



[Beef 2016 'Profitable Technologies, Teagasc, Grange, Dunsany, Ireland, Open Day July 2016, p138-141]

Bull fertility: important issues and current research

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Summary

- The stock bull is typically the most valuable animal in the herd and has the single greatest influence on herd fertility and genetic merit.
- It is essential that vigilance for bull fertility and mating performance is maintained on an on-going basis throughout the breeding season.
- Up to 5% of bulls can be infertile while up to 25% experience subfertility.
- Appropriate attention must be given to the nutritional, health and housing management of stock bulls.
- Current Teagasc research is examining the nutritional and genomic control of puberty and fertility in bulls.

The stock bull – often overlooked and underappreciated!

Natural service is the predominant breeding strategy used on Irish suckler cow herds; over 80% of calves born annually are sired by stock bulls. Consequently, given the small herd size and predominate use of single-sire mating, the fertility of the stock bull is of major importance to both the number of calves produced and the calving spread within herd. Indeed, level of fertility is much more important for an individual bull than for a cow, given that the former may be used to breed up to 40 females during a normal breeding season. Furthermore, while a bull may have a 4 or 5-star rating for genetic merit, this is solely a prediction of his progeny's production potential and has no bearing on the bulls own ability to get cows pregnant. While the reported incidence of sterility is generally low (<5%), subfertility, at a consistent level of 20-25%, is much more common in breeding bulls, with significant differences in fertility among individual animals. Subfertility may be caused by low libido, sperm quality/quantity, defects or physical factors affecting bull mobility or mating ability.

While a sub fertile bull may be capable of getting some cows pregnant, it will result in low pregnancy rates, an extended calving interval, reduced calf weaning weights and higher involuntary culling of cows for barrenness, unless the bull is operating within a herd with a very low cow: bull ratio. Frequently, subfertile bulls go undetected and herd owners may be unaware of the problem until much of the breeding season has elapsed or until such time that cows are checked for pregnancy. Furthermore, there is not guarantee that a bull will retain his fertility from season to season or even within a season. Thus, herd owners must be continually vigilant for potential fertility problems and keep breeding records of when cows are bred so that corrective action can be taken before it is too late.

Scrotal characteristics and bull fertility

Scrotal circumference increases with bull age, most rapidly between 6 months and 2 years, typically peaking at 3 years of age. Research has shown that it is highly correlated with paired testis weight, which is, in turn, positively related with daily sperm production and semen quality. Generally, bulls with larger, even sized, testes produce more and better quality sperm. Additionally, the heritability of scrotal circumference is relatively high and there is some evidence for a positive relationship between sire scrotal circumference and daughter fertility. On the contrary, however, an excessively large scrotal circumference and, or a pendulous scrotum, is undesirable as it can lead to injury to the

testicles which may render the bull infertile. Because of its relationship with overall reproductive potential and usefulness in identifying unsatisfactory bulls, scrotal circumference measurements are now a pre-requisite for entry to many bull sales.

It is also now well established, that for the production of fertile sperm, the temperature of the testes must be 2-6°C lower than core body temperature. Increased testicular temperature, irrespective of the cause, reduces semen quality and is probably the most common cause of infertility in bulls. The duration for which semen quality declines following a thermal insult would appear to be related to its severity and duration, with sperm morphology returning to normal within 6 weeks of the end of the increased temperature, though resumption of normal fertility may take somewhat longer. As discussed later, increased scrotal temperatures may be a consequence of contraction of disease, injury or indeed due to an increase in the fatness of the scrotum as a consequence of an excessively high plane of nutrition.

Health management

The purchase of a stock bull is one of the largest routine investments made by herd owners and thus, the health of such valuable animals should be protected appropriately. For example, as mentioned earlier, any event that leads to rise in the temperature of the scrotum, including inflammation or fever as a consequence of contracting a disease, can lead to damage to developing sperm cells and therefore temporary infertility. Pedigree bulls are often raised in small herds and, thus, on introduction to a new herd can be immune-compromised when exposed to diseases such as infectious bovine rhinotracheitis (IBR), pneumonia, respiratory syncytial virus (RSV), leptospirosis, to name but a few.

