SIMULTANEOUSLY OPTIMIZING FARROWING RATE AND LITTER SIZE

Introduction

I’ve recently had numerous conversations with individuals concerned with results they have been achieving with their artificial insemination (AI) program, specifically, number of piglets born alive (~10-10.5). The Catch-22 of these conversations is that most of the producers that I have spoken with are achieving very good farrowing rates that range from 87 to 92 percent on an annual basis. Both of these measurements would put these operations in the top 1/3 percentile, according to Iowa Swine Business Record summary. Ironically, the very fact that their farrowing rates are this high may be the direct cause for lower-than-desirable average litter sizes. Most of the time achieving a large litter size and conception rate are unrelated, whereas only a few oocytes need to be fertilized for pregnancy to actually occur. This number unfortunately is far short of many producers expectations of an ideal litter size, which is likely closer to 12 to 13 pigs born alive. As in the case of these previously mentioned operations, they are likely doing such a good job with their breeding program that sows and gilts that normally wouldn’t conceive in many operations are conceiving with a minimum number of fetuses (three to four), consequently, lowering average litter size. The question that producers need to ask themselves is whether they would like to sacrifice above-average conception rates to achieve a higher average litter size. Nevertheless, it is not unreasonable to achieve success in both of these categories. The focal point of this article is to describe the factors which influence these fertility parameters and to review methods to achieve high targets in both litter size and conception and farrowing rates, in herds that are relatively disease free.

Timing, Frequency and Quality of Insemination

The use of artificial insemination (AI) allows for a higher degree of quality control than natural service. In addition to having control of semen quality, AI users can also ensure that fertile semen is deposited into the uterus. Accurately timing multiple inseminations can be difficult but is fundamental to the success of AI. Mistimed inseminations lead to lower fertility and many of the problems associated with farrowing rates. Occasionally litter size can be attributed to poorly timed and performed inseminations. The major limiting factor for the number of piglets farrowed is ovulation rate. Most females ovulate between 15 and 20 oocytes approximately 40 hours after the onset of estrus. However, both number and timing of ovulations can vary considerably between females, genetic lines, environments, nutritional programs and management components such as short versus long lactation lengths. It’s true that multiple inseminations that are routinely performed throughout estrus increase the chances that one insemination will be performed at an optimal time relative to ovulation (<24 h) to optimize fertilization rates; this procedure does not necessarily assure a large litter size. Provided that a large number of oocytes are ovulated, the next most limiting factor is ensuring that a viable population of sperm is present in the oviducts at the time of ovulation. There are four factors: sperm and...
oocyte longevity in the female reproductive tract, estrus detection frequency, and projected estrus length for determining when and how often to breed to accomplish this is determined.

The fertile life span of a spermatozoa population in the female with the ability to produce a pregnancy is estimated to be from 12 to 36 hours, even though motile sperm have been recovered 10 days following insemination. The fertile life span of the ovulated egg is approximately eight hours. Therefore, once ovulation occurs, it is necessary for a viable population of spermatozoa to be present in the oviducts at this time because of the relatively short lifespans of the egg, coupled with a four to six hour period of time after insemination when sperm cannot fertilize an egg. Good fertilization rates (> 90 percent) can be achieved when a single insemination is performed during a 24-hour period before ovulation (Soede et al., 1995). This optimal “AI time” is assuming that 1) an adequate number of sperm are inseminated and retained (> 1 billion and less than 20 ml of back flow; Steverink et al., 1998), and (2) semen is relatively fresh (less than 38 h old; Waberski et al., 1994). This interesting finding would suggest that all producers need to do is determine when ovulation is going to occur and inseminate the sow. It is unfortunate however that, on average, ovulation takes place 35 to 45 hours after onset of oestrus (standing response in presence of a boar) but the variability between sows is extremely large, thus making it difficult to accurately time a single insemination. Therefore, performing multiple inseminations throughout estrus is an easy answer to increase the chances that one insemination will be performed at an “optimal time.” Although it is difficult to predict ovulation, research has shown that sows generally ovulate sometime during the last half of their estrus period. Thus, if a sow or gilt’s estrus length is known, then we have a pretty good idea when ovulation will occur and can then time our inseminations accordingly.

The goal in most swine operations should be to ensure that at least one AI is performed within 24 hours of ovulation. What we don’t know is if two or more inseminations performed during this time have an additive effect. Nevertheless, regardless of the interval between inseminations, the length of
day that the female “stands to be mounted” by a boar will determine how many times to inseminate. Perhaps the most important consideration to remember is that when estrus length increases, reproductive performance will improve with an increase in insemination frequency (i.e., from two to three inseminations per estrus period; Flowers and Esbenshade, 1993). Generally, females that are in strong estrus for three days will receive three inseminations or one insemination per day while in estrus. However, one should also consider that shortening the interval between the second and third insemination (i.e., from 24 to 12 hours) should in theory, help reduce the negative consequences of mistiming the last AI, which has been shown to reduce both litter size and farrowing rate (Rozeboom et al., 1997).

