Selection for Fertility

T.A. Thrift
Department of Animal Science
University of Florida

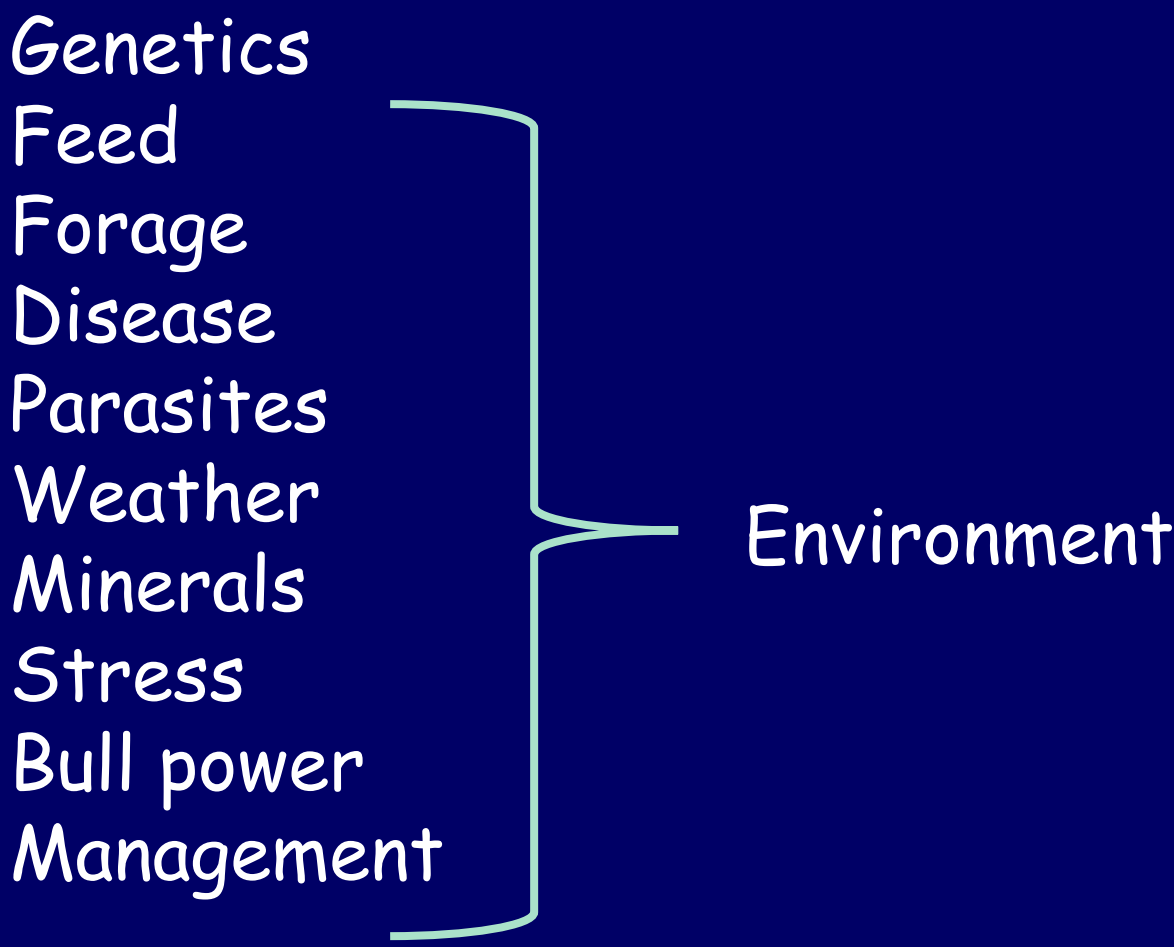
How important is fertility?

Trait	h^2	REV	REV*
Reproduction	low	10	4
Production	mod	2	2
Product	high	1	1

*Adjusted based on current trends towards product

Willham, 1967

What factors affect fertility?



Can I directly select for fertile heifers/cows?

Heritability of reproductive traits

Age at puberty	40%
Weight at puberty	50%
Age at first calving	20%
First service conception rate	20%
Conception rate	4%
Reproductive tract score	30%
Heifer pregnancy	20%
Calving interval	5%
Percent calf crop	10%
Scrotal Circumference	50%
Breeding soundness exam	10%
Primary sperm abnormalities	30%
Secondary sperm abnormalities	2%

Adapted from Field 2007, Cammack et al 2009

Reproductive traits are:

Lowly heritable
Hard to measure (0 or 1)
Expressed late in life

Heifer Selection Objectives

- Identify heifers that will:
  - Conceive early in the breeding season
  - Calve easily
  - Give a flow of milk consistent with the environment
  - Wean an acceptable calf
  - Make a positive contribution to the calves postweaning growth and carcass traits

Which Young Heifers Will Make the Best Cows???

Heifer Selection

Frame size

Weight per day of age

Weaning weight

Adj. 205 day weight

Yearling weight

Adj. 365 day weight

Sire of heifer

RFI / RADG

Temperament

Fleshing ability

Reproductive tract score

Structural soundness

Pelvic area

Muscling

Marbling

Fertility????