Disease prevention management for bulls should, essentially, be the same as for breeding females in the herd and veterinary advice on prophylactic care including vaccination programmes and parasite treatments should be sought. New animals introduced to the herd, should be screened for infectious agents prior to entry, if possible, or at least quarantined on the farm following purchase until test results are available. In many 'closed herds' purchase of a stock bull is the only animal movement into the herd and could potentially be a significant vector of disease. Bulls should only be purchased from reputable breeders who have an appropriate herd health management plan in place. Indeed, many of the main breed societies have strict health criteria and testing requirements that must be met before entry of animals is accepted to sales. Maintaining good hoof and limb health are also of critical importance to both the longevity and fertility of bulls. For example, data from a Swedish veterinary study found that, from a population of relatively young beef bulls culled for infertility most had evidence of arthritic lesions in their limbs, though they did not show overt signs of lameness. Joint lesions should, therefore, be taken into consideration as a possible contributory cause of reproductive failure in bulls with or without symptoms of lameness.

Breeding Soundness Evaluations

Because of the serious implications of an infertile or subfertile bull on herd productivity, a Bull Breeding Soundness Evaluation (BBSE), or pre-breeding examination is now widely recommended in order to aid the identification of potential fertility issues in advance of the onset of the breeding season. Ideally, a BBSE should be conducted on a yearly basis by a veterinary surgeon at least 60 days prior to the start of the breeding season. This will facilitate re-testing and ultimately timely replacement of bulls that may fail the examination.

The British Cattle Veterinary Association (BCVA) recently introduced a certification protocol for evaluating bulls and a number of Irish veterinary practices are BCVA accredited. These are offering this bull fertility assessment service to herds for breeding purposes which involves 4 main steps: i) *physical examination*, ii) *semen examination*, iii) *assessment of mating ability* (not generally performed) and, iv) classification or *overall prognosis*. While this or indeed any of the systems used, do not classify a bull as "fertile" or "infertile" their objective is to reduce the risk of poor fertility performance in stock bulls. Those classified as "satisfactory" will have reached minimum criteria for semen quality; scrotal circumference and no evidence of physical abnormalities have been found. Bulls with a low sperm count, with serious semen or physical defects, or which fail to meet minimum criteria for scrotal circumference are classified as "unsatisfactory" for potential stock bulls. A recent survey by our research group of stock bulls which underwent a routine BBSE (i.e. pre-sale or pre-breeding BBSE) identified that 25% of bulls failed. While these evaluations identify bulls with substantial deficits in fertility, they do not consistently identify subfertile bulls. Indeed, given that bull fertility is influenced by a wide range of factors, no single diagnostic test can accurately predict

fertility, although an appropriate combination of tests can be more informative and will help to avoid costly incidents of infertility.

Observation during the breeding season

During the breeding season it is important to check a bull for locomotion, any evidence of injury or arthritic problems, and that he is physically capable of mating cows. The best evidence of a bull's fertility potential is his ability to get cows pregnant. Therefore, it is advisable to record the identity of the first cows bred and either diligently check these cows for repeat to service or confirm pregnancy by ultrasonically scanning the cows 28-35 days after breeding. This is particularly important for young bulls joining the herd. While it is impossible to be precise regarding the exact number of cows to assign to a bull, given the many factors that can affect potential fertility, the general recommendation for yearling bulls is 20-30 cows; with up to 50 cows assigned to mature bulls of proven fertility.

Nutrition and bull fertility

Young bulls well grown for age will typically commence sexual activity earlier and have achieved a higher level of semen quantity and quality at the start of the breeding season than poorer performing contemporaries. This is the consequence of a complicated hormonal interplay between the brain, metabolic organs and the testes. Indeed, we and others have recently shown a positive effect of early life nutrition (up to ~ 6 months of age) on the age at which bull calves subsequently reach puberty, with very well-fed calves reaching puberty approximately 4-8 weeks ahead of their contemporaries maintained on a lower plane of nutrition. Indeed, our data suggest that if a bull calf has been exposed to a low plane of nutrition in the first 6 months of life (which can frequently occur with calves suckling cows with poor milk supply), increasing their feeding level thereafter will not appreciably advance puberty.

