Dairy cattle fertility has been decreasing for at least 60 years in the developed world. This has been associated with larger herd size, higher milk production, high energy density rations, and decreases in both cow and bull fertility that are not well explained. Fertility in cattle was not originally and is not currently strongly associated with AI vs. natural breeding when other factors are accounted for, but bull breeding is widely considered virtually essential when heat detection by humans is poor. Among many papers summarizing this are two in Journal of Dairy Science by Lucy, June 2001 and Blaschek et al., September 2011. Chenoweth in Theriogenology, June 2005 reports that there is considerable difference in semen quality and fertility among AI bull stud dairy bulls, even though they are selected for relatively high fertility. However, there is limited data on the overall fertility of non-AI natural breeding dairy bulls, and there are conflicting reports worldwide on whether male fertility in many animal species (as well as in men) is decreasing. More on the subject of bull infertility will be discussed below.

So how essential to the dairy industry are natural service bulls? What about a new method that might improve fertility of each AI straw?

Physical danger of dairy bulls

I have seen numerous situations where people who have been in dairy farming for most or all of their lives, veterinarians and others who work on farms, and other experienced farm employees (or inexperienced employees) have not adequately respected the physical danger of dairy bulls. I have seen people rub or pet the heads of dairy bulls through lockup gates or other gates, even calling them pet names as the bulls become more prone to rubbing their head on people. Often within days to weeks these same bulls have attacked people, hurled them into the air, or gotten them down and severely injured them. Dairy animals killing people are recorded as the total killed by cows and bulls; it is usually 20 people killed per year in the U.S. Anyone who has seen an aggressive charge by a dairy bull will probably never forget it. I have gotten over or through gates or even windows in sliding doors so fast I still can’t believe it, and seen how many people at once can escape rapidly from a pen to evade a bull charge. The bulls were usually considered safe before they attacked. However, in some instances it has been stated that for some time they were recognized as dangerous. I have never understood why anyone keeps a bull for one day after they are acknowledged to be dangerous. Of course most people in the dairy industry do respect and recognize the danger of bulls, but approximately 80% (some estimates are as high as 96%) of dairy farms keep some anyway. It has become widely accepted, and often appears to be true, that bulls are needed to get a substantial proportion of cows pregnant on dairy farms when AI has been unsuccessful many times. Is this really supported by evidence?
Do bulls detect estrus so much better than humans that they are essential to getting repeat breeders pregnant?

This important question is very difficult to answer. Recording exactly when and how many times one or more bulls bred a dairy cow, and when or if that cow was truly in estrus is almost impossible. It is often true that exactly which breeding date or which bull’s mating resulted in pregnancy is not determined. However, of more interest on farms are what proportion of cows became pregnant after each AI service, and what proportion became pregnant after exposure to bulls, regardless of number of breedings? This is not really a “fair apples to apples” comparison. Multiple bulls or matings will have more chances to result in conception compared with one or two AI breedings (usually one) per timed breeding or per human-detected heat. However, this is still the most practical and financially important comparison. Which management practice results in more pregnant cows, especially by 150 days in milk? Which one is most cost-effective? AI alone or combined with use of cleanup bulls? There are very few refereed journal publications on this subject.

However, a recent paper by Ribeiro et al. in Journal of Dairy Science, October 2011 investigated this. 1263 Florida Holsteins (457 cows), Jerseys (185) or H x J (621) crosses were exposed to either Presynch (634 cows) or G6G (629 cows) presynchronization, and then bull breeding if necessary. Cows were bred on the same day by AI after either presynchronization treatment (first day of breeding = day 0), again by AI if estrus was detected 19-35 days after breeding, and from days 36-100 they were “placed with bulls”. The bulls, how many of them, and cows per bull were not described. Presynch and G6G responses were not different (all P > .38). Overall results: 44% (554/1254) pregnant by day 65 from 1st AI on day 0, additional 48% (207/434) pregnant by day 65 from 2nd AI on days 19-35, additional 55% (269/489) pregnant from bull breedings - during days 36-100 - by day 100. Overall pregnant by day 100 = 82% (1037/1257); there were 7 additional pregnancies not accounted for in the totals above. This was not explained but probably they were bull breeding pregnancies totaling 276 instead of 269. Overall, on a pregnancies per breeding basis (bulls had 65 days of opportunity vs. 35 days for AI), this does not suggest a fertility advantage or an ideal solution coming from cleanup bull breeding. However, there is confounding because the bulls may have been presented with the “harder to get pregnant” cows, as is true on most dairy farms.

Another Florida study by Lima et al. in Journal of Dairy Science, November 2009 used 1055 Holstein cows blocked by parity and randomly either bred only AI (543) or only by bulls (512). Why those 2 groups were not closer in size with random allocation used was not explained. Cows with reproductive or other diseases were excluded. Bulls were 18 months old at study’s beginning and breeding soundness was examined every 3 months. Over 8 cycles of 21 days, pregnancy rates were 25% (417/1669) for AI and 26% (421/1641) for bulls, not different. Median days until pregnant were 116 and 111 days, respectively, also not different. However, at 223 days in milk (end of study), 76% of AI bred cows were pregnant vs. 85% for bull-bred cows, a significant difference (P = 0.001). The difference in pregnancy over the course of the study was attributed by the authors to, “bulls had the potential for daily detection of estrus and breeding of non-pregnant cows. On the other hand, because of the AI resynchronization scheme - - cows in the AI group had only 5 opportunities to be bred compared with a potential 8 times for cows in the [bull breeding] group. A greater number of non-pregnant cows in the [bull breeding] group had earlier opportunities to be bred than AI cows - - consequently the final outcome for - - pregnancy favored the [bull breeding] group.” (This actually reinforces the perceived advantage of cleanup bulls over AI breeding – the concept that they detect heat more readily and maximize the matings with cows in estrus.) However, the authors also commented that their frequency of breeding soundness exams (BSE) was not typical of industry practices, and likely removed the effect seen on most farms of the prevalence of infertility in dairy bulls.
Infertility, genetic inferiority, and disease transmission are problems with natural service bulls

