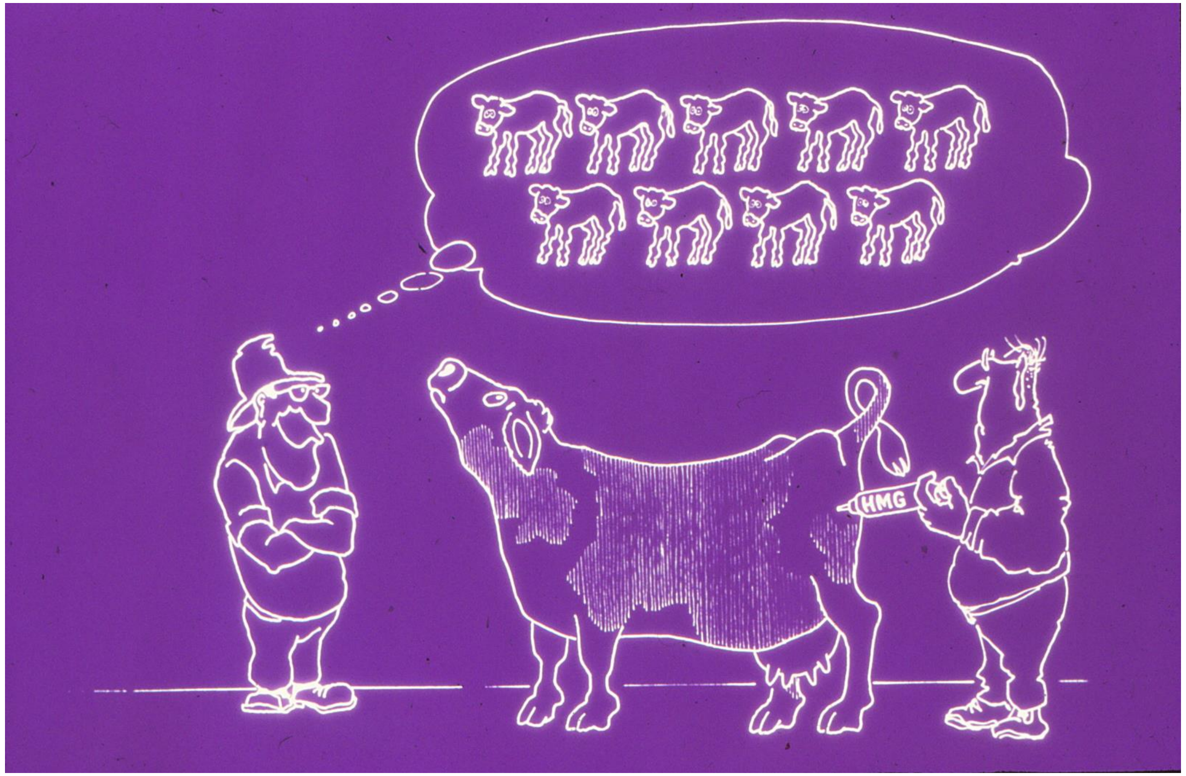
Superovulation of cattle

Michael McGowan – School of Veterinary Science

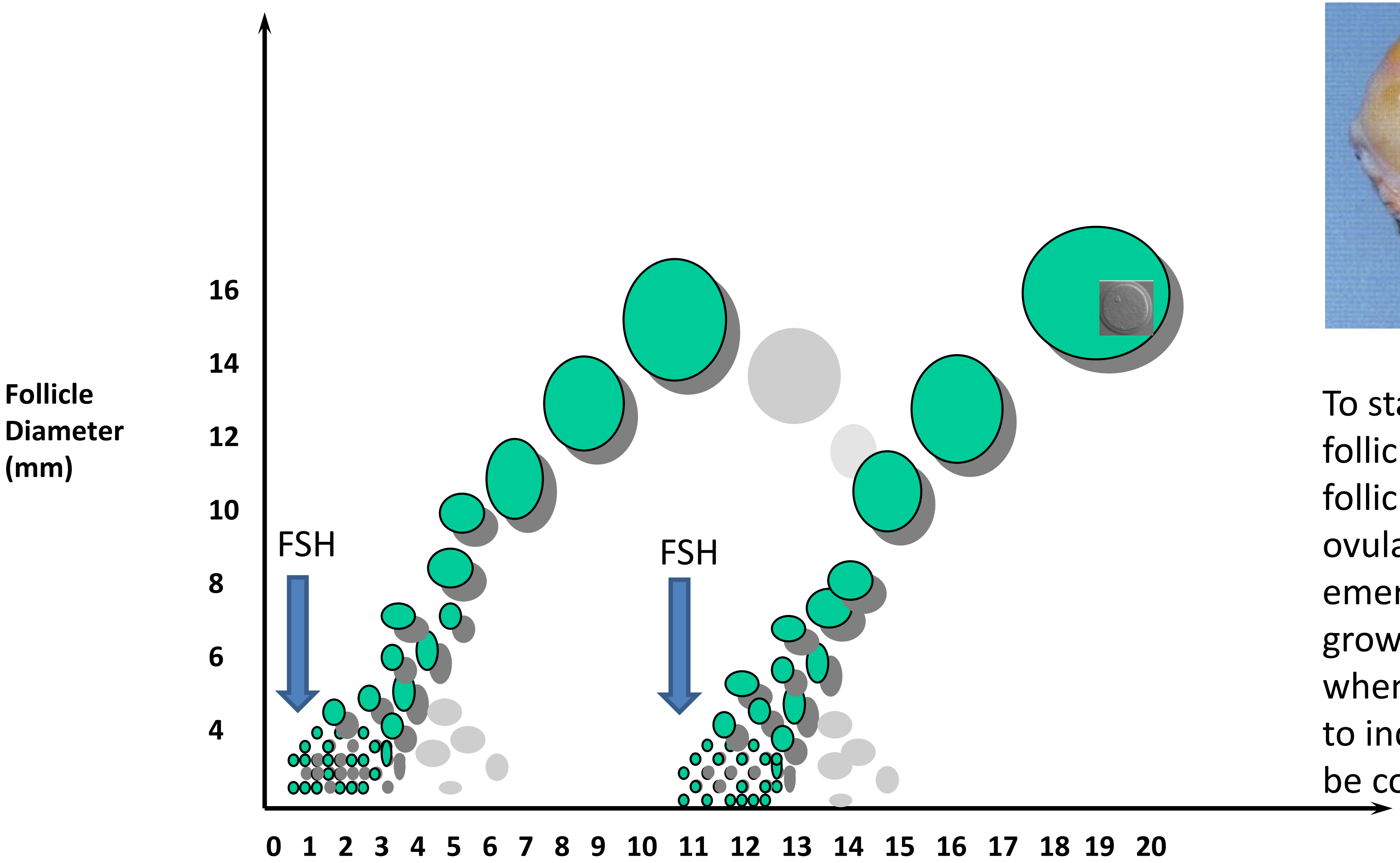
Where it all started – Western College of Veterinary medicine, Saskatoon, Canada

Outline of presentation

- Focus will be on factors affecting superovulation
- Managing superovulation programmes
- Differences between *Bos taurus* and *Bos indicus* genotypes will be highlighted

