

Reducing dose concentrations – How low can we go?

Kara Stewart

Low Dose Semen

1. How low can we reduce the semen dose before we impair fertility using PCAI?

| Dose of Semen (x10 ⁹ / volume) | Farrowing Rate (%) | Number Born Alive | Reference |
|--|-----------------------|-------------------|---------------------------|
| 1 / 80mL | 86.9 | 10.9 | Watson and Behan, 2002 |
| 2 / 80mL | 92.5 | 10.8 | |
| 3 / 80mL | 90.5 | 11.0 | |

22 boars, 5 commercial farms, ~1500 sows, 2 inseminations at onset of standing heat and 24h later

| Dose of Semen (x10 ⁹ / volume) | Farrowing Rate (%) | Number Born Alive | Reference |
|--|-----------------------|-------------------|-----------------------|
| 0.5 / 85mL | 78.0* | 8.6 | Rozeboom et al., 2004 |
| 1 / 85 mL | 87.0* | 9.3 | |
| 4 / 85mL | 94.4 | 10.5 | |

3 pools from 12 boars, 422 sows at 1 commercial farm, 2 inseminations 12h after onset of heat and again 24h later

Low Dose Semen

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| Dose of Semen (x10 ⁹ / volume) | Farrowing Rate (%) | Number Born Alive | Reference |
|--|-----------------------|-------------------|---------------------|
| 0.5 /50mL | 74.7* | 10.4 | Serret et al., 2005 |
| 1 / 50ml | 83.1* | 11.0 | |
| 2 / 50mL | 80.7* | 10.3 | |
| Conventional (3.5/100ml) | 93.7 | 11.8 | |

338 sows, 8 boars, 3 inseminations at 12, 24 and 36h after detected estrus OR after 7mm follicles detected by U/S

Low Dose Semen

1. How low can we reduce the semen dose before we impair fertility using PCAI?

| Dose of Semen (x10 ⁹ / volume) | Pregnancy Rate (%) | Total Embryos | Reference |
|--|-----------------------|--------------------|-----------------------|
| 0.25 / 20mL | 77.1 | 11.7 ^a | Mezalira et al., 2005 |
| 0.5 / 20mL | 85.5 | 14.3 ^b | |
| 1.0 / 20mL | 84.7 | 13.3 ^{ab} | |

211 sows, 4 boars, 1 insemination 25h after onset of estrus, slaughtered at 34-41 days gestation

| Dose of Semen (x10 ⁹ / volume) | Farrowing Rate (%) | Number Born Alive | Reference |
|--|-----------------------|-------------------|---------------------------------|
| 1 / 26mL | 84.1 ^{ab} | 12.2 ^a | Hernandez-Caravaca et al., 2012 |
| 1.5/ 40mL | 86.8 ^b | 12.6 ^b | |
| Conventional (3/80ml) | 82.3 ^a | 12.2 ^a | |

5063 sows, 20 boars, 2 inseminations 12h and 24 h after onset of estrus

Low Dose Semen

1. How low can we reduce the semen dose before we impair fertility using PCAI?
 - What if we control time of ovulation??

| Dose of Semen (x10 ⁹ / volume) | Pregnancy Rate (%) | Total Born | Reference |
|--|-----------------------|-------------------|-------------------|
| 1.5/45mL | 76.9 | 12.9 ^a | Knox et al., 2017 |
| 2.5/75mL | 82.4 | 13.7 ^b | |

400 sows, 29 boars, 1 insemination either 22, 26 or 30h after triptorelin acetate administration

Low Dose Semen

1. How low can we reduce the semen dose before we impair fertility using PCAI?

- What if we control time of ovulation??

