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Full length Research Paper

Breeding soundness examination: Understanding the causes of examination failure in young and mature Rams

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The objective of this study was to determine the causes of breeding soundness failure in rams using a breeding soundness examination and a scrotal circumference (SC) measurement. The experiment was performed with the breeding soundness examination records and SC measurements of 1.002 rams classified as young (18 months) and mature (more than 18 months). The breeding soundness examination parameters were analyzed using Chi-square tests, Pearson's correlation coefficients and principal component analysis. Scrotal circumference was submitted to analysis of variance, and the means were compared using a Tukey test at a 5% probability level. Some rams were eliminated from the breeding soundness examination, independent of age and breed, and an interaction between age and breed was detected. There were significant correlations of body condition score with teeth and leg problems and of mass movement, motility, and vigor with epididymis problems. Among the main causes of failure, 28.6% were related to problems with the penis, epididymis, testicles, mass movement, motility and vigor. The highest SC was found in Poll Dorset rams. The reproductive examination indicated that the rates of ram failure were variable and dependent on the age and breed of the animals examined.

Key words: Breeds**,** fertility, ram fitness, reproductive evaluation, semen.

INTRODUCTION

Natural mating is the main breeding method in sheep production systems, and herd reproduction efficiency essentially depends on ram and ewe fertility. In these systems, male fertility evaluation is important for the success of breeding (Lupton, 2008).

Accordingly, the Brazilian College of Animal Breeding published guidelines for the performance of the breeding soundness examination as a pre-breeding examination of

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the fertilization capacity of rams to minimize herd breeding losses (CBRA, 1998).

The variations in the causes of failure in this examination among rams require regular evaluation because factors such as management and farm technology, location where rams are examined, age and breed, season, type of test and veterinarian performing the test may contribute to those variations. However, there have been a few recent studies on the evaluation of such causes in sheep production systems (Hulet et al., 1965; Bruere, 1970; Moraes et al., 1977; Ott and Memon, 1980; Moraes et al., 1981; Galloway, 1983; Ruttle and Southward, 1988; Moraes and Oliveira, 1990, 1996; Freitas and Nunes, 1992; Fthenakis et al., 2001).

One of the most important reproductive traits of rams when determining their breeding potential and the sexual precocity of males and females is the scrotal circumference (SC). Rams presenting a larger SC may produce more and better quality semen compared with rams with a smaller SC (Ruttle and Southward, 1988). This trait has moderate to high heritability and is negatively correlated with age when their daughters are in puberty. Considering that the age at puberty of females is favorably associated with their subsequent production, the selection of rams with a larger testicle size may improve herd fertility (Maurya et al., 2010; Oberst et al., 2011).

In general, prior to the breeding season, young rams are submitted to a breeding soundness examination, but mature rams are not. Therefore, the objective of the present study was to identify the causes of breeding soundness examination failure in rams of different ages and breeds.

MATERIAL AND METHODS

Evaluated animals

A database including the records of 1.002 rams submitted to breeding evaluation between January and February 2011 was analyzed. The rams were between one and half years old (261 animals) and six years old (741 animals) were classified as young (18 months old) or mature (more than 18 months old). Young rams were considered those that had never been used in mating systems, whereas mature rams had previous sexual experience, that is, had mated during the previous breeding season. All of the animals were maintained on pastures with an adequate food allowance and were submitted to external and internal parasite control. The rams were from 21 different farms located in five counties of the region of the west border of the state of Rio Grande do Sul, Brazil.

The rams belonged to the following breeds: Corriedale (CO, 643), Australian Merino (AM, 52), Poll Dorset (PD, 31), Suffolk (SU, 87), and Texel (TX, 189). Scrotal circumference (SC) data were analyzed only from 429 rams belonging to the PD (32), SU (87), TX (191), CO (83) and AM (36) breeds, with 261 young and 168 mature rams.

