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Pre-screening of stud boars for fertility: What are the options?

Darwin L. Reicks[1], DVM; Chris Kuster[2], DVM, MS, PhD
[1]Swine Vet Center; [2]Kuster Research and Consulting

Introduction

Rapid adaptation of artificial insemination in swine largely occurred during the 1990's. Since that time, there really hasn't been much as far as new ways to practically evaluate boars in the stud for fertility. As a result most of the North American industry as well as the industry in many other countries have centered around 3 billion sperm per dose as the standard. As newly applied technologies such as post cervical artificial insemination (PCAI) take hold, there is a push for lower sperm counts in order to leverage the higher indexing boars further. As we go to lower and lower sperm counts, there may be boars whose fertility is fine at 3 billion sperm, but their reduced fertility will become apparent at the lower sperm counts. If we are to maintain the excellent fertility and fecundity rates seen in recent years, or possibly improve on those, there is renewed interest in finding better fertility predictors for boars, and screening these boars.

Historical screening of boars

Since the mid 1990's, most of the studs we (Reicks, Kuster) work with have been doing morphological assessments.[1] Typically the boar stud will count 50-100 sperm per ejaculate at line speed. The most common abnormalities identified are: proximal and distal cytoplasmic droplets, coiled tails, detached heads, and distal midpiece reflex. While not perfect, the count can typically be done in 20-30 seconds and allows the boar stud to screen these ejaculates out before extension, packaging and distribution. Motilities have been performed by nearly all studs at line speed, with most using this as a pass/fail test. Acrosome evaluations have also been performed routinely in many studs, focusing on the younger boars and screening out boars with < 70% of sperm with a normal intact acrosome. Some perform motility storage checks at expiration or longer prior to using boars in routine production.

Third part laboratory analysis

Starting in the 2003-2004, there was increased use of 3rd party laboratories to asses sperm counts and bacterial loads in the fully extended dose. This is often referred to as "end product monitoring."[2] This allows the boar stud to get an objective determination of sperm count, bacterial load, and also morphology, and has been a valuable tool. The Consortium of Independent Veterinary Andrology Laboratories (CIVAL) was formed to improve reliability across labs for consistent information across the industry.

Computer Automated/Assisted Semen Analysis (CASA)

CASA systems were implemented in many studs during the 2005-2007 time period, offering an objective motility evaluation and providing another mechanism for counting sperm. Some studs also implemented morphological assessment evaluations through the CASA screen.[3,4]

New technologies

As producers push for lower sperm counts in order to leverage high indexing boars over more sows and thus finishing pigs, there is a need to evaluate what more can be done to ensure only the most fertile boars are being used. Often, subfertile boars can only be identified as sperm counts drop below 2.5 billion, thus there should be concern that as sperm counts are reduced to 1.5 or 1.0 billion, these subfertile boars may display reduced fertility that was previously masked by having their ejaculates extended out to 2.5-3.0 billion sperm or more per dose.[5,6,7]

Single sire matings

Single sire matings are normally considered the gold standard for determining boar fertility. In North America, semen is often pooled so single sire mating results are not readily available. Pooled semen is normally only done on ejaculates that have been pre-screened by other methods, such as motility and morphological assessment. Most ejaculates would also be screened for subjective assessments such as smell, agglutination, and contamination. Ejaculates that are non-conforming would be discarded and thus not included in the pooled semen.

The following table shows the results of a small study involving 3 boars. One of the boars had low conception rates as a single sire. The other two had good conception rates as single sires. The results of the individuals were compared to the same 3 boars when they were pooled

together. The results of the pooled data is better than the weighted average of the individuals. All three boars passed the conventional semen quality measures at the stud such as motility, morphology, and acrosome integrity. (see table 1).

Distribution of single sire doses does add labor to the boar stud and mating sows with single sires adds labor at the sow farm. Rather than setting up a pool, or batch of semen containing 150 doses or more, the individual boar ejaculates must be set up. So rather than extending 5 boars at one time for example, a person must turn to the extender station 5 separate times. Likewise during packaging, for a pool of 5 boars with roughly 150 doses, starting and stopping happens one time every 10 to 15 minutes. If 5 individual boars are to be packaged as single sires, this step is repeated 5 times, every 3 to 4 minutes. Often, sow farms desire more than one batch number to reduce the risk of having a batch go bad, so there is still semen to use while the bad semen is replaced. On the other hand, semen motility is often checked on the sow farm. So by pooling semen at the boar stud, both of these goals are more easily met. Having fewer batches because of pooling makes distribution simpler at the boar stud and results in less batches to check at the sow farm, while still allowing the distribution of more than one batch per sow farm to reduce the risk of having no semen to use in the event of a bad batch. The important downside to pooling is of course that the traceability of fertility or defects to the individual boar is lost. This can be particularly concerning in the event of elevated rates of scrotal hernias.

