

*Full Length Research Paper*

## Study of seasonal sexual activity variations in Algerian rams: Sexual behaviour, testosterone concentration control and environmental factors

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**This study focuses on the determination of seasonal effect on two main andrological sexual activity parameters within young and adults rams of Rembi breed from Algeria for a period of one year. The experiment involved a weekly evaluation of males' sexual behaviour and a monthly measurement of serum testosterone concentration in order to know the main testicular endocrine activity. The purpose of this experiment was to assess better the characteristics of the reproductive activity between two categories of rams age-wise and to define the variations and interactions between the two parameters during each season. Data shows no statistically significant effect of age on the testosterone concentration but showed a highly significant difference between age groups in terms of sexual behaviour. Seasonal variations of the studied parameters were statistically significant in both ram ages with higher values during spring and autumn and lower values during summer and winter.**

**Key words:** Rembi, ram, testosterone, sexual activity, season, age.

### INTRODUCTION

In Algeria, sheep represent the main animal resource; about 23 million heads cover 40 million hectares of grazing arid regions, where 12 million hectares are steppe. Seventy five percent of sheep are thus concentrated in the steppe and are reared in extensive system (Nedjraoui, 2006). This system is characterized by a heavy dependence on the natural vegetation composed mainly of Alfa and therefore remains heavily influenced by climatic conditions (Nedjraoui, 2002).

The economic importance of sheep farming constitutes an important source of animal protein (meat and milk) and has a significant contribution in livestock products (skins and wool). For this purpose, it is essential to find ways to improve sheep productivity in Algeria. This improvement is associated with the control of repro-

duction which is the center piece of the economic efficiency of any breeding program (Nedjraoui, 2006). For successful productivity of sheep, herds must pass through the control of ram's reproduction (Ólafur and Jón Viðar, 2011). The Rembi race represents 12% of the national sheep flock and constitutes one of the most interesting Algerian races based on its physical, productive and reproductive skills by two lambings per year with a rate of twinning quite acceptable (Nedjraoui, 2006). It is the biggest sheep in Algeria; the ram weighs 90 kg, while the weight of the sheep is 60 kg. The proportional body shape of this race ensures excellent criterion for the success of sexual activity for both male and female.

The sexual behaviour and testosterone level point out

the effectiveness of male's reproduction because they are influenced by race and testicular size partly (Zamiri and Khodaei, 2005) and by the geographic location and season of the year (Karagiannidis et al., 2000). The control of sexual behaviour constitutes a key for improving the performance of and/or managing of producing animals. In most species, the expression of this behaviour depends on the rate of steroid hormones, nutritional status, physical and social environment and structure of the social group (Fabre, 2000).

Androgens or male hormones are steroid hormones that are able to develop and maintain male sexual characters involved in spermatogenesis and therefore command males' sexual behaviour. They are found principally in the internal testes secretions, adrenal and ovarian. Testosterone is the hormone that controls the operation of testis, epididymis and accessory glands as well as the expression of sexual behaviour; its dosage could provide explanation for the high and low levels of dead and abnormal sperm observed respectively from April to October (Issa et al., 2001).

In several rams' breeds programs, it was established that the release of the hormone testosterone into the blood was characterized by high peaks in European, American and Australian breeds. The frequency of testosterone peaks increases when the rams pass to the breeding season. Seasonal variations of testosterone have also been reported in adult rams breed "Chios and Daglic" in the province of Afyonkarahisar in Turkey when the highest concentrations of the testosterone in the plasma were recorded during autumn (Gundogan, 2007).

Sexual behaviour and hormone levels of testosterone vary also between breeds of rams age-wise (Langford et al., 1999; Kafi et al., 2004; Zamiri and Khodaei, 2005); this is because for there to be good improvement in the productivity of flocks of sheep, an attention must be focused on the proper earliest selection of the future genitors. It is to be noted that the seasonal variations of testosterone in sheep, even for Rembi rams, in our country including arid and steppe areas are still not yet considered. The unique use of adult dominant rams that may have infertility problems can induce significant losses in reproduction that may go undetected for some time especially if a good level of libido is maintained in these rams.