Breeding soundness examination

The breeding soundness examination was performed accor-according to the guidelines of CBRA (1998), which includes three steps:

- **Step 1** – general clinical examination: eyes (keratitis, keratoconjunctivitis, and tumors are reasons for failure), teeth (good and intermediate-height teeth are reasons for approval, and low and missing teeth are reasons for failure), body condition score (E1: very thin and E2: thin are reasons for failure, and E3: good body condition, E4: very good body condition, and E5: fat are reasons for approval), and leg conditions (sprain legs, osteoarthritis, kyphosis, lordosis, scoliosis, straight legs, spastic palsy, and hoof problems are reasons for failure);
- **Step 2** – special clinical examination of the reproductive tract: prepuce (sores, posthitis, prolapse, and papilloma are reasons for failure), penis (distension, papilloma, sore, balanitis, deviations, adhesions are reasons for failure), scrotum (dermatitis, sores, and myiasis are reasons for failure), testicles (D1 very firm and elastic, D2: firm and elastic, and D3: soft are reasons for approval, and D4: flaccid or spongy testicle, cryptorchidism, monorchidism, orchitis, hypoplasia and degeneration are reasons for failure), and epididymis (D1: very firm and elastic, D2: firm and elastic, and D3: soft are reasons for approval, and D4: flaccid or spongy, aplasia, and epididymitis are reasons for failure). Scrotal circumference was measured by pulling the testicles to the bottom of the scrotum and measuring the widest circumference with a metal tape in millimeters. The procedure was immediately repeated to check the measurement. Scrotal circumference was classified as follows: in young rams SC≥31 cm, approved, and <31 cm, failed; in adult rams SC≥32.5 cm, approved, and <32.5 cm, failed (Moraes, 1990).
- **Step 3** – semen examination: motility (approved when ≥50% and failed when <50%), vigor (I and II result in failure; III, IV, and V result in approval), mass movement (1 and 2 result in failure; 3, 4, and 5 result in approval), and sperm concentration. Semen collection was performed using the method of electro-ejaculation, as this method is convenient and fast, allowing for the assessment of a large number of rams in a short period of time. The small number of rams that was not responsive to this method had their semen collected using an artificial vagina method. When needed, a second semen collection was performed on the same day. Because of logistical reasons, a sperm morphology

Table 1. Percentage of rams that failed according to age and breed.

Breed	N	Young (%)	N	Mature (%)	General mean
AM	22	9,1 a	30	13,3 b	11,5
CO	109	17,4 b	534	18,0 c	17,8
PD	17	11,8 aA	14	7,1 aB	9,6
SU	57	29,0 cA	30	14,0 bB	19,5
TX	137	10,2 aB	52	15,4 bA	11,6
General mean		13,4		18,4	

AM: Australian Merino; CO: Corriedale; PD: Poll Dorset; SU: Suffolk; TX: Texel.
Means followed by different small letters in the same column and different capital letters in the same row are significantly different by the Tukey test at a 5% probability level.

Table 2. Correlations between general clinical examination, special clinical examination of the reproductive tract and in semen examination parameters.

	Teeth	Legs	Body condition	Penis	Prepuce	Testicles	Epididymis	Volume	Mass movement	Motility
Legs	-0.09									
Body condition	0.18*	0.19*								
Penis	-0.03	-0.004	-0.004							
Prepuce	-0.04	-0.008	-0.009	-0.001						
Testicles	0.01	-0.02	-0.02	-0.005	-0.01					
Epididymis	0.03	-0.01	-0.01	-0.004	0.11	-0.02				
Volume	0.30*	-0.01	-0.006	-0.02	0.06	0.16*	0.09			
Mass movement	-0.01	-0.008	-0.04	0.11	-0.01	0.11	0.17*	0.14*		
Motility	-0.04	-0.005	-0.04	0.11	-0.01	0.11	0.15*	0.14*	0.98*	
Vigor	-0.04	-0.004	-0.03	0.11	-0.01	0.12	0.15*	0.13*	0.98*	0.98*

*P<0.001

examination was not performed, although we are aware of its importance in the evaluation of male breeding soundness. In field studies with no laboratory support, veterinarians do not commonly use this examination; however, this is not an impediment for the diagnosis of reproductive failure (El-Alamy et al. 2001; Karou 2011).

Breeding evaluation was performed using the following order in the experiment: general clinical examination, special clinical examination of the reproductive tract, SC measurement, and gross and microscopic examination of the ejaculate. Even when a ram failed in one of the steps, it was submitted to the next steps and therefore all rams were submitted to all evaluation steps.