| Spz, Bill | Dose, mL | Flush, mL | Sows, n = | Preg, % | Viable Embryos |
|-----------|----------|-----------|-----------|------------|--------------------------|
| 1.2 | 40 | 0 | 67 | 81.4 ± 5.1 | 14.7 ± 0.6 ^a |
| 0.6 | 20 | 20 | 70 | 84.1 ± 4.6 | 13.6 ± 0.6 ^{ab} |
| 0.3 | 10 | 30 | 62 | 78.0 ± 5.4 | 11.6 ± 0.6 ^{cd} |
| 0.15 | 5 | 35 | 68 | 76.7 ± 5.4 | 10.8 ± 0.6 ^d |

Means that have no superscript in common are significantly different from each other P < .05
 Semen prepared weekly by pooling same three boars with motility and morphology >90%
 Sows synchronized and induced to ovulate using PMSG and Triptorelin acetate

2018 Preliminary data from Fast Genetics , Purdue University, University of Illinois

Low Dose Semen

1. How low can we reduce the semen dose before we impair fertility using PCAI?

Some Remaining Questions:

- What defines success and failure at low doses?
- What total insemination volume should we be using?
- What could improve litter sizes?

Low Dose Semen

2. If we place the semen into the uterine horns, will fertility be improved?

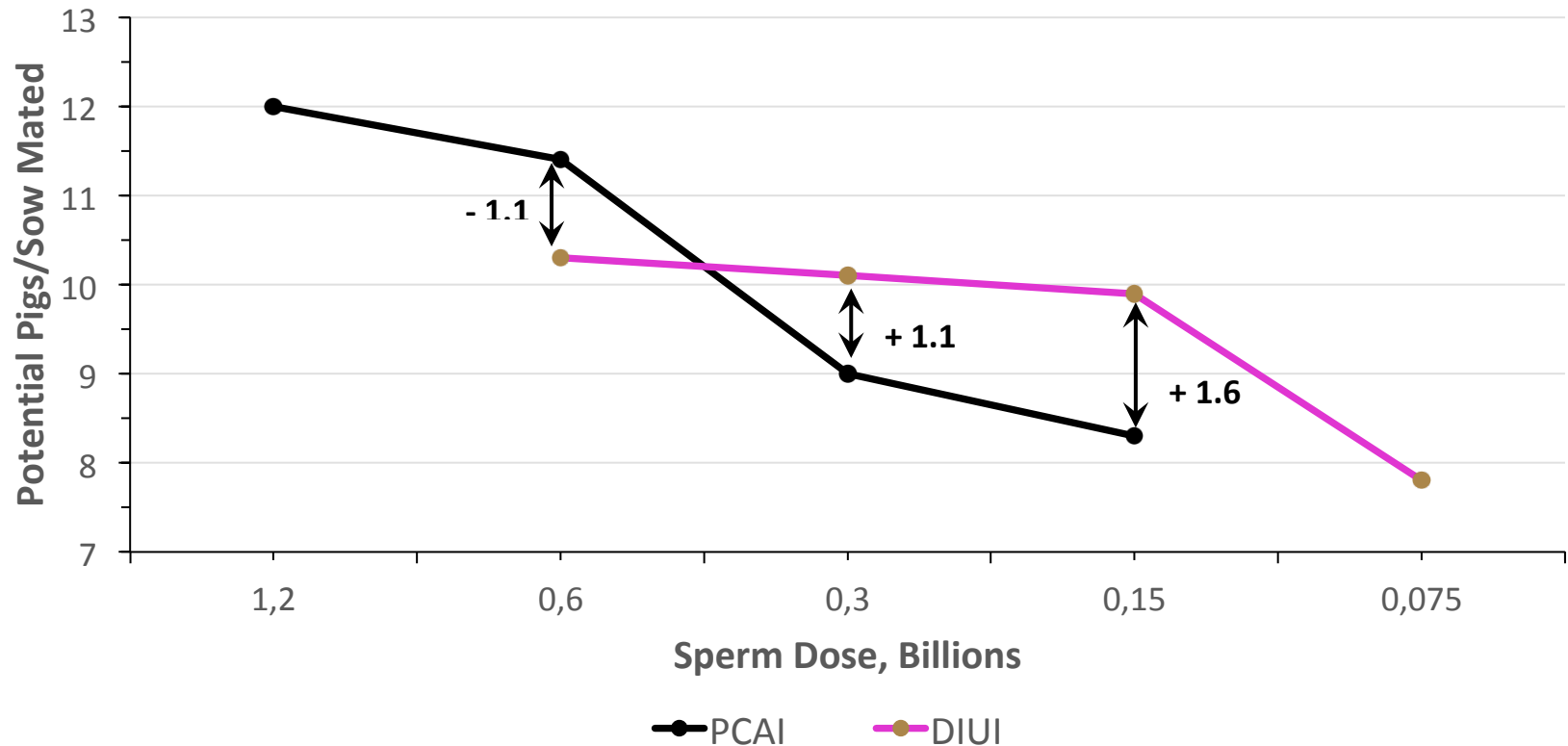
| Spz, Bill | Dose, mL | Flush, mL | Sows, n = | Preg, % | Viable Embryos |
|-----------|----------|-----------|-----------|------------|---------------------------|
| 0.6 | 20 | 0 | 66 | 78.7 ± 5.2 | 13.1 ± 0.6 ^{abc} |
| 0.3 | 10 | 10 | 71 | 83.3 ± 4.6 | 12.1 ± 0.6 ^{bcd} |
| 0.15 | 5 | 15 | 65 | 87.7 ± 4.3 | 11.3 ± 0.6 ^d |
| 0.075 | 2.5 | 17.5 | 64 | 75.0 ± 5.8 | 10.4 ± 0.6 ^d |

