Why do straws vary in quality and why does it matter?

Cryopreservation is the most common way to preserve sperm, or commercialize male genetics in both livestock and wild species. Cryopreservation is the process where fresh sperm are frozen down to –196°C (temperature which cellular metabolism stops). They can be stored at this temperature indefinitely. When we want to use the straws, the cells are thawed to be used in fertilization. In livestock, cryopreservation assists the wide spread of genetic diversity and generational productive gain through artificial insemination and in vitro fertilization. **However, freezing and thawing process has detrimental effect on the sperm physiology, causing damage to the cell as well as molecular modifications that eventually lead to the reduction of sperm fertility and even the early death of a resultant embryo (30 to 90 days into the pregnancy)**.

When freezing sperm, intracellular ice forms. When this happens, the pointy ice crystals and the changes in water content inside the cell causes damage called 'cryodamage' (induced by the act of cryopreservation). This cryodamage causes severe alterations in critical sperm structures such as plasma membrane, acrosome, mitochondrial activity which fuels the sperm with energy, and DNA integrity. Many of these points of damage reduce the fertility potential of the cells, even if they are still motile after thawing. In fact, most of the sperm damage that affects fertility cannot be seen by simply looking in a microscope. That's why traditional sperm assessment (looking at the straw in the field or in a lab with only a microscope) can lead to misinterpretation of sperm quality of particular frozen-thawed sperm sample. This is one big source of variation between straws, and can change between freeze codes.

Farm animals like boars, bull, ram, and stallion have sperm with less tolerance to cryopreservation when compared to human, rabbit, cat, and dog sperm [3]. There are several factors that affect the tolerance of the sperm to cryopreservation, termed "freezability" [4]. In addition to the variability male to male, intrinsic biological components of the particular sperm can lead to variable freezability, and sperm quality after freezing and thawing. The composition of the fats that an animal consumes can affect his sperm quality. Specifically the membrane quality (phospholipids and cholesterol molecules) will affect the freezability. Some genetics seem to affect post-thaw sperm quality health. There is a hereditary component to sperm quality, so considering this when you breed, will help to improve overall male fertility over time.

Within an individual bull or stallion, there is a large ejaculate and sperm quality variability. Beside the unknown biological factors, genetics (breed and genetic line), health (illness), antibiotic use, and nutrition status, dietary regime and supplements, housing and environmental conditions, season, stress, can directly and indirectly affect ejaculate and sperm quality within a particular male. Did you know that a fever can cause poor sperm quality for up to 60 days? And changes in nutrition can take 60 to 90 days to have an impact.

The sperm quality after freezing and thawing is also affected by technical aspects of the processing The use of cryoprotective agents in the freezing media, type and quality of freezing media, use of antioxidant and protective agent, protocol, timing, packing type, freezing and thawing curve by the use of manual or programable devices, thawing media and personnel among others play a critical role in the outcome of sperm quality after cryopreservation [4]. This is why different studs will have different sperm quality within the same bull.

Sperm quality plays an important role in not only fertilization, but also the initial development of the resultant embryo. It's important that you understand more than motility when you are picking the stud you are going to use. Have the sperm tested before you use it. It will save you a bunch of money! And remember, sperm quality can change. You can affect some of the changes of sperm quality… don't give up, just give us a call!

Want to learn more? Here are some articles you can read:

1. Bailey J, Morrier A, Cormier N. Semen cryopreservation: successes and persistent problems in farm species. Can J Anim Sci. (2003) 83:393–401.
2. Bailey JL, Bilodeau JF, Cormier N. Semen cryopreservation in domestic animals: a damaging and capacitating phenomenon. J Androl. (2000) 21:1–7.
3. Grötter LG, Cattaneo L, Estela P, Kjelland ME, Ferré LB. Recent advances in bovine sperm cryopreservation techniques with a focus on sperm post—thaw quality optimization. Reprod Domest Anim. (2019) 54:655–65.
4. Yeste, M. Sperm cryopreservation update: Cryodamage, markers, and factors affecting the sperm freezability in pigs. Theriogenology 85 (2016) 47–64
5. Lemma A. Effect of Cryopreservation on Sperm Quality and Fertility, Artificial Insemination in Farm Animals. Milad Manafi: IntechOpen (2011).
6. Khan I, Cao Z, Liu H, Khan A, Rahman S, Khan M, Sathanawongs A and Zhang Y. Impact of Cryopreservation on Spermatozoa Freeze-Thawed Traits and Relevance OMICS to Assess Sperm Cryo-Tolerance in Farm Animals. Front. Vet. Sci. (2021) 8:609180.