The Missing Piece of the Fertility Equation? Scrotal circumference effect on female fertility - is it real.

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One of the most difficult traits to select for in a beef cattle enterprise is reproduction since most fertility traits are lowly heritable and it can be difficult and time consuming to measure traits like cow longevity. It has been well documented that herd reproduction can be improved through crossbreeding or one can enhance the onset of puberty or pregnancy rates through increased nutrition during critical times of the production cycle. Although, the later is usually not cost effective and there is a point where feed cost are too great to over come and it no longer becomes economically viable for the producer. Consequently, producers look for traits that are easy to measure and have been shown to have some relationship with fertility. One of those traits is scrotal circumference.

Scrotal circumference is one of the most accurate indicators of puberty in bulls with the average scrotal circumference at puberty of 28 cm (range 25 to 30 cm), which can be both within breeds and across breeds. Scrotal circumference is an accurate predictor of sperm output in young bulls, as well as the future sperm producing characteristics of the testes. Increased yearling scrotal circumference size is positively related to increased sperm motility, increased normal sperm numbers, and a decrease in abnormal sperm numbers observed in an ejaculate.

In general, scrotal circumference is highly heritable in *Bos taurus* cattle, with estimates ranging from 0.36 to 0.71 (Latimer et al., 1982; Bourdon and Brinks, 1986; Morris and Wilson, 1997). In contrast, scrotal circumference is moderately heritable in *Bos indicus* based cattle with estimates ranging from 0.16 to 0.29 (Meyer et al., 1990; Kriese et al., 1991; Morris et al., 1992). In Nellore bulls, Boligon et al. (2011) reported heritability estimates of 0.24 at 229 days of age, 0.47 at 300 days of age, and 0.52 at 500 days of age, suggesting that scrotal circumference should be measured between 400 to 500 days of age in this population of Nellore bulls. Likewise, Silva et al. (2013) reported a heritability estimate of 0.40 in Nellore bulls at 18 months of age. Consequently, with a moderate heritability for scrotal circumference, selection and utilization of scrotal circumference EPD can probably still be used as a tool to improve male fertility. Having fertile bulls available to breed cows through multiple breeding seasons is essential for herd profitability.

Although, the heritability of scrotal circumference is moderately heritable, the heritability of traits associated with sperm in an ejaculate is more variable. Kealey et al. (2006) reported heritability estimates of the percentage of live sperm to be 0.22 and percentage of normal sperm in an ejaculate to be 0.35 in Hereford bulls. Primary abnormalities are typically reflective of abnormal sperm development within the testes and thought to be at least partially genetic in origin. Likewise, percentage of sperm with primary abnormalities had heritability estimates of 0.30, which was similar to 0.31 reported by Smith et al. (1989) in Hereford bulls. Meanwhile, Silva et al. (2013) reported heritability estimates of 0.02 for primary abnormalities in Nellore bulls. The heritability of secondary abnormalities (reflective of faulty epididymal sperm maturation) has low heritabilities ranging from 0.00 to 0.30 (Kealey et al., 2006) and 0.02 (Smith et al., 1989) in *Bos taurus* cattle and 0.16 in Nellore cattle (Silva et al., 2013). With such low heritabilities for both primary and secondary abnormalities, environmental effects may play a more important role in inducing primary and secondary abnormalities than genetics. Hence, developing a selection program to make progress on improving seminal characteristics of an ejaculate may prove challenging.

The seminal work completed by Dr. Jim Brinks group at Colorado State University reported that increased scrotal circumference in sires resulted in decreased age at puberty in daughters, which was a negative but favorable genetic correlation (See Martin et al., 1992). The genetic relationship ranges from -0.15 (Martinez-Velazquez et al., 2003) to -0.39 (Morris et al., 1992) in *Bos taurus* based heifers. In contrast, Johnston et al. (2014) reported a genetic correlation between scrotal circumference in 12 month old Brahman bulls and age at puberty in female progeny of -0.41. Additionally, Johnston et al. (2014) reported a genetic correlation between scrotal circumferences in 6-month-old Brahman based tropical composite bulls and age at puberty in female progeny of -0.30. Even though these correlations are low (*Bos taurus*) to moderate (*Bos indicus* based), it still suggests that selecting for increased scrotal circumference may lead to decreased age at puberty in the female progeny.

Although one may argue that there is minimal economic benefit to decreased age at puberty in females, there is an advantage to getting > 70% of the heifers reaching puberty before the start of the breeding season and getting as many heifers pregnant as early as possible during the breeding season since cattle that calve early in the subsequent calving season tend to calve early the remainder of their lifetime and have greater lifetime productivity. Additional economic benefits could include reduced feed cost in developing replacement heifers if the producer knows that a majority of their heifers will reach puberty at younger ages.

Another important question; is scrotal circumference related to other female reproductive traits such as heifer pregnancy rate? Heifer pregnancy rate is an important measurable trait that can have a significant economic endpoint. Most of the research suggests that the genetic relationship between scrotal circumference and heifer pregnancy rates is either non-existent or minimal and may depend on breed type. In *Bos taurus* breed types, Martinez-Velazquz et al. (2003) reported a genetic correlation of 0.00, whereas McAllister et al. (2001) reported a relationship of 0.05. In contrast, Eler et al. (2004) reported a genetic relationship of 0.20 in Nellore cattle; whereas, Johnston et al. (2014) reported a genetic relationship of 0.19 in Brahman cattle. It should be noted that in all of these studies, heifer pregnancy rate is reported as a breeding season pregnancy rate, where the breeding season is typically 60-90 days. In all of these studies, where during the breeding season heifers became pregnant is not reported. As indicated earlier, this is important since cattle that conceive early in the breeding season tend to calve early the remainder of their lifetime and have greater lifetime productivity.

Additional research must be conduced to determine if there is a genetic relationship between yearling scrotal circumference and age of puberty in heifer progeny particularly in cattle of *Bos inducus* breeding. Additionally, the relationship on when in the breeding season heifers became pregnant and its long-term effects on cow longevity and herd economics must also be examined.

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