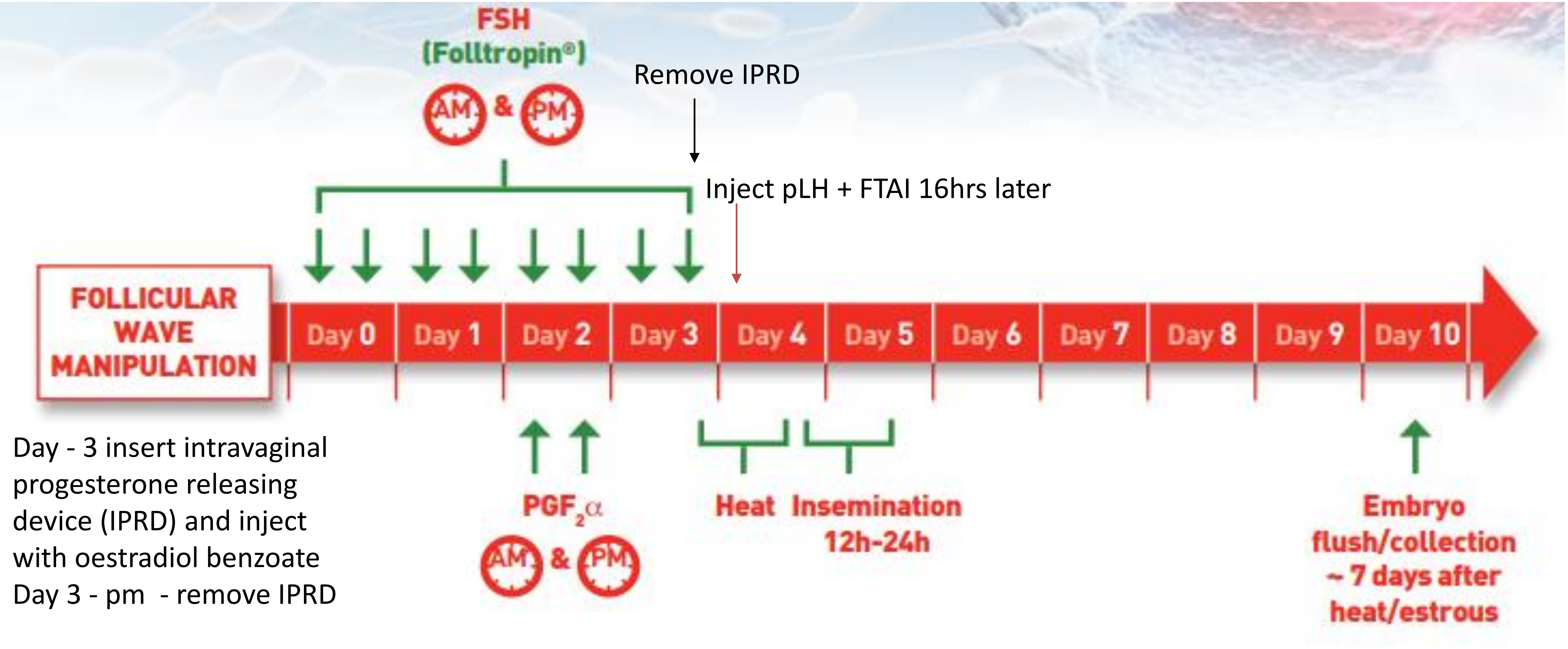


Throughout the oestrous cycle secretion of follicle stimulating hormone (FSH) by the pituitary is responsible for initiating the regular growth of groups of immature follicle



To start a new wave of follicle growth the dominant follicle must be induced to ovulate. This results in predictable emergence of new wave of growth of small follicles. This is when treatment with purified FSH to induce superovulation should be commenced

Traditionally superovulation treatments were commenced between day 8 to 12 of the oestrous cycle. However, timed superovulation programmes have been developed which don’t require heat detection.



Day - 3 insert intravaginal progesterone releasing device (IPRD) and inject with oestradiol benzoate

Day 3 - pm - remove IPRD

Despite improvements in our ability to control the timing of superovulatory events the results in terms of number of transferable quality embryos has not improved

Table 1. Number of bovine flushes and embryos recovered yearly in the USA between 2002 and 2008

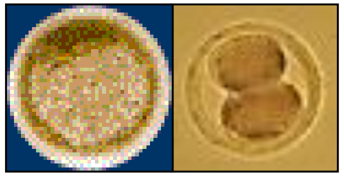
Year	No. flushes	No. embryos	Mean embryos/flush
2002	28,109	172,118	6.1
2003	34,896	205,441	5.9
2004	40,701	248,469	6.1
2005	48,233	305,129	6.3
2006	51,802	319,984	6.2
2007	54,080	332,486	6.1
2008	52,804	329,171	6.2

From Hasler (2010)