There is no ideal number or insemination interval. The ideal frequency and intervals between each insemination on each farm is influenced by semen age at AI, semen storage conditions,
individual boar fertility and the composition of the AI dose (percentage of seminal plasma). Conserva-
tively speaking, when freshly extended (<72 hours old) semen (3-4 billion motile cells) containing 10-
12 percent seminal plasma is inseminated by an experienced technician at 24-hour intervals, a viable population of spermatozoa should be in the female at all times. However, research suggests that spermatozoa viability and fertility in the female tract decrease when any of these factors are reduced or changed (Flowers, 1994; Waberski et al., 1997; Rozeboom et al., 1999). Therefore, it is reasonable to presume that when semen conditions fall outside these criteria, intervals should be reduced to 12 to 18 hours. Finally, it’s important to consider that gilt estrus behavior patterns differ from sows. Estrus lengths are generally shorter and often less pronounced in gilts and therefore, the first insemination should occur immediately following detection of estrus. A follow-up insemination 24 hours later should be conducted provided the gilt is still in standing estrus.

Increasing the frequency of estrus detection will provide for a more accurate determination of the true beginning and end of estrus. Estrus detection is very labor-intensive and time-consuming, and consequently, most operations do not check heat more than once per day. However, it may be of benefit to heat check sows twice a day for three to four breeding periods in order to get a better idea of the average herd estrus lengths. This information may be useful in determining if the first AI can be delayed after the female is first detected in estrus (i.e., wait 12 to 24 hours before first AI because of extremely long estrus lengths such three or four days). Although 2x/day estrus detection provides a more accurate assessment of the true onset of estrus, it may be too impractical on most operations, and thus delaying the first insemination is probably not justified on most farms with limited labor resources. Because of the variation that exists between farms, it is important to set realistic targets and evaluate reproductive performance after approximately 75 to 100 matings. Readjustments can then be made to optimize your AI schedule.

Last, consider the quality of inseminations. In a recent study, we investigated the influence of insemination quality on a single AI performed <24 hour prior to ovulation. The results show that when females exhibit a strong standing heat reflex, have a tight cervical lock on the spirette, and very little semen back flow occurs, that a higher conception rate will occur. Females that received a high quality AI (n = 44; strong heat, tight lock, and little or no back flow), had a 25 percent advantage in conception rate compared to females that received a poor quality AI (n = 52; restless, poor cervical lock and some to moderate back flow).

Summary

Ensuring that a viable population of sperm is present in the oviducts at the time of ovulation is the most significant factor that influences fertilization rates. This factor is largely influenced by AI timing relative to ovulation and the efficiency of sperm transport to the site of fertilization. Litter size, however, is a much more complex process and, as a result, troubleshooting suboptimal numbers of piglets born alive on farms can be a more frustrating task. Litter size to a larger degree than conception rate is influenced by ovulation rates, the quality of semen that reaches the oviducts (fertilization rates) and embryo survivability (embryo quality, uterine environment, external conditions, and inherent fertility). Use these guidelines for establishing an AI schedule and simultaneously optimizing farrowing rate and litter size. But remember if your system isn’t broken, don’t fix it.

- Determine the average estrus length of females in your operation by conducting 2x/day heat checks on three to four breeding groups from the beginning to the end of a standing heat response.
- Under ideal conditions (i.e. fresh, high-quality semen), breed females once per day with a quality service as long as they are in standing heat (good estrus detection is the key!).
- Using estrus length averages for both gilts and sows, determine an appropriate interval between estrus detection and the first AI for sows (0, 12, or 24 hour) and decrease the interval prior to the last AI by 1/2 (i.e., from 24 to 12 hour) to minimize the risks of performing a late service that may impair the uterine environment.
- Test your schedule on approximately 100 matings and make adjustments if necessary,
which could be:
- Decreasing or increasing the interval from estrus confirmation to first AI.
- Increasing estrus detection frequency.
- Reducing the interval between inseminations.

**Suggested Readings**


Kevin J. Rozeboom

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**ON-THE-FARM PERFORMANCE TESTING:** The following breeders with validated herds have tested animals in the past 30 days.

<table>
<thead>
<tr>
<th>Breeder</th>
<th>Address</th>
<th>Breed</th>
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<tr>
<td>Bob Ivey*</td>
<td>314 NC 111 S, Goldsboro 27530</td>
<td>L,D,H,Y,CW,X</td>
</tr>
<tr>
<td>Wesley Looper*</td>
<td>4695 Petra Mill Rd., Granite Falls 28630</td>
<td>Y,L,H,D,X</td>
</tr>
<tr>
<td>Thad Sharp, Jr. &amp; Sons</td>
<td>5171 NC 581 Hwy., Sims 27880</td>
<td>Y,D,X</td>
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<tr>
<td>Tommy Spruill</td>
<td>Rt. 1, Box 149, Columbia 27925</td>
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<tr>
<td>Swan Acre Farm</td>
<td>1060 Main St., Swan Quarter 27885</td>
<td>X</td>
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<tr>
<td>Thomas Farms</td>
<td>8251 Oxford Rd., Timberlake 27583</td>
<td>X</td>
</tr>
<tr>
<td>UCPRS</td>
<td>Rt. 2, Box 400, Rocky Mount 27801</td>
<td>X</td>
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(Swine Development Center)

*Realtime Ultrasound

Frank Hollowell, David Lee