35 Gigante de España does were studied throughout March 1988-Septembre 1991 from the first mating to their death, removal or their last parturition previous to the final date.

The animals received a commercial diet and water, both ad libitum, and they were housed individually in metal cages disposed in flat-deck. Light was adjusted to 16 hours per day.

The study was conducted at the experimental farm of the Veterinary Faculty of the Zaragoza University, Spain. Two locations were used: the first had windows for ventilation and flat floor and was cleaned daily by a pressure hose (until January 1991); the second was a new building which had a controlled atmosphere and a deep pit to amass the excrements (January-Septembre 1991).

Procedures

All the does were mated with Gigante de España bucks chosen taking into account their small grade of inbreeding with the females.

The mating is programmed in agreement with the prolificity of each parturition as follows:

- Five or less pups born alive: mating 1 day post-partum.
- 6-8 pups born alive: mating 11 days post-partum.
- Nine or more pups born alive: The mating was programmed at firts for day 11 post-partum. If on this day there were still 9 pups the mating was put off 1 week introducing the females to the buck 18 days post-partum. On the contrary, the female was introduced this same day 11 post-partum if the number of pups was smaller than 9.

The weaning also was adjusted to prolificity and the pups from small, medium to big litters were weaned 25, 30 or 35 days respectively after parturition.

When all the pups of the litter died, their mother was inmediatly given the opportunity of remate.

Does refusing to mate on the day programmed or does that failed to conceive were subsequently placed with bucks on monday, wednesday and friday until acceptance. Therefore, to be able to make the study four patterns were defined for remating intervals according to the moment that the doe accedes to the male or conceives: intensive (days 1-8 post-partum), semi-intensive (days 9-16 post-partum), extensive (days 17-25 post-partum) and "weaning rhythm" (from day 26 post-partum). This last pattern was not planed but was used on does with incorrectes phisical condition at the time of mating (6 cases only).

In the same way, following the methodology of SURDEAU et al.(1984), four reproductive rhythms can be defined:

- Planned rhythm: Determined by the prolificity of each parturition.
- Applied rhythm : Established when the doe accedes to the male. It can agree with the previous or not, for instance when the mating was delayed by pathologie or advanced if the doe lost all her pups they do not agree.
- Accepted rhythm: Was the rhythm in which the females accepted the male, being able to carry

out pregnancy or not, not agreeing with the applied rhythm when the doe refused to the male many times.

- Real: Was the rhythm where the mating was fertile and provided parturition.

Statistical analysis

All the dates were analysed from the second parturition because the first was naturally out of rhythm. The effect of the reproductive rhythm was studied by oneway variance analysis. The Duncan test was used to compare the means when F was significative. The mating response, pregnancy, fertility and mortality rates of each rhythm were compared by chi-square test.

So some factors, such as season, grade of inbreeding or age of the doe, may have effects on the reproductive performances or interact with the rhythm, a factorial analysis of variance was used according to the following model:

$$Y_{ijk} = u + R_i + O_j + (RO)_{ij} + e_{ijk}$$

where u=general means, R_i =fixed effect of the reproductive rhythm, O_j =fixed effect of season, inbreeding or age of the female, $(RO)_{ij}$ =interaction effect between fixed effects, e_{ijk} =residual term.

To evaluate season effect the season for fertile mating was considered first but, as the parturition season could affect mortality, their effect was also analysed. The age of the doe was determined according to its productive years and the parturition order. The coefficient of inbreeding was estimated following to WRIGHT (1922, ment. LACADENA, 1981).

Results and discussion

a. Changes of the reproductive rhythm

78 matings in a intensive interval, 122 in semi-intensive and 142 in extensive were planned along this experiment. This distribution indicates the high number of pups per litter because the mayority of matings were planned for the extensive rhythm. But delays due to illness of the does, refuses to the male or lack of conception, as well as when the number of pups decreases exposure to the male was earlier, made changes in the planned rhythm.

In this way, initially there was a balanced distribution around the semi-intensive condition so the intensive rhythm was applyed in 78 cases, the semi-intensive in 180, the extensive in 78 and the weaning rhythm in 6 cases (Table 1). The greatest percentage of parturition was actually obtained in the semi-intensive rhythm (39.18%), but the proportion of parturition corresponding to intensive rhythm mating was low (10.53%) and the weaning rhythm elevated (31.00%). Remembering that the parturitions in the last condition were only planned for exceptional cases, so these parturitions were results to failed matings, conceptions or parturitions due to exposure to the male near to the previous parturition time. Concluding the initial rhythm applied only agrees with the real rhythm (with parturition) in 59.1% of the cases.