Response to superovulation treatments is quite variable

- In one large study 24% of beef donors produced no embryos, 64% produced fewer than the average and 30% produced 70% of the transferable embryos
- In a more recent study the percentage of superovulated dairy heifer/cows which failed to produce any transferable quality embryos ranged between 7.7% to 18.2%
- Despite much good quality research of this problem responses to current superovulation protocols are still variable

The problem of unfertilised ova



Hormonal treatments to induce superovulation cause disturbances in follicle and oocyte development. In one study 48% of superovulated cattle had normal oocytes, 25% produced both normal and abnormal oocytes and 27% produced only abnormal oocytes. Superovulation has also been shown to cause disturbances in sperm and ova transport, and in establishment of a sperm reservoir in the oviduct.

The quality of the frozen-thawed semen used for inseminations can also have a big effect as shown by Stroud and Hasler (Theriogenology 65: 65–76).

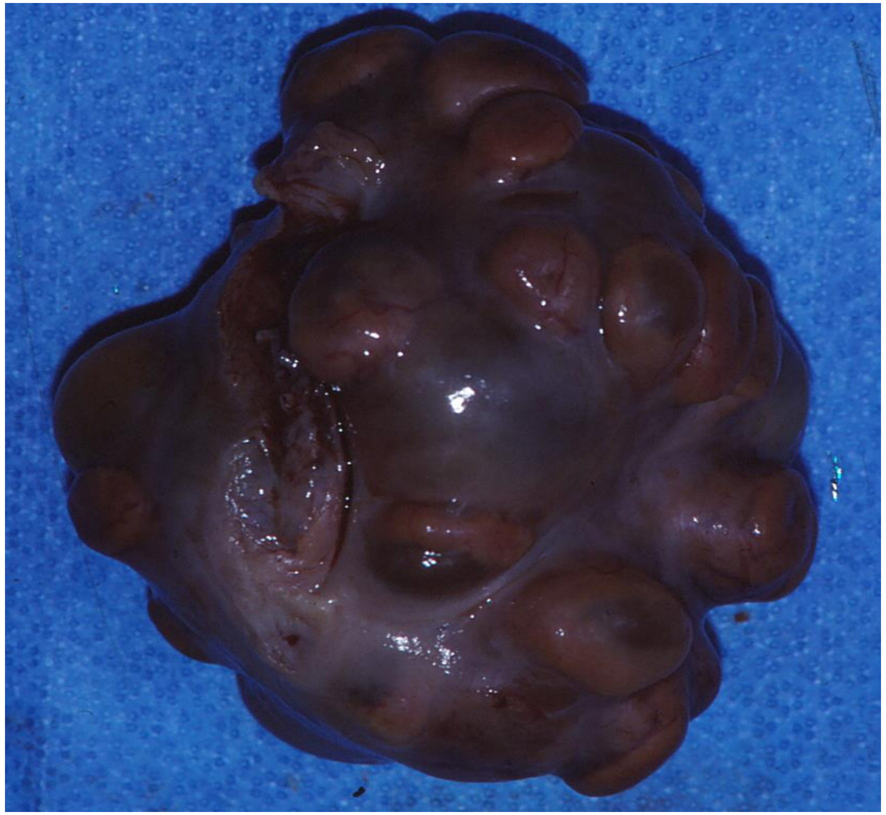
Effect of semen quality on fertilization rate and embryo quality in superstimulated cattle (227 bulls used on 742 donors)

Semen quality[e]	Fertilized ova (%) ($n = 9732$)	Excellent embryos (%) ($n = 4035$)
Excellent	82.1 a	61.2 a
Good	67.6 b	55.7 b
Fair	58.3 c	53.9 c
Poor	51.8 d	33.7 d

The problem of unovulated follicles

Overstimulation syndrome
Use of eCG versus FSH-P
Environmental or management stress

Normal superovulated ovary Day 7



Superovulated ovary containing unovulated follicles

BVDV infection during superovulation significantly reduces ovulation rate and yield of transferable embryos