In general, the published information, to-date, on the effect of nutritional management on reproductive characteristics of young bulls would suggest that a balanced diet, consistent with achieving moderate to high (1.1-1.3 kg) growth rates through the first 12 months of life. This will ensure that producers can achieve the dual aims of ensuring bulls reach the required growth targets, while also achieving early onset of puberty and normal subsequent fertility. Following purchase and movement to a new herd, young bulls should be gradually transitioned from the high plane nutrition typical of pre-sale rearing regimens to a moderate diet that should be offered during the breeding season and beyond. This requires that bulls are purchased well in advance (ideally two months) of being joined with the cow herd. Indeed, too often, young bulls are turned out with cows very quickly following purchase, leading to dramatic loss of weight and body condition which can have implications for their subsequent fertility.

The specific dietary protein requirements to support reproductive development and fertility in bulls has not been examined; suffice to say that it appears to be consistent with the protein and amino acid requirements for normal growth. Similarly, while a number of trace elements (i.e. manganese, selenium, zinc) have been cited as being important to testicular function and sperm development, there is a lack of studies that have examined this subject in any detail and accurate information on the precise requirements to support optimal sperm development is needed. Prior to the onset of the breeding season mature bulls should be managed at least as well as their cow contemporaries and fed to attain a moderate level of body condition score (~3.5 on a 5-point scale); the concept of being 'fit but not fat' is applicable.

Genomics of bull fertility and future developments

As discussed earlier, a number of key fertility traits in bulls including scrotal size and sperm production capacity are known to be heritable and thus, facilitate genetic selection. The identification of genes in cattle, which have been shown to regulate fertility in other species, holds significant promise for understanding the regulation of fertility in bulls. On-going research by our group, funded by the Department of Agriculture, Food and the Marine, is examining key genes regulating the onset of puberty in young bulls and how these are affected by prevailing plane of nutrition. Internationally, studies are examining the relationship between specific differences in the DNA sequence of individual bulls and their reproductive performance. Progress is slow, given the difficulty in procuring information on the fertility status of bulls to compare with their DNA profile. Despite this, the advent of portable automated electronic technology that can conduct multiple tests on semen samples to better characterise sperm fertility and viability will aid with more accurate diagnostic and prognostic evaluations of a bull's reproductive capacity. Additionally, consistent with current plans for female

fertility traits, such information for bull fertility traits could, in future, be incorporated into national genomically assisted breeding programmes for beef cattle, which will be aided by the current Beef Data and Genomics Programme.

Acknowledgements

The authors gratefully acknowledge financial support from the Department of Agriculture, Food and the Marine under the Research Stimulus Fund (Project 11/S/116).

The above article was adapted and reproduced courtesy of Teagasc.

Footnote comment from Simon Marsh, Principal Lecturer – Beef Cattle Specialist, Harper Adams University.

Semen testing of bulls prior to purchase or entering the herd is recommended which is part of the BCVA certification protocol. An electro-ejaculation test can typically cost £90 per bull (October 2017) with reductions for multiple bull tests. Most veterinary practices offer this service which is certainly well worthwhile. From my experience in the field over the last 35 years most instances of extended calving intervals in suckler herds have been due to sub fertile or infertile bulls.

Another issue of concern for the industry are the numerous anecdotal comments from commercial suckler producers of issues with regard to infertility and longevity in bulls purchased at breed society sales that have been 'pumped with concentrates' throughout their life to reach show condition for the sale. Ideally bulls should be purchased based on their EBVs together with correct functional traits direct from a pedigree breeder, in 'working condition' that have been fed forage throughout their lives from a breeder that accurately and honestly records data for the EBVs. Some pedigree breeders and breed societies may not welcome this comment!