We don't know of any article that studies with detail the changes of reproductive rhythm experienced by the does but the extensification of the rhythm must be frequent according to the reproductive performances divulged in the studies on this subject.

b. Mating rate and fertility

The mating reponse for the applyed rhythm was 82.16% and 73.67% pregnancy rate and 71.53% fertility was obtained (Table 2).

The mating rate decreased from 87.19 to 73.08% when the interval after parturition was increased. This fall was not significant. The pregnancy rate and fertility, on the contrary, increased significantly when the reproductive rhythm was extensive (52.94 to 83.33%).

Table 1. Distribution of the changes of the reproductive rhythm.

REPRODUCTIVE RHYTHM	Intensive	Semi-inten.	Extensive	Weaning	TOTAL Applied ↓
Intensive	36 (46.15%)	20 (25.64%)	7 (8.97%)	15 (19.23%)	78 (22.81%)
Semi-intensive		114 (63.33%)	13 (7.22%)	53 (29.44%)	180 (52.63%)
Extensive			46 (58.97%)	32 (41.03%)	78 (22.81%)
Weaning				6 (100.00%)	6 (1.75%)
TOTAL Real →	36 (10.53%)	134 (39.18%)	66 (19.30%)	106 (31.00%)	342 (100.00%)

At the same time, the means of pregnancy and fertility rates were increased slightly if the does didn't accept the rhythm imposed but any posterior were included in the calculations (73.67% to 75.73% and 71.53% to 73.78%). Fertility from the second matings of non pregnant does using the accepted rhythm (83 cases) or from those pregnant but failing to give birth was of 74.44%, this value being higher than the one from the first mating, in this way increasing the total fertility of this experiment (74.03%).

The results indicate that when the reproductive rhythm depends of the litter size of each parturition the females behaviour within the different rhythms was similar to that observed in experiments where some fixed reproductive rhythms were used. Therefore response to mating was deteriorated when the remating interval was prolonged, according with the results of SURDEAU et al. (1980), PERRIER et al. (1982), MARTINEZ et al. (1987) and LAMB et al. (1991) when reproducing does in differents groups with intensive, semi-intensive and extensive conditions. Pregnancy and fertility rates were higher when the remating interval was increased, obtaining better performances for the extensive rhythms compared to those from intensive rhythms (PRUD'HON et al., 1969, COLIN et al., 1980, GIAVARINI et al., 1980, PERRIER et al., 1982, SZENDRO et al., 1984, MENDEZ et al., 1986a). The low ovulation rate (HARNED and CASIDA, 1969, TORRES et al., 1977, LAMB et al., 1991) and an inferior proportion of fecundant ova during the intensive rhythm (TORRES et al., 1977) could be the cause of this low fertility after the post-partum mating. The mean of oestradiol-17β concentration 1 h. post-coitum was also lower for does mated on day 1 post-partum compared to those mated on day 14 post-partum (LAMB et al., 1991). The fertility improved during the second matings (PRUD'HON et al., 1969, MAERTENS and OCKERMAN, 1988, BLOCHER and FRANCHET, 1990). This increase in fertility for these matings was due to the does which accepted the first mating during the intensive rhythm but did not become pregnant it was here where a clear fertility increase was shown.

Table 2. The effects of the applied rhythm on mating, pregnancy and fertility rates. Fertility at second matings

Reproductive rhythm	Mating response (%)	Pregnancy rate (%)	Fertility rate (%)	Fertility of the accepted rhythm	Fertility of second matings (%)
Intensive	87.19	52.94[a]	52.94[a]	52.94[a]	84.38
Semi-inten.	83.33	79.33[b]	76.00[b]	75.64[b]	63.16
Extensive	73.08	82.46[b]	80.70[b]	81.82[b]	78.57
Weaning	100.00	83.33[c]	83.33[c]	86.66[c]	83.33
TOTAL	82.16	73.67	71.53	73.68	74.44
	NS	***	***	***	NS

Means bearing different letters differ significantly ($P<0.05$).

c. Prolificity and litter size at weaning

c.1. Real reproductive rhythm

Both the total number of pups born and the number born alive increased when the fecundant remating interval was prolonged (Table 3). The difference was of 1.23-1.69 total pups per litter or 1.07-1.65 alive pups per litter less for the intensive rhythm. These results are in agreement with PRUD'HON et al. (1969), SURDEAU et al. (1980), PERRIER et al. (1982), PARTRIDGE et al. (1984), LAMMERS and PETERSEN (1988).