	Control heifers n=12	Infected heifers n=13
Follicles ≥ 9 mm[a] (Day 0)	6.2 ± 0.8[d]	4.7 ± 0.8[d]
Follicles ≥ 9 mm[a] (Day 1)	1.1 ± 0.3[d]	3.8 ± 0.7[e]
Corpora lutea[a] (Day 6)	7.4 ± 1.2[d]	1.7 ± 0.6[e]
Corpora lutea[b] (Day 7)	9.2 ± 2.2[d]	3.0 ± 1.4[e]
Total ova/embryos	5.8 ± 2.3[d]	0.6 ± 0.3[e]
Fertilised ova[c]	4.5 ± 1.5[d]	0.2 ± 0.2[e]
Transferable embryos	4.0 ± 0.7[d]	0.2 ± 0.2[e]

Kafi et al (1997) Theriogenology 48:985

There is an optimum total dose of FSH-P for superovulation. This varies between genotypes, to a lesser extent between breeds and individual donor females.

Human menopausal gonadotrophin dose response study

Treatment#	Mean CL's	Mean Follicles >10mm	Mean Ova/embryos	Mean Fertilised	Mean transferrable	% transferrable
HMG 200%	26.8	13.9	15.4	6.2	2.5	16
HMG 100%	26.7	8.9	14.3	11.1	7.3	53
HMG 50%	6.2	1.7	3.8	3.3	2.9	76
HMG 25%	3.2	1.9	1.3	1.1	1.0	77

Bos taurus beef heifers   McGowan et al Theriogneology 24:173

Bos indicus cattle are much more sensitive to superovulation treatments. Barurselli et al (2003) showed that you could reduce total dose of Folltropin-V from 200mg to 100mg.

Selection of females for superovulation

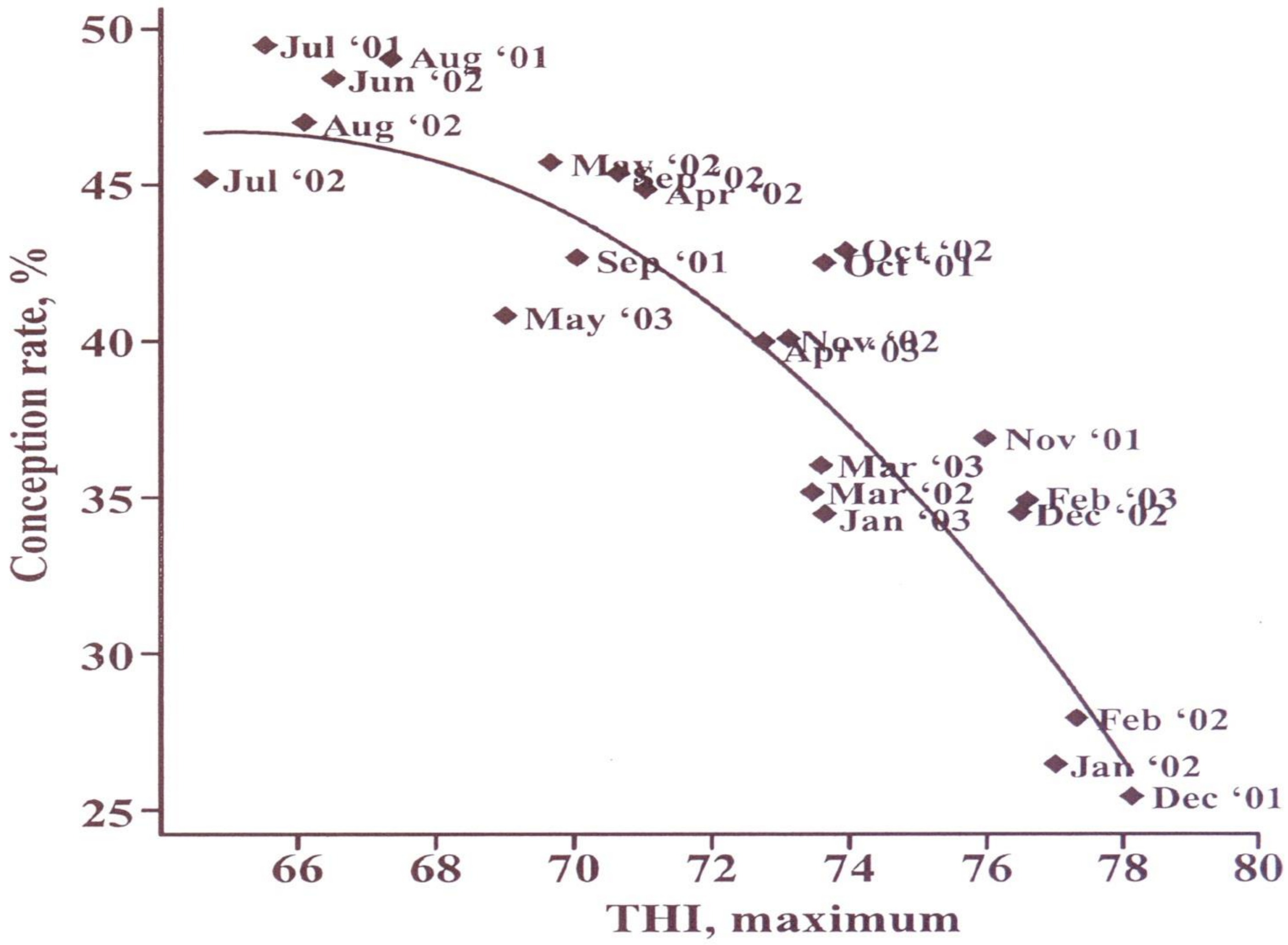
- What is their genetic merit for major production traits
- What was the fertility of their dam and sire
- Have they been superovulated before and what was the outcome
- What is their vaccination status for diseases causing death, fever/illness and infertility
- For heifers when did they reach puberty and have they been cycling normally
- For cows when did they calve, were their an peri-partum disease problems, have they been seen on heat and was the mucus clear.
- All potential donors should undergo a systematic reproductive examination including ultrasonography of the reproductive tract. Critical to check for any evidence of endometritis