For a proper management of sheep farms, knowledge of the optimal season for breeding rams is of great importance, especially in Algeria, where majority of farmers prefer spring and autumn seasons for breeding periods. In these periods, births coincide with the time of food availability and the most favourable climatic conditions as well as the choice of the best time for marketing. Performance and management of sheep farms can be improved, in particular by reducing the variability of fertility and controlling the optimal time of reproduction. Sexual behaviour is of obvious interest from this point of view. The performance of a farm depends on reproduction which is the function of the willingness and

ability of animals to engage in sexual behaviour and fertilize at the right time. In order to control the expression of sexual behaviour, it is necessary to know the various influencing factors such as age, season, environment, food, climate, testosterone level etc. Our work describes the state of knowledge about sexual behaviour and evolution of the plasma testosterone levels.

The aim of our study was to determine the factors and parameters involved in rams' sexual activity by studying the evolution of the sexual activity of Rembi race and the intervening factors in this activity during the four seasons of the year.

## MATERIALS AND METHODS

### Experimental design

The study was conducted in an experimental farm located in a steppe pastoral region (geographic coordinates: longitude 2°19'E, latitude 35°10'N, altitude 839 m.s.l.). The climate is arid with cold and wet winter and hot and dry summer; the temperature varies from -1.1 to 16.4°C in winter and from 21.9 to 39.5°C in summer. The daily photoperiod varies from 9.34 h during the winter solstice to 14.23 h during the summer solstice. Rembi is from the leading Algerian sheep breeds, located in the Northwest of Algeria; it has a low size, tawny head, very strong members and carcass of red fawn colour. It is an interesting race based on its physical, productive and reproductive abilities.

Ten (10) Rembi rams aged between 02 and 06 years in addition to three live wire sheep aged between 02 and 04 years were selected for our experiment in 2010. Males were separated into two groups (young: n = 03 aged between 02 and 03 years and adults: n = 07 aged between 04 and 06 years). Males were in contact with the sheep during the time of sexual activity test. Prophylactic treatments were recommended, and only healthy subjects were selected. Each ram was identified and medically examined with emphasis on the integrity of the genital area. These animals belonged to a semi ranching, in addition to grazing on natural woody plants (Alpha, sagebrush, Atriplex). They received a nutritional complement of barley, corn, soybeans and hay (600 g/day) while water was provided ad libitum.

The sexual behaviour of males is under the control of testosterone or its metabolites. In castrated males, testosterone treatment restores males' sexual behaviour, whereas before treatment, it tends to persist for several months after castration in sexually experienced animals. In seasonal breeds, these steroid secretions vary with the season. However, hormonal changes are gradual and it takes several weeks after a change in plasma level to observe an effect on sexual behaviour.

### Evaluation of sexual behaviour (Libido)

The evaluation of the sexual activity of rams is a very important aspect in reproduction and sheep industry. The tests assess libido sexual motivation (number of mounts/time) and sexual efficiency (number of ejaculations/ram/time). Rams used in this study were separated from females, and were brought into them during tests of sexual activity. All tests were performed once a week in the afternoon between 13 and 16 h (Ahmed and Noakes, 1995).

Tests of sexual behaviour were conducted by exposing rams individually to ewes (1 to 3) in oestrus for 10 to 15 min. These sheep were treated by Estradiol Benzoate (0.5-1 ml by intramuscular 24 h before test) in order to stimulate their sexual activity (Price et al., 1988). Thereafter, these tests were carried out

**Table 1.** Seasonal variations of testosterone concentrations and sexual behaviour of rams.

Season	Testosterone concentration (ng/ml)			Sexual behaviour		
	All	Young	Adult	All	Young	Adult
Spring	2.80 ± 0.84	3.28 ± 0.54	2.60 ± 1.05	8.87 ± 1.14	6.94 ± 2.71	9.70 ± 0.51
Summer	0.60 ± 0.07	0.48 ± 0.09	0.65 ± 0.07	6.58 ± 1.82	4.02 ± 2.09	7.67 ± 1.72
Autumn	2.68 ± 0.54	2.64 ± 0.34	2.69 ± 0.64	8.66 ± 0.90	6.66 ± 1.81	9.52 ± 0.51
Winter	0.93 ± 0.39	1.22 ± 0.65	0.81 ± 0.30	5.66 ± 1.45	2.63 ± 1.33	6.96 ± 1.61