The reproductive rhythm did not affect significantly the litter size at weaning, perhaps because the does that followed the intensive condition lost a total of aproximately 1 pup per litter whereas the mortality of the other models increased gradually until 1.79. In this paper the number of pups born had a positive and significant correlation with the number of pups died ($r=0.413$, $P<0.01$) although the percentage of total mortality was not affected by the reproductive rhythm. Nevertheless, the intensive reproductive rhythm still gave aproximately 1 weaned pup less than the other rhythms.

Table 3. The effects of the real reproductive rhythm on litter sizes and mortality

Reproductive rhythm	No. of cases	No.born /litter	No.born alive /litter	No.weaned /litter	Mortality along lactation	Total mortality
Intensive	36	6.97^{a}	6.28^{a}	5.28	15.93^{a}	24.30
Semi-intensive	134	8.20^{b}	7.35	6.19	15.84^{ac}	24.57
Extensive	66	8.65^{b}	7.74^{b}	6.20	19.96^{abd}	28.37
Weaning	106	8.66^{b}	7.93^{b}	6.14	22.59^{b}	29.09
TOTAL	342	8.30	7.49	6.08	18.88	26.77
		**	*	NS	**	NS

Means bearing different letters differ significantly ($P<0.05$).

c.2. Applied reproductive rhythm

The litter size of the postponed parturitions, either by mating reffuse or by negative pregnancies, tended to increase when the fertile mating was prolonged respect to the imposed rhythm (Table 4), agreeing with PRUD'HON et al. (1969) and MAERTENS and OCKERMAN (1988). However, with this increase of prolificity it was not posible to reach the litter size of the does which were imposed more extensives conditions. Thus, the does which were subjeted and became pregnant within the intensive rhythm gave less number of pups (6.97) than those that having been mated during the intensive rhythm didn't achieve pregnancy until the semi-intensive (7.85), extensive (7.43) or at weaning (7.60). Nevertheless, this last prolificity was less than that of the does subjeted and pregnant within the semi-intensive (8.26), extensive (8.85) and at weaning (9.83), respectivelly. These results confirm that the previous manipulation applied to the does influences the following reproductive response, suggestion proposed by SURDEAU et al.(1984). The number of pups alive progressed in a similar way while the tendence of the weaning litter size was less clear (Table 4).

d. Effects of the season, grade of inbreeding and age to the doe on the reproductives performances. Reproductive rhythm interactions.

The season of fertile matings, the season of parturition and the inbreeding grade didn't have effects on the reproductive features. Some tendencies might be commented. For instance the prolificity and the littersize at weaning were lightly higher in winter matings (8.59 and 6.62 respectively), according to PRUD'HON et al. (1969), MENDEZ et al. (1986a) and YAMANI et al. (1992b), and fell in autumn matings (8.18 and 5.75), agreeing with GARCIA et al. (1984) and YAMANI et al. (1992b). Likewise, summer and winter were unfavorable seasons for parturition because the mortality at birth (13.43% and 13.23% respectively) and during lactation (22.32% and 20.19%) was high.

Table 4. The effects of the applied and real reproductive rhythm on the litter size

a) Effects on the litter size at birth

Reproductive rhythm	Intensive	Semi-int.	Extensive	Weaning	TOTAL Applied ↓	
Intensive	6.97 (36)	7.85 (20)	7.43 (7)	7.60[a] (15)	7.36	NS
Semi-intensive		8.26 (114)	8.62 (13)	8.38 (53)	8.32	NS
Extensive			8.85 (46)	9.41[b] (32)	9.08	NS
Weaning				9.83 (6)	9.83	-
TOTAL Real →	6.97	8.20	8.65	8.66	8.30	*
		NS	NS	*	*	

b) Effects on alive pups at birth

Reproductive rhythm	Intensive	Semi-int.	Extensive	Weaning	TOTAL Applied ↓	
Intensive	6.28	6.80	7.00	6.93	6.60	NS
Semi-intensive		7.45	8.00	7.57	7.52	NS
Extensive			7.78	8.75	8.18	NS
Weaning				9.33	9.33	-
TOTAL Real →	6.28	7.35	7.74	7.93	7.49	*
	-	NS	NS	NS	NS	

c) Effects on pups weaned per litter

Reproductive rhythm	Intensive	Semi-int	Extensive	Weaning	TOTAL Applied ↓	
Intensive	5.28	5.70	5.14	6.00	5.51	NS
Semi-intensive		6.27	6.15	5.62	6.07	NS
Extensive			6.36	7.00	6.63	NS
Weaning				6.50	6.50	-
TOTAL Real →	5.28	6.19	6.20	6.14	6.08	NS
	-	NS	NS	NS	NS	