Means that have no superscript in common are significantly different from each other $P < .05$
 Semen prepared weekly by pooling same three boars with motility and morphology >90%
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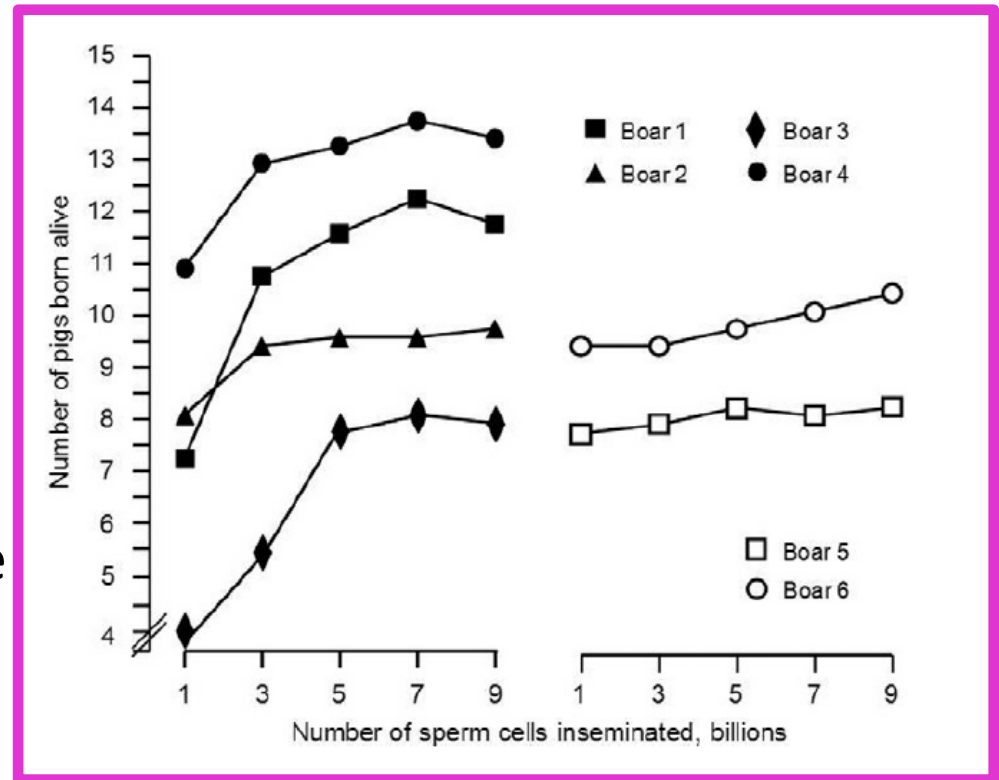