by exposing the whole set of rams of the two age categories to the sheep in oestrus to determine their behaviour. During the trial period, behaviours were recorded by an observer located outside the site of action at a distance of approximately two meters in order to calculate the overall level of physical activity. During each test, we recorded the number of anogenital flairages and the various components of Flehmen and consummatory phase of ram's sexual behaviour (advancement of the foreleg, mounts attempted, mounted with or without ejaculations) (Price et al., 1988). This allowed us to record the total number of mounts of one or more rams for one or more sheep during a defined test period. From these observations, a score of 10 points was calculated (Ahmed and Noakes, 1995). The ram that shows no interest in sheep (not more than one goes without ejaculation) will receive a score of 0 (marked as low and insignificant libido); the ram that rides twice with or without projection (at least 01 or 01 up ejaculation) will get a score of 05 (marked as acceptable, average libido); the ram that engages in two or more times ejaculations (at least 02 ejaculations or 05) and still shows an interest in the female will get a score of 10 (marked as high strong libido).

This test will mainly present results on levels of sexual behaviour and reproductive performance of rams during mating with the flock throughout the active sexual period. The purpose of this experiment is to study and monitor the characteristics and components of the sexual activity of Rembi race during each season.

#### Hormone dosage

Monthly samplings of blood tests (at 09 h am) for each ram were performed during the whole year of our study to estimate their blood testosterone. The operation took place in the quiet to avoid males' stress. The blood was collected from the jugular vein of each ram in individual tubes heparinised and immediately placed in a cooler. Blood samples were then transported to the laboratory, centrifuged at 3000 rpm/min for 20 min. The collected plasma was stored at -20°C until radioimmunoassay of testosterone was done (Kafi et al., 2004). Testosterone was measured by radioimmunoassay method testosterone (RIA), direct REF IM 1119 ISO 9001/13485 certified (IMMUNOTECH FRENCH). Assayed sera were incubated in antibody coated tubes with a testosterone tracer labelled with Iodine 125. After incubation, the tube contents were emptied by inspiration and the bound radioactivity was measured. A calibration curve was established and values were determined.

#### Statistical analysis

Data were arranged into a single matrix. The variance of homogeneity of the data was assessed and conformed to the model which would permit analysis of variance (ANOVA) on the data set in order to determine seasonal or monthly significant differences between sexual behaviour and testosterone concentration of rams for each age group and for both groups together. The term,

significance indicates differences in which  $P < 0.05$  under the confidence level of  $\alpha = 95\%$ . Collected data were used also for calculation of correlations based on the coefficient of Pearson among examined traits. Data were analyzed using the General Linear Model (GLM) procedure implemented in the statistical software SPSS v16 (Chicago, 1986).

## RESULTS

The statistical analysis did not show significant effect of ram's age on testosterone concentration ( $P > 0.05$ ); however, a very high significant difference was found between the two age groups with regard to sexual behaviour ( $P < 0.001$ ). Our results show that rams' sexual behaviour varied significantly between different examined seasons of the year ( $P < 0.001$ ). Overall, the sexual behaviour was at its peak during spring from March to May and during autumn from September to November. Plasma testosterone concentration varied significantly between months as well as between seasons of the year ( $P < 0.001$ ), but did not vary significantly between the two groups in terms of age ( $P > 0.05$ ). Monthly variations of testosterone concentrations were similar to the previous changes regarding seasons. Maximum values were recorded during months of spring and autumn while lowest values were observed during the months of summer and winter. This observation was similar for young as well as adult rams with higher testosterone concentration synthesis during spring ( $3.28 \pm 0.54$  ng/ml against  $2.60 \pm 1.05$  ng/ml, respectively). Lower testosterone concentrations were mainly reported during summer from June to August for both age groups ( $0.48 \pm 0.09$  ng/ml for young and  $0.65 \pm 0.07$  ng/ml for adult) and then during winter (December to February) (Table 1).

Ejaculate latency was lesser during spring and autumn when the sexual behaviour of males was very clear. A slight decrease in the intensity of the sexual activity with an acceptable copulatory activity was observed during the warm periods of summer mainly in August as well as when temperatures decreased in January for both groups. Higher values were observed for adult rams compared to young rams at any season.