Management of females prior to, during and after superovulation

Critical to appreciate that the oocytes ovulated today commenced development at least 60 days ago. Body condition and quality and quantity of dry matter intake influence follicle and oocyte development. However, over-conditioning cattle can adversely affect response to superovulation. Cattle should be managed to be in 'fit not fat' condition

There is often great debate about use of mineral and vitamin supplements. Very little evidence of any benefit except where mineral/vitamin deficiencies have been confirmed as being responsive to supplementation.

Heat stress can have a major effect on response to superovulation. Follicle and oocyte development ovulation, corpus luteum development, fertilisation, embryo and foetal development can all be adversely affected.



Lactating cows are at particular risk of heat stress. To minimise the impact of heat stress on superovulatory responses donor females should have access to effective cooling strategies throughout the entireperiod of expected high environmental temperature-relative humidity conditions

From Morton et al (2007)

Use of sex-sorted semen

I. Kaimio et al. / Theriogenology 80 (2013) 950–954

Mean numbers of transferable embryos, degenerate embryos, and UFO in recoveries from heifers and cows bred with sex-sorted versus conventional semen (% per total embryos/UFO).

Type of embryo/ova	Heifers			Cows		
	Sex-sorted (N = 130)	Conventional (N = 945)	P	Sex-sorted (N = 88)	Conventional (N = 324)	P
Transferable	6.1 (59)	7.2 (63)	ns	4.9 (45)	9.1 (70)	<0.001
Degenerated	1.6 (15)	1.9 (17)	ns	2.4 (22)	1.5 (11)	<0.05
UFO	2.8 (26)	2.3 (21)	<0.01	3.6 (33)	2.5 (19)	<0.01
All	10.6 (100)	11.4 (100)		10.9 (100)	13.0 (100)	

Abbreviations: ns, nonsignificant; UFO, unfertilized ova.

Acknowledgements

Professor Reuben Mapletoft,
Professor Walter Johnson
Dr Vlad Pawlyshyn
Marilyn Braithwaite

Questions