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Low-Dose Semen

3. Can all boars perform equally at lowered doses?

- **Compensable** semen traits
 - those where increasing the sperm number will improve fertility
 - Motility, morphology, capacitation, etc.
 - Typically measured in the boar stud
- Determine the slope of the lines



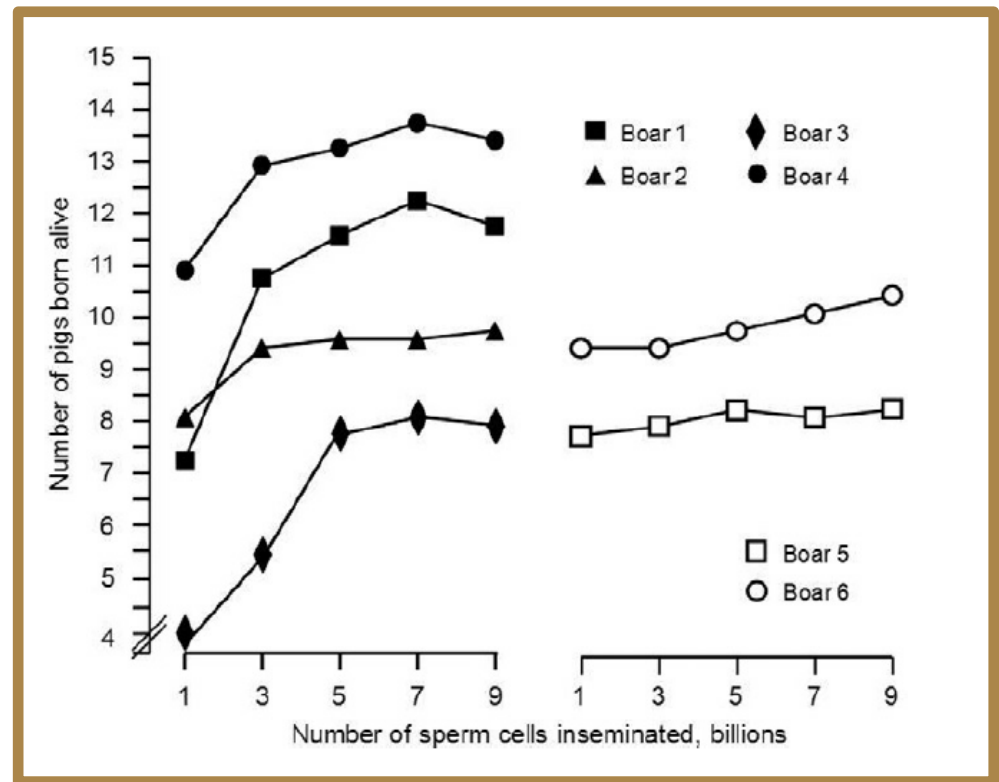
Flowers, 2013

Low-Dose Semen

3. Can all boars perform equally at lowered doses?

- **Noncompensable** semen traits – fertility does not respond to increasing numbers of sperm
 - Plasma membrane binding, DNA integrity, formation of zygotes, etc.
 - Not typically measured in the stud
- Determine the plateau of the line

Salisbury and Vandermark, 1961, Saacke et al., 2000



Flowers, 2013

Low-Dose Semen

3. Can all boars perform equally at lowered doses?

| Boar | A | B | C | D | |
|-----------------------------------|--------------------|---------------------|-------------------|-------------------|--------------------|
| Sperm Dose (x10 ⁹) | Pregnancy Rate | Pregnancy Rate | Pregnancy Rate | Pregnancy Rate | MEAN (n=47/trt) |
| 0.25 | 80.0 ^a | 85.7 ^a | 95.6 ^a | 20.0 ^b | 77.1 ^x |
| 0.5 | 79.2 ^{ab} | 100.0 ^{ab} | 96.3 ^a | 55.6 ^b | 85.5 ^x |
| 1.0 | 82.1 ^{ab} | 87.7 ^{ab} | 96.1 ^a | 60.0 ^b | 84.7 ^x |

