ARTIFICIAL INSEMINATION: A REVIEW AND WHAT’S NEW

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Background

Artificial Insemination (AI) in swine is not a new technique initiated in the 1990s. Reports as early as the 1920s (Lush, 1925) describe the collection and use of porcine semen for AI. If we venture to look further back in time, ancient scriptures suggest a form of AI was used in ancient Egypt on horses.

Further information was reported in the 1940s (Ito et al., 1948) proposing AI in swine as a viable future option. Scientists continued to research and promote the use of AI in the 1950s and 1960s (Polge, 1956; Melrose, 1966), but resistance in the commercial field continued.

European countries, such as the Netherlands and Denmark, have successfully utilized AI in swine for more than 40 years.

AI was tried commercially on a number of occasions in North America during the 1970s and 1980s. In the early 1990s, due to the rapid growth in the North American pig market, improved AI techniques, commercial AI equipment, genetic programs and the packers payment structure (Singleton, 2001), AI was implemented again successfully. By the end of the 1990s, AI was used in more than 85% of US and Canadian pork production (Burke, 2000). Today, AI is used in almost all pork production systems in the US and Canada.

The fastest growing nations implementing AI currently are Russia, Brazil and China. Expansion is taking place with large new high-tech studs being built.
**History**

**Dose Profile**

In the 1990s, using a 100-120ml dose was typical, but as the process has been fine-tuned and better understood, the volume has decreased steadily down to 65-70ml per dose using a conventional dose, and as low as 30ml using a Post Cervical Artificial Insemination (PCAI).

A dose (for a single insemination) was originally packaged in a bottle with a screw cap (often reused many times) before the introduction of the tube and/or bag that were heat-sealed and designed for a single-use purpose. Also typical up until the early 90s was a reusable “Melrose” catheter that had to be sterilized between uses. Today, a single-use disposable foam/gel or spiral tip are standard on most farms.

During the re-introduction in the 1990s, concentrations from 5- to 6-billion total cells were normal, but with little knowledge or ability to perform any quality control across on-farm studs. Semen was collected on-farm and used within 48 hours; this was the beginning of AI becoming common place on commercial sow farms.

Many producers and systems used combination matings to introduce AI onto a farm. This would consist of one natural mating followed by an insemination 24-hours later (sometimes two AI’s 24-hours apart).

Some on-farm labs used a haemocytometer to determine the concentration, before moving onto some form of spectrophotometer or photometer. Standard options were the Minitube Spermacue™ or IMV’s MicroReader™. Very few on-farm studs remain operational. The show-pig circuit is the only venue for on-farm collection today.

By the mid-1990s the growth of custom-built AI studs exploded. When the new millennium began, there were over 150 US studs (50 boars or more) with over 32,000 boars and over 40 Canadian studs and 7,000 boars in operation. Some of these were purely commercial semen suppliers, but the majority were dedicated internal integrator studs supplying semen to a system or pod.

Today the average US stud is over 200 boars, with the largest stud’s housing 700-800 boars and producing in excess of 14,000 doses per week. Larger, newer studs are more efficient, cost effective, and can more easily justify the investment in the latest technology, as it can be leveraged over more boars and more importantly, more doses.

A conventional dose would be 2.25- to 2.75-billion total cells and gross (and increasingly detailed morphology) morphology will be performed on each and every ejaculate.

Most studs with greater than 400 boars would now have a Computer Aided Semen Analysis (CASA) System, such as SpermVision™ from Minitube or IVOS/Ultimate™ from IMV/Hamilton Thorne Research.
Long term, the number of studs will continue to decrease. The advent of lower concentration per dose (via conventional or PCAI delivery), fewer dose per sow per year for insemination, boars producing more doses per collection, and a better and more thorough understanding of morphology and fertility needs.

**Extender Evolution**

Most studs and producers use an extender with a 5-7 day shelf life. The market leaders are Andropro Plus™ from Minitube, Gedi™ from IMV and PreservXtra™ from ReproQuest.

Extenders with a 5-7 day shelf life are divided into two (2) types: extenders with Bovine Serum Albumin (BSA) and non-BSA. This is a detailed subject in itself and I will not endeavor to cover the pros and cons in this paper.

Other extenders such as BTS (Beltsville Thawing Solution) are still used within large systems and are low-priced basic extenders with a 2-3 day shelf life. Other longer term (10 days) extenders, such as Enduraguard™ from Minitube developed to primarily target the once-per-week delivery opportunity and to accommodate PCR testing in semen still exist, but are primarily used for semen exports.

Cryoprotectants in extenders are also used today. The market leader is the CSP™ (Cell Shield Plus) from Minitube and is included in all its “PLUS” range of extenders (Androhep Plus™, Andropro Plus™, Apx2 Plus™ and Enduraguard Plus™).