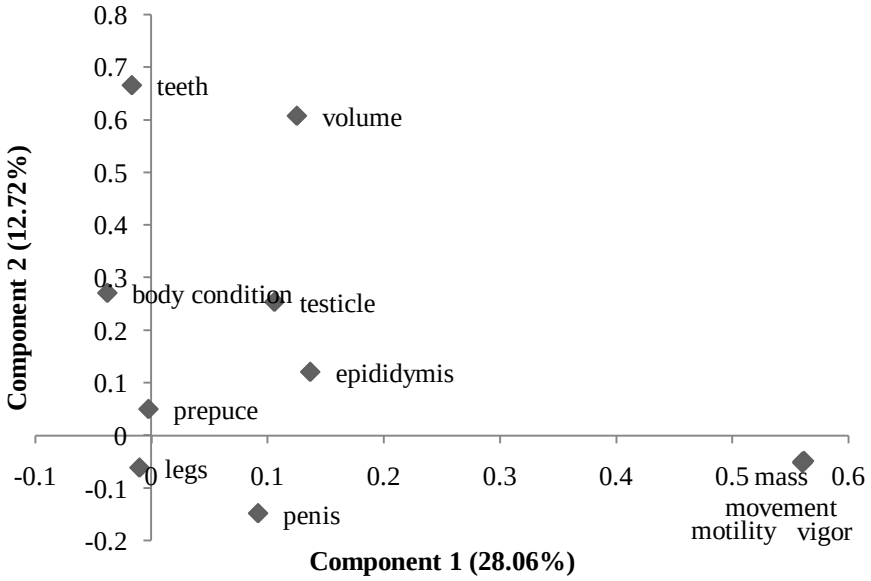

Figure 1. Graph representing the first two principal components of the causes of failure of rams in breeding soundness examinations.

However, only 429 randomly selected rams had their scrotal circumference measured to replicate previous experiments and validate this technique.

Statistical analyses

The Chi-square test (PROC-FREQ) was used to investigate the relationship
of the binary variable (approval or failure) among breeds and age classes (young or mature). Scrotal circumference was submitted to analysis of variance (PROC GLM), and the means were compared by using a Tukey test at a 5% probability level. Pearson's correlation coefficients among the parameters evaluated in the general clinical examination, in a special clinical examination and in the semen examination were calculated. Failure results were submitted to principal component analysis to identify the causes that most contributed to the failure of rams in the breeding soundness examination.
All statistical analyses were conducted using the Statistical Analysis System (SAS Institute Inc., 2002) software package.

RESULTS

Rams failed the examinations with rates between 9.1 and 29.0% in young rams and between 7.1 and 18.0% in mature rams, independent of breed and age. Moreover, there was an interaction between age and breed in failure rates, with a significant difference for the meat breeds (PD, SU and TX; Table 1).

The rate of failure of AM and CO rams was not affected by age (P>0.05). On the other hand, in PD and SU animals, young rams had higher failure rates, whereas mature TX rams presented higher failure rates. There were significant correlations of body condition score with teeth and legs problems (0.18 and 0.19, respectively) and semen volume with teeth and testicle problems (0.30 and 0.16, respectively). Mass movement, motility and vigor were significantly correlated with epididymis problems and the semen volume as well as semen physical characteristics and mass movement, motility and vigor (Table 2).

Among the main causes of failure, 28.6% were related to problems with the penis, epididymis, testicles, and semen volume, mass movement, motility and vigor, whereas 12,72% were due to leg and teeth problems, body condition score and prepuce defects (Figure 1). The average scrotal circumference (SC) was not different between young (32.89 cm) and mature (33.21 cm) rams. Relative to breeds, PD rams presented the highest average scrotal circumference (36.62 cm), whereas AM rams presented the lowest SC (31.33 cm) with significance differences (Table 3).

DISCUSSION

The selection of fertile rams with excellent sexual performance allows for the mating of a high number of

Table 3. Mean and standard deviation of the scrotal circumference (SC) of rams, according to age and breed.

