# REPRO TRACKS

*by Cliff Lamb, Texas A&M University*

## Developing Bulls

*Effects of nutrition on the fertility of developing bulls.*

Although we frequently focus our discussion of the effects of nutrition on reproduction in females, we seldom address issues associated with nutritional development and reproduction in bulls. It is a well-known fact nutritional management has a significant influence on attainment of puberty in bulls, along with more acute effects with the potential to affect sperm motility and morphology.

This is important because bulls account for a substantial portion of the genetic influence in a cow herd and are the primary means through which the majority of producers affect genetic progress. Producers who breed bulls to market to other seedstock producers or to commercial producers need to ensure the bulls perform.

Bulls retained for breeding are commonly fed high-energy diets in order to meet or exceed the rate of physiological development required to achieve sexual maturity prior to their first breeding season, while simultaneously evaluating genetic merit for growth and other economically relevant traits such as feed efficiency. Although current dogma suggests postweaning nutrition has the greatest environmental influence on sexual development in bulls, there is some compelling evidence to indicate preweaning nutritional management influences these outcomes to a greater degree.

In many cases there is a preconceived notion bull calves will generally receive the nutrients required to sustain growth at the level necessary to initiate the onset of puberty from their dams. While this may be the case in nutrient-rich environments mitigating cow body condition loss, this should not be expected in nutrient-limited environments.

Bull calves raised by multiparous dams (those that have given birth to more than one calf) have been observed to have larger testicles at weaning compared to bulls raised by first-calf heifers.

This indicates sexual maturity of bull calves raised by first-calf heifers may be delayed as a result of a reduction in nutrients of the younger cows than older cows who yield greater amounts of milk. Therefore, in nutrient-limited environments, creep-feeding developing bulls may be a practice for those producers who plan to market bulls and want to ensure they have attained puberty at an early enough age.

Development of young bulls occurs in three distinct phases: infantile, prepubertal and pubertal, with each stage dependent on gonadotropin levels. The gonadotropins necessary for reproduction in bulls include luteinizing hormone (LH) and follicle-stimulating hormone (FSH), and their secretion is dependent upon gonadotropin-releasing hormone (GnRH).

Low production and concentrations of gonadotropins are commonly observed during the infantile stage. The prepubertal phase is characterized by increases in gonadotropins and a subsequent increase in testosterone secretion between 8 and 20 weeks of age. When the pubertal period is reached, gonadotropin concentrations decrease, while concentrations of testosterone remain elevated.

Hormones affected or induced through nutrition that influence these reproductive hormones include leptin, insulin and insulin-like growth factor-I (IGF-I). Nutrient restriction has been shown to decrease leptin and LH secretion in cattle. IGF-I receptors reside on Leydig and Sertoli cells of the testes, and are partially responsible for the production of testosterone and support of spermatogenesis, respectively. Proliferation of Leydig cells occurs in response to exposure to IGF-I and LH.

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Therefore, nutrient restriction results in lower concentrations of IGF-I and decreased LH secretion in peripubertal bulls, which leads to decreases in overall testosterone production.

In other words, bulls fed greater levels of energy and protein preweaning will likely achieve puberty at a younger age and have larger testes compared to bulls that receive low protein and energy in preweaning diets. Research has demonstrated bulls fed low-energy diets during the preweaning phase were not only restricted in the attainment of puberty, but these negative effects were unable to be reversed by feeding high-energy diets during the postweaning phase.

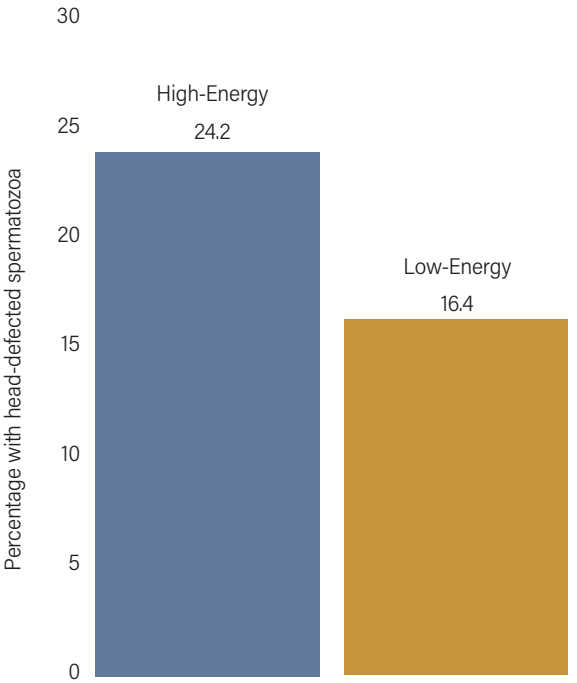
Postweaning development is generally dependent on high-energy diets, as they provide the greatest potential for evaluation of genetic merit for growth and other economically relevant traits. While preweaning nutritional management plays an inherent role in fertility outcomes, postweaning nutritional management also has the ability to elicit changes in development and subsequent indicators of fertility.

A great amount of concern exists across the beef cattle industry pertaining to the negative consequences of overnutrition during the postweaning development phase. These concerns have, in large part, been driven by reductions in spermatozoa motility and increases in the prevalence of morphologically abnormal spermatozoa that have coincided with the postweaning development of bulls using aggressive nutritional management strategies resulting in high levels of growth performance.

In general, bulls receiving high-energy diets during the postweaning phase may have an increase in scrotal circumference. Research has demonstrated these diets also have negative effects on spermatozoa production and result in the maintenance of fewer epididymal spermatozoa.

In one controlled experiment, bulls that received a postweaning high-energy diet for 168 days had an incidence of head-defected spermatozoa exceeding 24%. In comparison, bulls that received a low-energy diet for the same interval had head-defected spermatozoa rates of 16.4% (see Figure 1). Other research has demonstrated bulls fed the high-energy diets yielded less motile and morphologically normal spermatozoa than bulls reared on low-energy diets.

**Figure 1:** ***Incidence of head-defected spermatozoa in bulls receiving high- or low-energy postweaning diets for 168 days prior to assessment (Adapted from Mwansa and Makarechian, 1991).***




Another consequence of high-energy diets for bulls is scrotal temperature is also greater than bulls receiving a lower-energy diet. Elevated dietary energy likely increases scrotal fat deposits, which may affect semen quality.

Bull testes must be 4 to 6°C cooler than core body temperature to produce fertile spermatozoa, and the accumulation of adipose tissue around the vascular system of the testes may limit the ability of the pampiniform plexus to act as a countercurrent heat exchanger. Restriction of this mechanism from elevated dietary energy and scrotal adiposity offers one explanation to the effects of high-energy diets on semen quality.

It appears preweaning nutritional management likely affects the attainment of puberty to a much greater degree, whereas postweaning management may only play a minor role on attainment of puberty as long as bulls receive suitable minimum dietary requirements.

Other factors may also play a role in semen quality — such as pH of the rumen, stress and climate.

Producers should pay close attention to the diets of their bulls to ensure the animals are capable of passing a breeding soundness exam (sometimes referred to as a BSE), before being introduced to females for mating. AJ

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