

PROFITABLE USES OF SEXED SEMEN

George Seidel

Colorado State University

**Sex is THE most
important genetic
trait**

**Selection of sex at
conception –
The most sought-after
reproductive
biotechnology of all time**

Democritus, 470-402 BC

Right testis produces males
Left testis produces females

PATENTS ON SEXING SPERM

- ◆ Over 250 patents
- ◆ Most procedures not efficacious or useful

Beltsville Method of Sexing Sperm

Patented: USDA

Inventor: Lawrence Johnson

Licensed: XY, Inc. via Sexing
Technologies

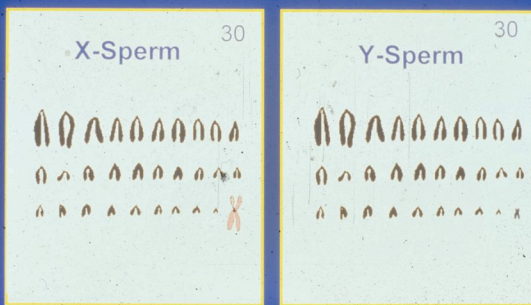
In Use: Major bull studs –
various countries

Other Methods Don't Work

PRINCIPLES

- ◆ 50% (X-chromosome)
- ◆ 50% (Y-chromosome)
- ◆ Sperm are essentially identical in size, weight, charge, swimming speed, etc.

Bovine Sperm Chromosomes

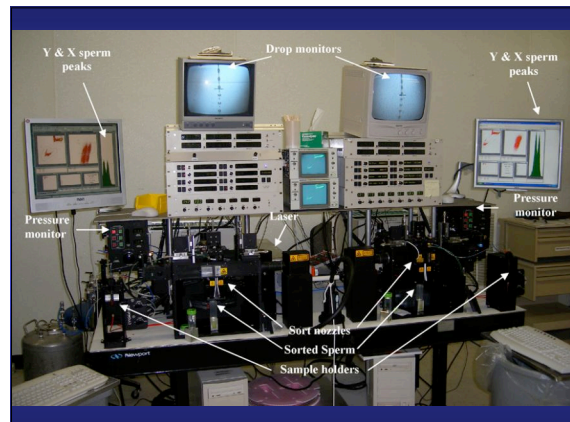
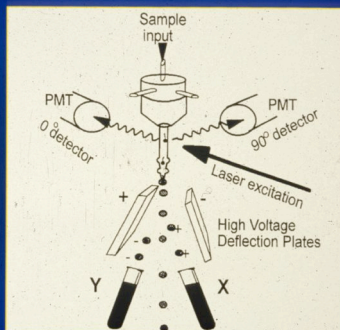


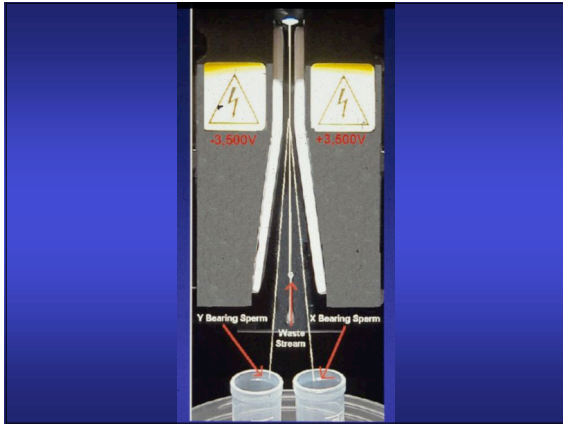
SEXING SPERM

HO33342 binds to DNA
X- sperm have more DNA
Aim laser light at sperm
HO33342 fluoresces
Measure fluorescence
Computer analysis

Sorting by charge

Johnson et al., J. Anim. Sci. 77, Suppl. 2:213-220, 1999





SPERM SORTER

25,000 sperm/sec
 80,000 drops/sec
 180,000 measurements/detector/sec
 50 miles/hour
 Cost: >\$500,000 for 2-nozzle
 version