Significant correlations were found between the plasma testosterone concentration and the sexual behaviour in rams and were even more pronounced in adult than in young group. Thus, testosterone concentration and libido

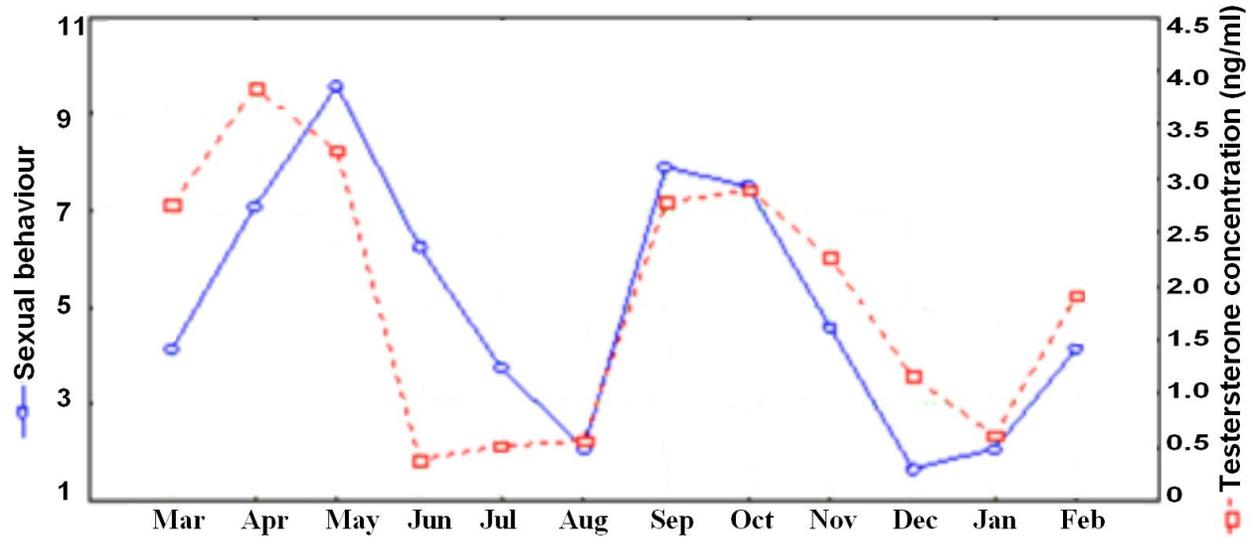


Figure 1. Monthly changes of the sexual behaviour and testosterone concentration in young rams.

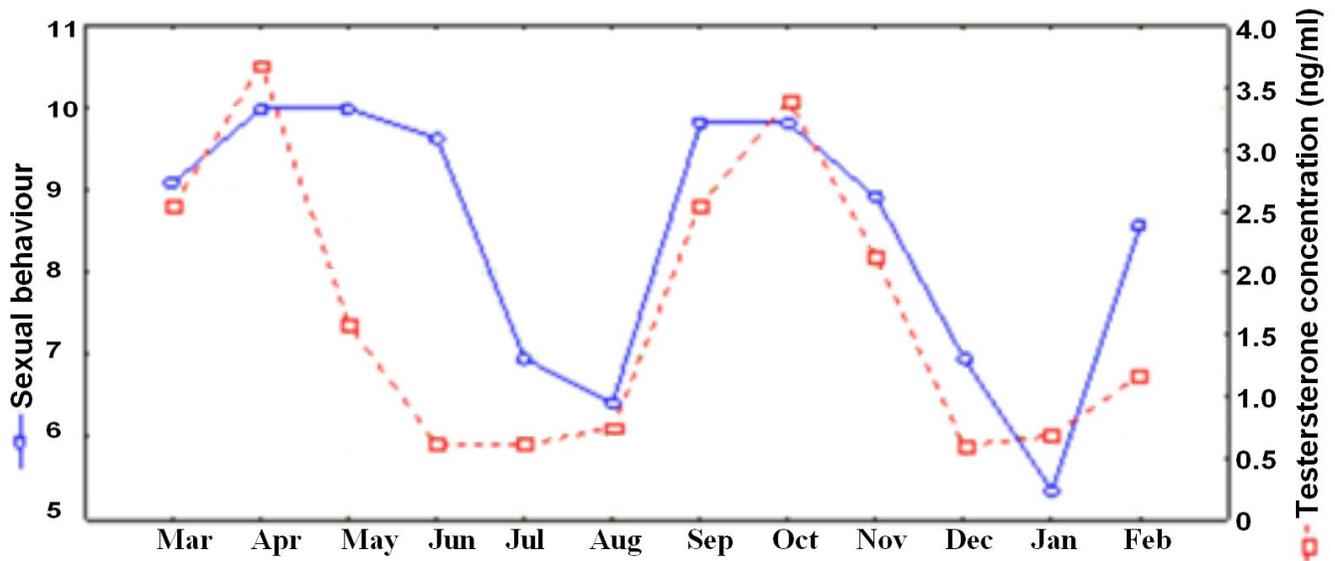


Figure 2. Monthly changes of the sexual behaviour and testosterone concentration in adult rams.

scores were negatively correlated with season ( $r=-0.23^*$  and  $r=-0.27^{**}$  respectively). It appears that the sexual activity of Rembi breed adult rams did not vanish throughout the year. This activity was higher in spring and autumn but lower in summer and winter (Figures 1 and 2).