Breed	Young (cm)			Mature (cm)			General mean
	N	Mean	SD	N	Mean	SD	
CO	27	30.11	2.51	56	32.17	1.99	31.50 cd
AM	22	30.09	2.32	14	33.28	1.85	31.33 d
PD	18	35.52	2.05	14	38.03	1.78	36.62 a
SU	57	34.71	2.34	30	35.33	1.88	34.93 b
TX	137	32.78	2.35	54	31.85	2.31	32.51 c
General mean		32.89			33.21		

AM: Australian Merino; CO: Corriedale; PD: Poll Dorset; SU: Suffolk; TX: Texel.
Means followed by different small letters in the same column are significantly different by the Tukey test at a 5% probability level.

females over a short period of time, which contributes to improving the reproduction efficiency of a herd (Hulet et al., 1965; Ott and Memon, 1980; Kimberling and Parsons, 2007; Pacheco and Quirino, 2010). This emphasizes the importance of the regular performance of a breeding assessment. In the present study, consistent causes of failure were identified, and the rates varied according to age, breed, and type of examination (general and special clinical examination and semen evaluation). Kimberling and Butler (1986) found higher failure rates in the breeding soundness examination of mature rams than those obtained in the present study. This variability may be explained by many factors, such as management practices, technologies employed for the intensification of production systems, location where rams are examined, season when the breeding soundness examination was performed, type of examination, veterinarian that performs the examination, and even the method applied for statistical analysis (Amann, 2005).

The main causes of the reproductive failure of rams in the present study were physical (missing teeth, pododermatitis, poor body condition, testicle hypoplasia and epididymitis) and associated with semen (poor mass movement and motility), which is in agreement with the findings of other researchers (Moraes et al., 1977; Ott and Memon, 1980; Moraes and Oliveira, 1996). In addition, the main causes of failure were physical, although the observed cumulative rates are different from those found in other studies, as the causes are variable and dependent on numerous factors. According to Moraes et al. (1977), Moraes et al. (1981), and Selaive-Villaroel and Moraes (1987), 30 to 40% of rams in a population fail because their semen quality and quantity are inadequate and/or they present physical defects, which is consistent with the findings of the present study.

In the state of Rio Grande do Sul, sheep production relies on grazing on predominantly natural pastures, and their quality and quantity are often not taken into consideration (Metre et al., 2012). Seasonal variations in forage availability in natural pastures cause severe nutritional deficiencies in the winter, mostly of energy, and this may reach different magnitudes according to year (Prates et al., 1979). The poor body condition score determined in the general clinical examination accounted for the failure of rams, which stresses the importance of adequate nutritional planning for the winter feed shortages and the breeding season, as adequate feeding is essential for the expression of their breeding potential.

Maurya et al. (2010) concluded that the breeding efficiency of rams is better when their body condition is adequate during the breeding season. A study carried out by Maia et al. (2011) found that rams with a moderate body condition score (3.0) presented better performance in most of the evaluated parameters compared with those with low (2.5) or high (4.0) body condition scores, which is consistent with the results obtained in our experiment. The effects of nutrition on the sexual behavior, testicle measurements, and semen parameters of rams were well-documented in the semi-arid region of India, where it was demonstrated that rams with a 3.0 or 4.0 body condition score presented better performance than those with a body condition score of 1.0 (Maurya et al., 2010).

Clinical examinations are essential and should be the main criterion to identify rams that should not be approved as breeders (Bruere, 1970; Watt 1972; Ott and Memon, 1980; Galloway, 1983). A study performed by Fthenakis et al. (2001) with 293 rams in 47 farms in southern Greece demonstrated that 143 rams (49%) presented at least one abnormality in any of the steps of the breeding soundness examination. General health causes represented 33% of the abnormalities, including mainly interdigital dermatitis, hoof lesions, and breast lesions; genital causes represented 20%, with high frequencies of testicle hypoplasia and prepuce lesions.

These results are higher than the rates found in the present study (27%); however, the main pathologies are similar to those found in this study.

In Rio Grande do Sul, a survey on the incidence of causes of failure due to genital problems of 68 Corriedale, Ideal, Romney March, Hampshire Down, and Texel rams reported 36.77% abnormalities (Silva et al., 1976), which is much higher than the percentage found in this experiment (5.84% in young rams and 5.01% in mature rams).