Means bearing different letters differ significantly ($P<0.05$)

The age of the doe, determined by the productive year and by the order of parturition, had a main effect (Table 5 and 6). The number of pups born and weaned was significantly higher during the first year than later. The third year also tended to have a slight advantage with respect to the second, perhaps because the does that had not been withdrawn were the most healthy and productive ones. It may be underlined that the prolifity and the mortality evolved in an opposite way when the age advances. Also the parturition interval increases with the age (52.06 days in the first year, 55.18 in the second and 57.38 in the third, P=NS) but this extensification did not achieve a high prolificity, so apparently the reproductive potential decreases when does have a high age independent to the reproductive rhythm. Also pointing out that some parturitions in the second year and all those during the third agreed with the transfer and adaptation of the does to the second building, the mortality having increased significantly during this period respect to the previous location (P<0.05), so the mortality during the second and third years might be increased by this fact.

Table 5. The effect of the productive year on litter sizes and mortality. Year x rhythm interaction

Year	No. of cases	No. born /litter	No.born alive /litter	No.weaned /litter	Total mortality
Year 1	227	8.83[a]	8.03[a]	6.58[a]	25.72
Year 2	91	7.14[b]	6.37[b]	5.00[b]	29.70
Year 3	24	7.71[b]	6.67[b]	5.42	30.24
TOTAL	342	8.30	7.49	6.08	27.09
F year	-	***	***	***	NS
F Rhythm	-	**	*	NS	NS
F Interaction	-	NS	NS	NS	NS

Means bearing different letters differ significantly (P<0.05).

Table 6. The effect of the order of parturition on litter sizes and mortality. Parturition x rhythm interaction.

Parturition	No. of cases	No. born /litter	No.born alive /litter	No.weaned /litter	Total mortality
Parturition 2	35	9.83	9.40	8.09[a]	16.43
Parturition 3	35	8.91	8.14	6.89	22.74
Parturition 4	35	8.71	7.89	5.86[b]	31.57
Parturition 5	34	8.35	7.53	6.38[b]	27.27
Parturition 6	30	8.20	7.33	5.70[b]	30.65
Parturition 7	26	8.50	7.53	6.46[b]	22.66
Parturition 8	24	8.83	7.70	5.92[b]	33.96
Parturition 9	17	8.94	8.00	6.59	26.65
Parturition 10	16	8.13	7.50	6.00[b]	27.75
TOTAL	252	8.75	7.95	6.49	26.28
F Order part.	-	NS	NS	*	NS
F Rhythm	-	**	*	NS	NS
F Interaction	-	NS	NS	NS	NS

Means bearing different letters differ significantly (P<0.05).

About the effect of the parturition number, and analising only the first 10, in this paper the fact that the second parturitions tend to be the most prolific was observed, in agreement with HULOT and MATHERON (1980) when studying the size of four first parturitions. The litter size at weaning also was significantly higher during the second parturition (Table 6).

Interaction between the parturition season and the reproductive rhythm performed a significative effect on total mortality. This interaction was produced because parturition from semi-intesive and extensive conditions had a low mortality during summer and winter, respectively, when compared to the other rhythms. The decrease in mortality during the summer in the extensive rhythm could be due to a lower prolificity within this season. Nevertheless, for the scarce mortality during winter of the semi-intensive model we have not found and adequate explanation, as during this season the parturitions in this rhythm had a high prolificity.

Conclusions

This reproductive rhythm conditions the does reproductive response. Age also has an effect on the litter size at birth and weaning time.

The result show that a particular doe responds to more intensive rhythms with better acceptance, lower fertility and prolificity than when this same female follows more extensive rhythms. The reproductive rhythm effect seems to stand until weaning although loosing statistic significance.

Prolificity of the delayed parturitions due to refusing the male or non pregnancy tends to increase when the parturition-fertile mating interval is longer, but this increase is insuficient to equal the values from the females that initialy followed more extensive models.

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