The use of antioxidants in semen extenders has also been widely explored. Apx2™ and Apx2 Plus™ from Minitube contain a synthetic antioxidant that promotes fertility.

**Morphology**

All US and Canadian studs perform some form of morphology on the semen on arrival into the lab. The standard assessment would be to perform a “gross” morphology assessment to assess the incidence of tail abnormalities, abnormal heads, proximal and distal droplets. This is typically performed at line-speed on a live, motile sample. Accurate gross morphology cannot be performed by a technician on a live, motile sample.

Alternatively, a stud could perform stained morphology to accurately assess abnormalities. However this cannot be performed at line-speed, and typically a sample is prepared during processing and analyzed later in the day or later in the week. If semen is shipped before the stained morphology is reviewed, then the results have limited value.

Some studs routinely or randomly perform a detailed analysis to get a better overall assessment of a boar’s morphology.
Measurements would include:

- Disrupted Acrosome
- Abnormal Head
- Detached Head
- Abnormal Tails
- Distal Mid-Piece Reflex
- Abnormal Mid-Piece
- Proximal Droplets
- Distal Droplets

Alternatively, and more commonly, a stud would contract this detailed morphology assessment to an independent third-party laboratory.

Seasonally a stud would trash between 6-8% of ejaculates for semen quality issues and in the peak of the summer, this trash rate can often double (sometimes triple), depending upon the severity of the summer and the genetic line.

**Boar-to-Sow Ratio**

During the natural mating days, a 1:17 boar-to-sow ratio was typical. As AI was introduced, the ratio changed rapidly from a 1:100 ratio to today's conventional AI ratios of 1:225 to 1:250. Utilizing PCAI and new and up-and-coming technology could multiply these values three- or four-fold in the next few years.

**Frozen Semen**

Much of the early work with AI and swine was involved with frozen semen. The interest and application of frozen AI has varied over the years but has become more popular again in the last 12 to 18 months. The purpose today is mainly for semen export and genetic archiving.

Today a standard dose would be made from 5-7 frozen 0.5cc straws and a target of 4-billion cells viable post-thaw.

**Single-Timed Insemination**

Several companies have marketed products to allow for a single-timed insemination practice to be adopted. Bioniche in Canada and JBS United in the USA have promoted and tested products to attempt to make this a standard breeding practice. Adaptation has been limited to date.
Post-Cervical Artificial Insemination (PCAI)

More than 10% of USA sows are now bred with Post Cervical AI and this continues to grow slowly and steadily each year. The sole purpose of using PCAI in commercial production is to access and leverage highly-elite performing sires across a wide sow base.

Results to date in almost all systems have been encouraging, although too many producers persevere with a conventional concentration per dose and higher insemination catheter costs. This, in itself, defeats the purpose. There has to be a game plan and milestones set prior to start-up.

Dual Compartment AI (DCAI) With AM and PM Extenders

This is a new concept developed by Minitube of America (Verona, Wisconsin). It involves a conventional-sized semen tube with two (2) separate extender compartments.

The lower compartment contains semen and a Preservation Media (AndroPro PM™) for supporting and stabilizing the sperm cells. Concentrations have been lab-tested down to 0.5-billion total cells in a 15ml volume. The upper compartment is filled with an Activation Media (AndroPro AM™) and has a volume capacity of up to 55ml. The upper compartment contains NO semen, only extender. The two compartments are then mixed together prior to insemination by breaking a silicon seal between the chambers. This mixing then activates and stimulates the sperm cells prior to and during the insemination.

Field trials are ongoing at this time and data will be available in the Spring of 2014. Packaging machines with the dual-fill option are now available.

Near Future

Sexed Semen/Gender Selection

Sexed Semen/gender selection has been talked about for many years in swine. This technology brings the obvious and tangible benefits of minimizing castration and boar taint (if gilt offspring are chosen) and the huge benefits to commercial boar and gilt multiplication (if the technique allows the producer to select between male and female offspring). This would also be highly desirable from the packer perspective.

Minitube of America has been working on perfecting this technology for more than seven years and is getting close to releasing a commercially-applicable method of semen sexing that can be performed at line-speed in today’s commercial studs.
Future Vision.....

DULDISS (Deep Uterine Low Dose Insemination w/Sexed Semen)

This delivery method would combine all viable current technology with the introduction and implementation of “near-future” technology. As the name clearly suggests, this would be trans-cervical, low volume, less than 1.5-billion cells of the preferred gender.

Conclusions

AI has been used successfully in the US and Canada for the past 20 years, with gradual and ongoing development and upgrades. The next five years will revolutionize the genetic delivery process we know as AI today.

Technology, research and science will rapidly change the way we select genetics, semen suppliers and market pork meat. This change will happen rapidly, and the willingness and ability to embrace these new delivery methods are essential for the modern pork producer to thrive and survive in the global protein supply chain.

References