SORT RATES

- ◆ Can exceed 5,000 sperm/sec of Each sex at 90% purity
- ◆ In practice about 15,000,000/h
- ◆ Too slow to use normal sperm numbers / dose economically

PURITY

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

SPERM INSULTS

- ◆ Waiting to be sorted
- ◆ High concentration H33342
- ◆ High laser power
- ◆ Exit at 50 miles/hour
- ◆ Very high dilution
- ◆ Centrifuge to concentrate
- ◆ Cryopreservation

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

On The Edge

- ◆ No. sperm/dose
- ◆ Sorter speeds
- ◆ Semen handling
- ◆ Insemination techniques
- ◆ Cattle management
- ◆ Profitable applications

Fertility

- ◆ Excellent Management
70 to 90% of controls
- ◆ Average Management
50 to 70% of controls
- ◆ Poor Management
Buy a bull

Estrus Synchronization

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

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).

Angus Cows – 3 Bulls and 2 Inseminators – One Herd

Treatment/site	No. cows	% preg 2 mo	% calved	% male
20x10 ⁶ unsexed/body	21	76	71	53 ^a
3.0x10 ⁶ sexed/body	42	57	55	91 ^b
3.0x10 ⁶ sexed/horns	42	50	50	90 ^b

^{a,b} (P<0.01).

Superovulation of Angus Cows and Heifers

	No. flushes	% fertilized	No. good embryos
2 x 10 ⁶ sexed sperm	30	40 ^a	3.3 ^a
10 x 10 ⁶ sexed sperm	30	49 ^a	4.1 ^a
40 x 10 ⁶ control sperm	29	69 ^b	8.7 ^b

^{ab} P<0.05

Accuracy of Sexing Sperm

89%

N = 1,036 calves born

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.



Applications

- ◆ No shortage replacement females
- ◆ No shortage breeding males
- ◆ Can saturate market

Current Beef Cattle Breeding

Objectives

Herd replacements –
Breed 50% of herd
for maternal traits

Beef production –
Breed 50% of herd
to terminal cross sires

Product

25% females (ideal)
25% males (by-product)

25% females (suboptimal)
25% males (ideal)

Calf Deaths -- Birth to Weaning (N)

	<u>Primiparous</u>	<u>Multiparous</u>
Male	18% (916)	6% (2579)
Female	10% (822)	4% (2488)

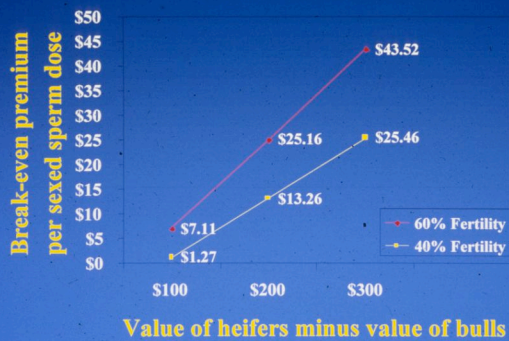
Applications

- ◆ ↓ dystocia heifers
- ◆ ↑ biosecurity herd expansion
- ◆ ↑ profit dairy x beef
- ◆ Crossbred beef replacements
- ◆ Specific matings
- ◆ Conservation programs

Current Costs

- ◆ \$20/dose extra
- ◆ >\$30/dose for custom sexing
- ◆ Biggest cost – lower fertility

Economics of Sexed Sperm



CONCLUSIONS

- ~90% accuracy routinely
- No excess abortions
- Calves appear normal
- Low dose sexed fertility—
70-90% of high dose unsexed

Acknowledgements

- ◆ XY, Inc. funding and staff efforts
- ◆ Graduate students and technicians
- ◆ Farmer and rancher collaborators
- ◆ AI cooperatives and companies