The biggest weaknesses of natural service sires are their possible infertility considering that the vast majority are not tested by BSE, their genetic inferiority compared with AI sires, and the fact that they can introduce and transmit diseases within the herd. In the Lima study above, 3/26 (12%) of young bulls had venereal disease or were infertile based on semen abnormality (another bull rapidly developed bad temperament and was culled, a risk discussed earlier). However, most estimates of infertility in the general population of dairy bulls are between 20% and 40%. Chenoweth et al. in Theriogenology, August 1988 pointed out that there is no relationship between bulls passing a BSE and their subsequent sex drive in mating cows; 25% of bulls that passed a BSE did not service cows aggressively or at all. I must admit I have helped teach Theriogenology courses and performed many BSE’s, but I had not fully considered this aspect; an AI straw does not make up its mind whether it is interested in breeding a cow but a bull who is reproductively capable can decide not to, or he can be intimidated by other bulls or he can be lame, have other disease, etc. and not perform. Chenoweth also asserts that there is no one current test that addresses social ranking, libido and scrotal and sperm characteristics as measured in a typical BSE in bulls, but of course all of those factors are critical to getting cows pregnant.

I recall reading several years ago that natural service bulls rank in the bottom 2% genetically of all bulls when they are compared with AI bulls. Nevertheless, I can find no reference now for this kind of comparison. Cassell et al. in Journal of Dairy Science, December 2002 studied lifetime production records of nearly 2.5 million dairy cows over 18 years, comparing bull sired cows to AI sired cows. With an average milking life of just over 24 months (2.8 calvings), AI daughters produced a mean of 3100 pounds more milk and were $148 more profitable during their lifetime. This would extrapolate to a pen of 250 cows all sired by AI compared with another pen all sired by non-AI bulls making $37,000 more during a 2 year productive lifetime from about 2 to 4 years of age.

I have seen instances where long-time closed dairy herds have bought bulls and this has been associated with IBR, BVD, mycoplasma, BLV or Johne’s disease showing up in the herd. Complete certainty of the source is usually difficult to verify. I have worked with many dairy herds that screened regularly multiple times per year and were mycoplasma-negative, only to have mastitis, arthritis, and/or pneumonia caused by confirmed Mycoplasma spp. appear only after bulls were purchased with no other additions or fence line contact with other livestock. Even if one wants to discount the above, a threat from bringing bulls into any dairy herd that is under-appreciated in the dairy industry is the possibility of bringing in trichomoniasis. A complete discussion of this important and under-diagnosed venereal disease is beyond the scope of this article. Bulls bring many biological risks, including uncertainty of their fertility, into a dairy herd.

Can we improve AI fertility on a per-straw, per breeding basis? Use of magnets

There is increasing interest in the dairy industry in not only focusing on cow fertility, but in trying to improve the fertility of each AI straw so that in turn, each AI breeding is more likely to result in a (usually a female is desired) calf being conceived. Together with presynchronization programs attempting to overcome heat detection challenges, increased AI straw fertility could reduce the frequency of using cleanup bulls.

Peter Sutovsky of the University of Missouri has done numerous studies investigating a process whereby defective sperm in many species, including bovines, are tagged in the epididymis by the protein ubiquitin for eventual destruction by proteolysis. Many types of sperm defects result in the sperm being ubiquitinated, but many of these defective “marked for death” sperm were not detectable by previous evaluation methods. Therefore they were included in sperm counts, and included in the dose of semen in AI straws. They cannot survive attempts to fertilize an egg, so their inclusion was a waste, and overestimated the number of fertile sperm per straw.

Until recently, there was no practical application of this knowledge. A U of Mo extension article from May 7, 2012 states: “In faulty sperm, ubiquitin migrates to the surface of the cell. Using nanotechnology, Sutovsky coats
small metal particles with an antibody that lets the nanoparticles bind to ubiquitin on the defective sperm, then uses a strong magnet to literally pull down those cells. ‘When we pull down bad sperm in a test tube, we can skim off the good sperm cells. That means that we can use fewer cells per dose if we isolate only the good ones. The standard AI dose is around 20 million sperm. If you can cut it down to 10 or 15 million, that would be beneficial,’ Sutovsky said.”

I hope the AI industry will consider the possibility of using the same or similar dose of 20 million sperm per straw, but including only apparently fertile sperm not tagged by ubiquitin, to evaluate whether the % pregnancy resulting from AI breedings increases when such sperm is used.

The article continues, “AI farms can refine samples using his method without buying expensive equipment. ‘In the lab we use a very simple, regular magnet. It’s a little stick with three magnets on it. You put three test tubes on it and within a few minutes it pulls down all the metallic nanoparticles and the bad sperm with it,’ Sutovsky said.”

Please let us know your comments and also suggestions for future topics. I can be reached at (435) 760-3731 (Cell), (435) 797-1899 M-W, (435) 797-7120 Th-F or David.Wilson@usu.edu.

David Wilson, DVM
Extension Veterinarian

"Utah State University is an affirmative action/equal opportunity institution."