Our study shows that the sudden introduction of stimulated ewes into the group of rams induced some changes in male's behavioural state. The presence of females generally improved the sexual activity level. Interestingly, these effects appeared to be less pro-

nounced during anoestrus periods. At the beginning of each experiment, the sexual activity remained fairly limited with rams faltering parades. In contrast, males engaged in fighting, usually between males of the same age. Females gradually became more tolerant towards males' approaches and the sexual activity level increased. Later, males' sexual parades became shorter, giving way to a more expeditious and brutal behaviour. Thus, the physical contact and dominance among the strongest rams for mating were significantly marked in the presence of all the other rams around stimulated

females.

The rams showed high levels of sexual performance and we found that mature rams were highly efficient and had a significantly greater effect on the ewes in oestrus compared to young rams which had less sexual activity. However, analysis of behavioural data showed that young rams spent more time near the ewes than adults. The adult rams were more efficient and experienced and demonstrated their libido with ease compared to young rams. Males of 04 and 05 years were the most involved in reproduction and young rams showed a significant participation. It should be noted that the presence of a viewer dominant ram can inhibit sexual activity of a young subordinate.

During oestrus, each female may mate with several males (young and adult) and each male with several females (from 2 to 4). Females in natural or artificial oestrus play an important role in facilitating the full expression of sexual behaviour of males. Rams are particularly sensitive to the effects of the environment on sexual responsiveness, which sometimes can be inhibited or stimulated. Increasing the time between successive couplings with a single sheep could be interpreted as resulting from the physiological evolution of an internal mechanism. However, the presentation of a new receptive sheep induced intense recovery of copulatory activity.

## DISCUSSION

Our results show that monthly changes in sexual behaviour were not marked. The ram's sexual behaviour began to grow in early spring and reached its highest during this period; and then it was followed by a decrease during the summer season and increased again during autumn (Table 1). It is to be noted that there was no stopping of the ram's sexual activity throughout the year; the lowest scores recorded were during winter. Through observed variations and despite a constant supply throughout the duration of the experiment, this result indicates that the season had a great influence on males' reproductive physiology regardless of changes in food resources.

There is some association between testosterone concentrations and the different scores of sexual behaviour throughout the year with some lag. Indeed, the increase in testosterone levels preceded the four weeks of elevation of sexual behaviour scores during spring season. In rams, the level of sexual activity fluctuates during the year in conjunction with the rate of testosterone.

Ahmad and Noakes (1995) reported that sexual function in sheep appears in adulthood; the information acquired during ontogeny appears to be involved in its organization. Price et al. (1988) reported that inexperienced younger rams showed a gradual increase

in sexual behaviour from the age of puberty. A brief exposure (white cross) to ewes in oestrus may increase their level of sexual behaviour at a level very similar to that of experienced adult rams. Other studies have shown that young ruminants also manifested an increase of sexual behaviour level over time (Godfrey et al., 1993).

According to our results, the performance of adult rams' sexual behaviour (from 4 years) did not improve with age; no change in latency to protrude between the first and the fourth ejaculates. In contrast, repeated stimulation by females was effective. By contrast, these performances were higher within the older rams (06 years old). We noticed that the sexual activity of all rams correlated with food context. In times of flushing, the degree of sexual behaviour and libido increased significantly. The same result was observed in spring season (April-June) while the rams were grazing. Knowing that during the most difficult periods of the year, a decrease of sexual activity is directly related to the exclusion of food resources in both sexes.