Another potential downside in doing single sire matings to determine boar fertility is time. With more emphasis and knowledge available on EBV (estimated breeding values) from the genetic companies, it is desirable to get high indexing boars into production as soon as possible so that more pigs can be generated from the high indexing boar rather than a lower indexing boar. In a stud that is well managed for genetic value, boars should only be entering the stud that have a higher index than boars that are currently being culled. The number of high indexing pigs that can be generated by these new boar entries is determined by: how soon the boar is trained, whether his semen quality is acceptable, the number of doses he can produce, and the fertility of his semen. To wait for single sire results can take a significant amount of time. For example, a boar may be trained in isolation, but in order to be sent out to sow farms, the stud must wait until he has passed all of his blood tests. This could be around 4-6 weeks in many studs. Then, the boar may only be producing 10-12 doses of semen at 3 billion sperm until he matures. To get useful results on single sire matings, typically we like to have 30-50 sows or more bred per boar. At 2.3 doses per sow, a boar producing 12 doses per collection and collected once/week is only going to breed about 5.2 sows per week. So it may take 8-10 weeks to get the proper number of sows bred to be able to determine fertility of the boar. By the time the sows all farrow and the data is entered, it would be another 17-20 weeks. So it could be as long as 30 weeks after entry before the boars fertility can be determined. Several groups of new boars may have entered in the mean time, and some of those boars may have entered with a higher index than the boar which we are awaiting offspring to determine fertility. Adding to the problem is the possibility of a low fertility boar having a significant effect on sow farm performance until he is identified and removed. Plus, there is no guarantee of "lifetime fertility" for a boar just because his single sire mating results were good. So, in a higher replacement stud that is aggressively managed for maximum finishing performance, it would be more desirable if there was a test or tests that could be performed on the boars ejaculate while still in isolation.

Possible tests to replace single sire matings

CASA motility

An evaluation of various sperm motility metrics have been evaluated over the years. At this time, there is some

Table 1: Comparison of single sire matings to pooled matings involving 2 boars with acceptable results and 1 with unacceptable single sire mating results. (Reicks and Foxcroft, unpublished data 2011).

	Pool	Single sire			Weighted mean
		871A	873A	876A	
No. bred	37	53	40	39	
D30 pregnancy rate	94.6	96.2	77.5	92.3	89.4
Count	35	50	33	36	
Total born	13.4	12.9	9.7	13.5	12.2
Born alive	12.2	11.9	9.3	12.9	11.5
Stillborn	0.9	0.7	0.3	0.4	0.5
Per 100 sows bred	1267	1241	751	1246	1094

potential for certain parameters to show a correlation with fertility (Feitsma, personal communication 2011).

Nuclear shape

The relationship between sperm nuclear shape and fertility has also been recently evaluated.[8]

Flow cytometry

Flow cytometry offers the opportunity to screen a number of parameters with more precision due to the large number of sperm that can be evaluated relative to more traditional methods.[9] Chromatin structure must be normal for proper fertilization and embryo development. The most extensively studied method (SCSA®), utilizes flow cytometry to determine chromatin stability to identifiy sires at risk for reduced fertility. Other flow cytometry assays can determine the viability of the sperm cell membrane as well as acrosome intactness. Numerous other tests have been described and are at various stages of development or validation for practical application to boar sperm.

Research study

A study has been set up to test whether some of the currently available screening methods could substitute for single sire matings in determining a boars fertility and thus eligibility for use in the stud. A follow up part of the study was to evaluate the selected boars in a PCAI study.

Objectives of study

Determine the effect of a complete post cervical artificial insemination (PCAI) system (with a 38 ml, 1.5 billion total sperm dose) on Farrowing Rate and Total Born when compared to conventional AI at 76 mls and 3.0 billion sperm per dose.

Materials and methods

50 boars boars of the same genetic line were selected for phase one (boar qualification phase) of the study. Semen was extended at 2.75 billion (of normal morphology which resulted in approximately 3.0 billion total sperm per dose) and distributed to two sow farms as single sire doses. Ejaculates needed to pass normal screening criteria for the stud (motility, morphology, and acrosome integrity > 70%). A target of 50 sows bred per boar was used. A representative dose of semen was sent from each of the boars for various standard and flow cytometric assays (Kuster Research and Consulting) and evaluated at day two post-collection. Evaluations performed included: full morphology differential (CIVAL), motility (CASA on Hamilton Thorne Ultimate), sperm plasma membrane viability, acrosome integrity, merocyanine assay for determination of asymmetry of phospholipids in the sperm cell membrane, and chromatin structure (Guava EasyCyte Plus).[10] Boars with no apparent fertility or abnormal test results were selected for PCAI phase of study. For PCAI, boars were collected into pools of 5 and extended to 1.5 billion total sperm per 38 ml. dose. Semen was distributed to 2 sow farms (2500 and 5000 sows respectively). Heat checking occurred as normal in the morning with a boar and a trailer boar. Even numbered sows were inseminated at the time of heat check with two bags of the 1.5 billion 38 ml dose (3.0 billion in 76 ml. total). Approximately 45-60 minutes later and with no boar present, odd numbered sows were bred with one 1.5 billion total sperm per 38 ml dose. Gilts were not included in the study. Data were collected and available results will be presented at the Leman Conference.

Summary

With renewed interest in PCAI, and an ever increasing emphasis on improving genetic value of the finishing pig, there is a need to implement new methods to screen out boars with lower fertility. While a higher percentage of boars are likely to be removed from the stud for fertility reasons, it may be a key step to reduce the risk of poor production as boars are leveraged over a much larger number of sows in the future.

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