

Sex is THE most important genetic trait

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10 years of commercially available sexed semen

- ◆ History
- ◆ Success Rates
- ◆ What has changed
- ◆ What to expect in the next 5 years

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History

- ◆ Early 1980's - Lawrence/Livermore Experiments
- ◆ 1989 - L. Johnson Beltsville experiments with rabbits
- ◆ Early 1990's - Mastercalf experiments UK and Ireland with IVF
- ◆ Late 1990's - XY, Inc experiments with AI in Colorado
- ◆ 2002 - First Commercial license - Cogent
- ◆ 2007 - XY, Inc. acquired by Sexing Technologies in Texas

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Funding for much Ag research has changed from public to private

- ◆ Seeds
- ◆ Sexed semen

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PATENTS ON SEXING SPERM

- ☒ Over 300 patents
- ☒ Most patented procedures not efficacious or useful

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Private funding made sexed semen practical

- ◆ Insufficient public funding
- ◆ Patents, licenses, royalties
- ◆ Sexing Technologies, Inc owns most relevant intellectual property
- ◆ Data information proprietary
- ◆ Attorneys are expensive

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US Holsteins Bred with Sexed Sperm

Year	Heifers	Cows
2006	1.5%	0.1%
2007	9.6%	1.3%
2008	14.2%	2.1%

Hutchison and Norman, 2009

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Problems

1. Too expensive to use normal numbers of sperm/dose
2. Sperm damaged slightly by the sexing process
3. Sorting frozen-thawed sperm and refreezing equals poor fertility

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Technology Summary

- ◆ Speeds of sexing doubled
- ◆ Fundamental procedures unchanged
- ◆ Sperm still sorted one at a time
- ◆ Other methods don't work!

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PURITY

- ☒ Can exceed 95%
- ☒ Industry standard = 90%
- ☒ More pure = more expensive
- ☒ Similar accuracy X and Y

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Normality of Calves from Sexed Sperm

	Sexed	Control
No. ^a	1158	787
Abortion rate (%)	4.5	5.0
Gestation length (d)	279	279
Neonatal death (%)	3.5	4.0
Calving ease score	1.22	1.23
Birth weight (kg)	33.9	34.1
Live at weaning (%)	91.7	91.5
Weaning weight (kg)	239	241

^a N were lower for some responses.

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Increasing numbers of sexed, frozen sperm above 2 million/inseminate does not increase pregnancy rates greatly

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Huge Differences

- Heifers
- Lactating dairy cows
- Postpartum beef cows
- Nursing 1st calf beef heifers
- Superovulated females
- Pre-pubertal heifers
- Heat-stressed cattle

Angus Heifers – 2 Bulls and 4 Inseminators – One Herd

Treatment	No. heifers	% pregnant
20x10 ⁶ unsexed	126	67 ^a
4.5x10 ⁶ sexed	126	51 ^b
1.5x10 ⁶ sexed	123	54 ^b

a,b (P<0.05).

Field Trial – Holstein Heifers (3 bulls, 2 inseminators)

Treatment	No.	% pregnant
2 x 10 ⁶ sperm sexed	179	56%
10 x 10 ⁶ sperm sexed	180	62%
10 x 10 ⁶ sperm, control	88	61%

Schenk et al., 2005

Holstein Heifers

Treatment	N	%Pregnant
2.1x10 ⁶ sexed	2319	38 ^a
10.0x10 ⁶ sexed	2279	44 ^b
2.1x10 ⁶ unsexed	2282	55 ^c
10.0x10 ⁶ unsexed	2292	60 ^d

Dejarnette et al, 2011; (a-d, P20.05)

Estrus Synchronization

- ☒ Works well with sexed semen if AI 12-24 h after onset of estrus
- ☒ Fixed time AI not recommended

With Sexed Semen

- ☒ Best to have egg waiting for sperm
- “ Sexed sperm degrade while waiting
- “ Best to inseminate 6-12 h later than with unsexed sperm

Timing of AI and Pregnancy Rates, Sexed Sperm

0.5 day	266/586, 45.4%
1.0 day	203/414, 49.0%

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Delaying FT AI-Sexed Semen

Estroject	Semen	N	% Pregnant
Tripped	Control	105	77
Untripped	Control	113	37
Tripped	Sexed	215	47
Untripped	Sexed	113	2
Untripped*	Sexed	110	39

*FTAI delayed 20 h; Thomas et al, 2013

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Superovulated Dairy Cattle

Treatment	N	Transferable Embryos	Unfertilized/Degenerate
Heifers, sexed semen	130	6.1	4.4
Heifers, control semen	945	7.2	4.2
Cows, sexed semen	80	4.9 ^a	6.0 ^a
Cows, control semen	324	9.1 ^b	4.0 ^b

Kaimio et al, 2013; (a-b, P<0.01)

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Embryos Produced with Sexed Sperm

	N	% Preg	% Female
Sexed sperm	42	47.6	90
Unsexed sperm	68	52.9	53

Acta Sci Vet 2008;36 (Suppl 2):s433

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IVF

1. Collect oocytes on farm
2. Mature oocytes during overnight shipment
3. Sort frozen unsexed semen
4. IVF and culture
5. Ship embryos to recipients or freeze

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Sexed Fresh Semen

Treatment	N	Non-Returnrate
Sexed Semen	51,712	69%
Control	57,085	73%

Xu, 2014

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Sexed ULTRA

Method	N	Preg %
Standard	3384	41.6%
Sexed ULTRA	3546	46.1%

Vishiwonath, 2015

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Timed Sexed AI Protocol

April 8, pm: Insert CIDRs

April 22, pm: Remove CIDRs

May 8, 4 pm: PGF & Estroprotect patches

May 11, 9 am: AI if tripped patch
GnRH if untripped patch

May 12, 8 am: AI those given GnRH

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Success Rates

- ◆ 46/56 tripped; 35 pregnant
10/56 not tripped; 3 pregnant
38/56 = 66%
- ◆ 18 not pregnant; 11 synchronized for repeat AI

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Protocol for Repeats

May 23, am: Insert CIDRs

May 31, 9 am: Remove CIDRs,
+ Estroprotect patches

June 2, 4 pm: AI those with patches
tripped by 9 am, June 2

June 3, 4 pm: AI those with newly
tripped patches

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Current Costs

- ☒ \$15/dose extra
- ☒ >\$25/dose for custom sexing
- ☒ Biggest cost – lower fertility
- ☒ Extra semen collection

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More sperm

- ◆ 2 to 4 million sperm/dose
- ◆ ↑ 5 percentage points fertility
- ◆ Doubles cost of semen

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Cost Analysis

- ◆ \$30/ straw for sexing accurately
✗
- ◆ 55% pregnant
✗
- ◆ 95% female
✗
- ◆ 90% survived to breeding age
✗
- ◆ $\frac{\$30}{0.55 \times 0.95 \times 0.90} = \$64/ \text{ heifer}$

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Sexed Semen Fertility Higher than Conventional?

- ◆ Already discard dead/ dying sperm
- ◆ Already improves IVF
- ◆ Already same pregnancy rates sheep
- ◆ Already evaluating individual sperm
- ◆ Could select for positive sperm traits and against negative ones

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Unsexed Sperm Could become obsolete

- ◆ One sex or the other always more valuable
- ◆ Fertility of sexed semen higher than unsexed?
- ◆ Sexing costs would need to be low

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