Baril et al. (1993) reported that in rams, libido decreases severely from five to ten weeks after the beginning of undernourishment (observed in a long-term deficiency of vitamin A). Rams of tropical and subtropical breeds (if well fed) do not show seasonal variations in their behavioural and spermatogenic activity. In some cases, however, the situation may be complicated by the fact that in tropical and subtropical countries, high temperatures during hot seasons cause the appearance of dead and abnormal sperm (Baril et al., 1993). These authors reported that while spermatogenesis within sheep living in middle and high latitudes does not stop the number of sperm produced by the testis, it decreases at certain seasons of the year. Outside the breeding season, the total number of sperm per ejaculate decreases more rapidly with the order numbers than successive ejaculates during the breeding season. This goes in line with the findings of our research. The intensification of sexual behaviour during the sexual season is due to an increase in testosterone that occurs earlier. This hormone is responsible for the proliferation of Leydig cells, Sertoli cells and germ cells, resulting in increased testicular size and sexual activity.

Male sexual behaviour has no short-term variations. In temperate zones, sheep sexual activity is seasonal; the male's sexual responsiveness varies slowly and gradually over the years in a parallel manner, but offsets with respect to the development of androgen production. In the short term, testosterone is secreted within males in the form of discrete episodes. These rapid changes in circulating levels do not show a direct relationship with sexual behaviour (Signoret and Balthazart, 1983). The importance of seasonal effect in sheep depends more on latitude as we get close to the equator, and less is important (the main factor responsible for this seasonality is photoperiod). Temperature can also play a role by artificial manipulation of illumination and can possibly

lead to changes in the breeding behaviour (Fabre-Nys et al., 1993).

Sexual behaviour and plasma testosterone levels were reported to be highest during spring and autumn. This trend coincided with a decrease in the length of day and ambient temperature. The pronounced increase in the level of testosterone during autumn was also reported in the studies done by Kaya et al. (1999) and Keskin and Keçeci (2001). These researchers suggested that stimulation of the pituitary gland in the ram is more likely to begin in autumn during low and ambient temperatures and reduced length of day. A similar trend of our results was observed in several varieties of sheep in Northern Turkey, showing a maximum testicular androgen activity in autumn and a minimum in summer (Aral and Tekin, 1996; Ataman et al., 1996; Gündoğan and Demirci, 1999; Gündoğan et al., 2003).

A slight modification of the environment (change of mating or feeding location), can inhibit or activate the sexual behaviour of rams. Sexual activity and reproductive health are reduced or inhibited in subordinate rams having suffered social stress. Motivation and sexual performance of rams may be modified by competition and existing hierarchy in a group. In males, the dominant can block or reduce the activity and gonadal androgen secretion within the dominated party (Signoret and Balthazart, 1983).

In dominated male, androgen secretion is often inhibited by the presence of dominant or is not in conjunction with high levels of corticosteroids and sexual activity is itself reduced. Social stress and adrenocortical activation are also involved in rams and found when the population density increases (Fabre-Nys et al., 1993). Where there are stable relations of dominance-subordination between males, the dominant has preferential access to receptive females. Competition can lead to fierce battles, especially when foreign males are involved.

Subordinates may be excluded and the group becomes a permanent or temporary harem. However, the existence of dominance does not necessarily lead to a complete exclusion of subordinate males. Changes in levels of aggression/tolerance of the dominant, the degree of synchronization of receptivity in females and their dispersion in space are all factors that may allow access of subordinate males to reproduction (Fabre-Nys et al., 1983).

## Conclusion

Rembi breed rams living in the area of Ksar Chellala are constantly nurtured whether young or adults and are sexually active throughout the year. This reflects the conservation of sexual activity at all stages (sexual behaviour and plasma testosterone concentration) with some seasonal variations. Regarding reproductive parameters, sexual behaviour was positively correlated with testosterone that is much more pronounced within adults.

Young rams of the Rembi breed were quite sensitive than adults to the adverse effects of heat, stress and food. We noted a decrease in sexual activity of the youth category during times of very high temperatures "ram sterility of summer", during winter, periods of food restriction and poor pasture. However, the reproductive activity of all rams continued during the year with spring and autumn at its peak (decrease of ejaculation latency; increase of servings by test) with a decrease during summer and winter (increased latency of ejaculation with a decreased number of overlaps per test). The presence of a dominant ram can cause a kind of hierarchy within a group of males, resulting in a slight decrease in reproductive performance of subordinate subjects.

In conclusion, we can say that the importance of these seasonal effects was not marked to prevent the rams of the Rembi breed to present an acceptable sexual activity (quantity and quality) throughout the year. This requires a fight against severe weather while food intake must be adequate with a supplement in seasons of struggle and during bad times; however, a good clinical follow-up of breeding rams could be useful.

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