In the present study, the rates of failure in the semen examination were important, despite the lack of consideration of seasonal differences, as in the study of Karagiannidisa et al. (2000). When studying the seasonal variation in semen production among rams within each breed, those authors found significant differences in semen quantity and quality. Moreover, Oberst et al. (2011), in a similar study to Lacaune rams, observed that except for sperm concentration, all other semen characteristics presented seasonal variation. Consistent with the present study, Metre et al. (2012), when performing 14,667 BSEs of 11,804 rams, found that 29.0% failed and that the most common reason for failure was substandard semen parameters (43.8%). However, this seasonal effect is not sufficient to prevent rams from being used year-round, as their performance varies according to region, breed, and management practices. Freitas and Nunes (1992) stressed that for some breeds in determined regions, seasonality may not limit sperm volume and morphological characteristics.

Semen evaluation must be performed routinely, as there are quantitative and qualitative differences within the same breed. Another cause of individual variation within a breed is nutrition, reinforcing the need for regular examinations. For instance, Maurya et al. (2010) found significant differences in the semen characteristics of Malpura rams, except for sperm concentration, between rams with a low (2.5) and moderate (3.0 to 3.5) and high (4.0) body condition score.

The variation obtained in scrotal circumference may indicate genetic differences among rams, as demonstrated by other researchers. Moraes and Oliveira (1990) evaluated Corriedale rams that were fed and prepared for breed exhibitions and found an average SC of 31.2 cm for young rams and 32.5 cm for mature rams, and Jobim et al. (1989) obtained SC values of 32.82 and 30.77 for Suffolk and Texel rams, respectively. These values are smaller than those obtained in the present study. Braun et al. (1980) obtained SC values for Corriedale, Poll Dorset, and Suffolk yearling rams of 33.5, 37.3, and 37.1 cm, respectively, which are higher than those found in the present study. These differences are most likely due to variations in management practices, location, evaluated year, and rearing systems between the three aforementioned experiments and ours.

In addition, the association between testicle measurements and spermatogenesis quantitative parameters was reported (Souza, 2003). Söderquist and Hultén (2006) detected a high correlation (r^2>0.90) between the scrotal circumference and testicle weight and, consequently, with sperm production in rams. Different from the present study, Maia et al. (2011) did not find any influence of breed on semen parameter or scrotal circumference. According to Silva and Nunes (1984), the variations in testicle circumference are more important than breed when considering sperm production. In a study performed by Ruttle and Southward (1988), SC was measured in 3.167 Rambouillet and Debouillet rams of different ages, and the authors recommend a minimum value of 32.2 cm for the selection of rams for this characteristic. The authors mentioned that rams with low SC (<30.8 cm) were considered not approved by the breeding evaluation (P<0.001).

Scrotal circumference and testicle weight have been widely used to predict breeding soundness of males (Sarder, 2005; Raji et al., 2008), and body condition and nutrition are determinant factors in the development of SC. Braun et al. (1980) demonstrated that rams belonging to large breeds have larger SC, and there is a significant correlation between this parameter and body weight in all breeds. This was clearly demonstrated in the present study, where meat-type rams, which are larger and heavier, presented higher SC than those belonging to double-purpose or wool breeds.

In addition, when selecting rams for SC, the selection must be made within contemporary groups (Moraes and Oliveira, 1996). Therefore, for selection for scrotal circumference purposes, it is possible to recommend – as Coulter et al. (1987) and Menegassi et al. (2011) suggested for bulls – to use one standard deviation above the mean for the selection of rams, as all rams present a marked variation both in SC and semen quality influenced by seasonality (Moraes and Oliveira, 1996). Söderquist and Hultén (2006) suggest using the mean SC value plus two standard deviations above the mean as a practical tool for the exclusion of rams with suboptimal breeding soundness.

The breeding soundness evaluation results of rams were found to be consistent, independent of breed and age. Physical problems were the main causes of failure, and their incidence varied according to age and breed. Meat-type rams (Suffolk, Poll Dorset and Texel) presented with a higher scrotal circumference than wool-type rams (Australian Merino and Corriedale). Based on the reproduction examination, it can be concluded that the rates of failure of rams were variable and dependent on the age and breed of the animals examined.

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Abbreviations: CO (Corriedale); AM (Australian Merino); PD (Poll Dorset); SU (Suffolk); TX (Texel); SC (scrotal circumference).

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