Adapted from Mezalira et al., 2005

-Single PCAI ~25hrs after onset of estrus

-All boars had >90% motility and >90% normal sperm

^{a,b} Values in row differ (p<0.05)

^x Values in column do not differ (p>0.05)

Low-Dose Semen

3. Can all boars perform equally at lowered doses?

| Boar | A | B | C | D |
|-----------------|-------------------|--------------------|-------------------|------------------|
| Pregnancy Rate | 98 ^a | 94 ^{ab} | 84 ^{bc} | 72 ^c |
| Total born | 11.7 ^a | 10.9 ^{ab} | 10.0 ^b | 8.1 ^c |
| Fertility index | 11.4 | 10.1 | 8.4 | 6.0 |

Adapted from Ruiz-Sanchez, 2006

^{a,b} Values in row differ ($p < 0.05$)

- Gilts inseminated with 1.5×10^9 normal motile sperm/50mL
- All boars had >80% motility and >85% normal sperm

What impacts success at low doses?

- Management at sow farm
 - Insemination technique
 - Timing of AI relative to estrus/ovulation
 - Volume of dose (??)
 - Sow management – WEI, feed intake, etc.
- Quality of semen going into doses
 - Accuracy and consistency in dose preparation
 - Equipment needed in the lab??
 - Adjusting cut off values??
 - Boar management

Will success be similar on commercial farms?

- Research studies “cherry pick” both sows and boars

Table 2. Effect of sperm number category on farrowing rate in swine ($P = 0.29$)

| Sperm no. ($\times 10^9$ /dose) | No. of inseminations | Mean farrowing rate (%) |
|-------------------------------------|-------------------------|----------------------------|
| < 2.5 | 638 | 69.9 |
| 2.50-2.99 | 1845 | 70.3 |
| 3.00-3.49 | 3266 | 71.1 |
| 3.50-3.99 | 2233 | 67.1 |
| 4.00-4.49 | 1024 | 75.9 |
| 4.5 and more | 496 | 81.2 |

Reicks and Levis, 2008

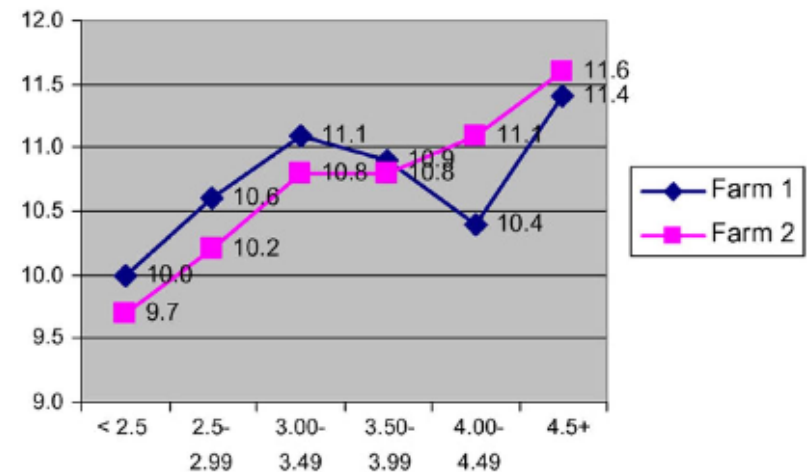


Figure 2. Effect of sperm number on total number of piglets born ($P = 0.03$), with an interaction by farm.

Conclusions

- Clear as mud?????

Currently, 1.5-1.25 billion appears to be “doable” on **WELL MANAGED** SOW FARMS..... some of which control the time of ovulation.....

Realistically, below 2 billion you may need to take out more “insurance” – increase cell number to **COMPENSATE**



Thanks!

Kara Stewart