Heifer Selection

- Replacement heifers generally have lower returns:
  - lower overall productivity
  - greater nutrient requirements
  - additional labor and management

- Replacement heifer selection impacts:
  - performance as first calvers
  - lifetime productivity

Heifer Management

- It is very difficult to *select* for puberty so management of the heifer is very important
- Heifers should reach puberty 1-3 months before being bred
  - -puberal estrus is less fertile
- Heifers that become pregnant early in the breeding season have higher lifetime production potential

Factors Affecting Puberty in Beef Heifers

- Breed
- Age
- Weight
- Body condition score
- Preweaning growth rate
- Postweaning growth rate
- Scrotal circumference of sire
- Social interaction
- Ionophores
- Bull exposure
- Implants
- Anthelmintic
- Hybrid vigor
- Seasonal factors

Age at puberty is an extremely important as a trait when heifers are bred to calve as 2 year olds in systems that impose restricted breeding periods

Genetic Factors Affecting Puberty in Beef Heifers

In general:

-Dairy breeds are the youngest at puberty

-Bos indicus breeds are the oldest at puberty

-Heavy milking beef breeds are younger at puberty

-Large variations exist within and between breeds

Age at puberty can be reduced genetically by:

- selection within a breed for younger age at puberty???

- selecting a breed with a younger age at puberty

-crossbreeding with another breed that has a similar or younger age at puberty

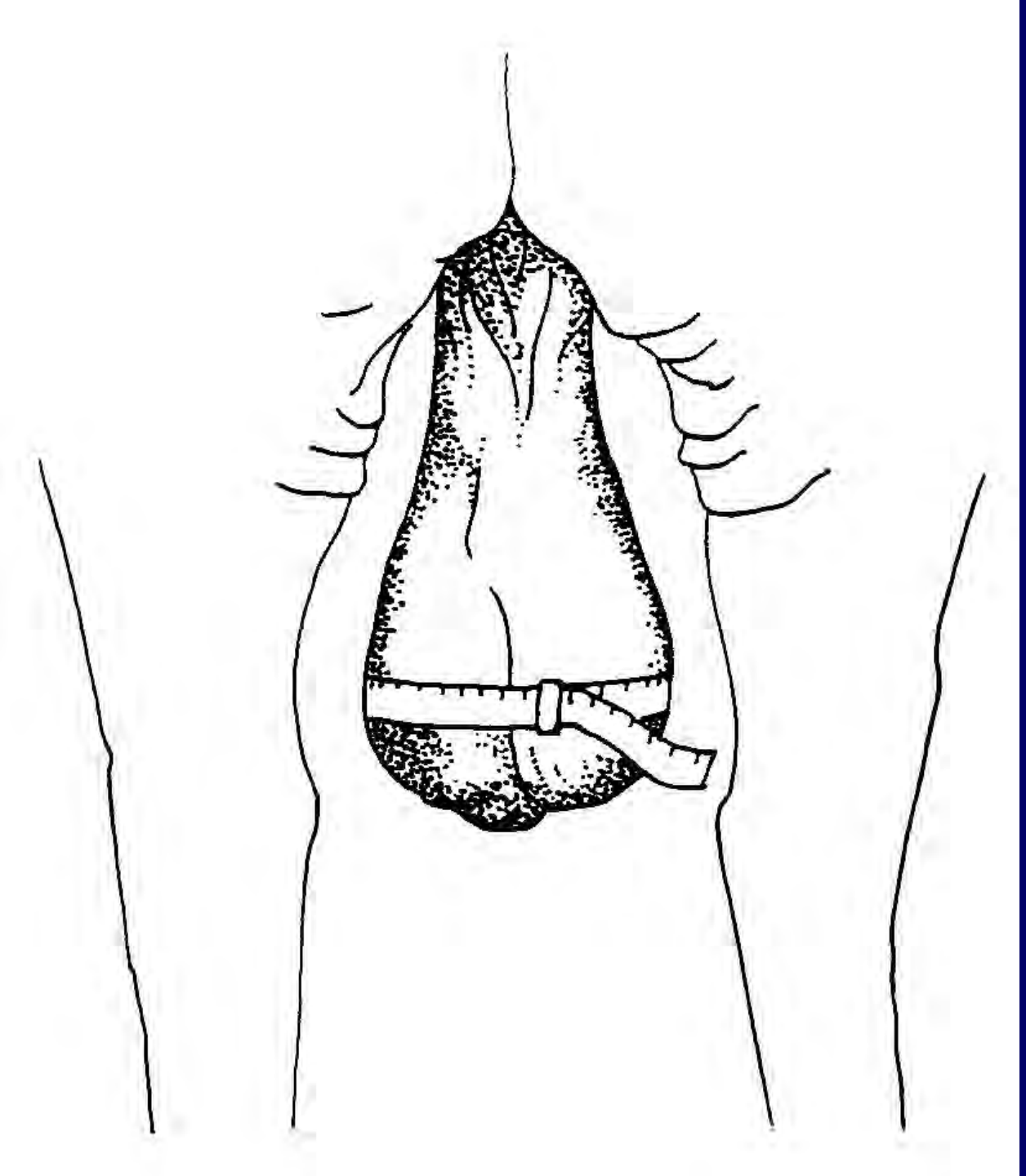
Hybrid vigor

- Is highest in factors affecting efficiency of cows
  - Fertility
  - Calf survival
  - Longevity
- Is intermediate in growth traits
  - Milk Production
  - Weight gain
- Is low in carcass traits
  - Fat thickness
  - REA

Hybrid vigor for most traits seems to be greatest in sub-optimal environments

Using Indicator Traits

- Scrotal circumference
- Reproductive tract score



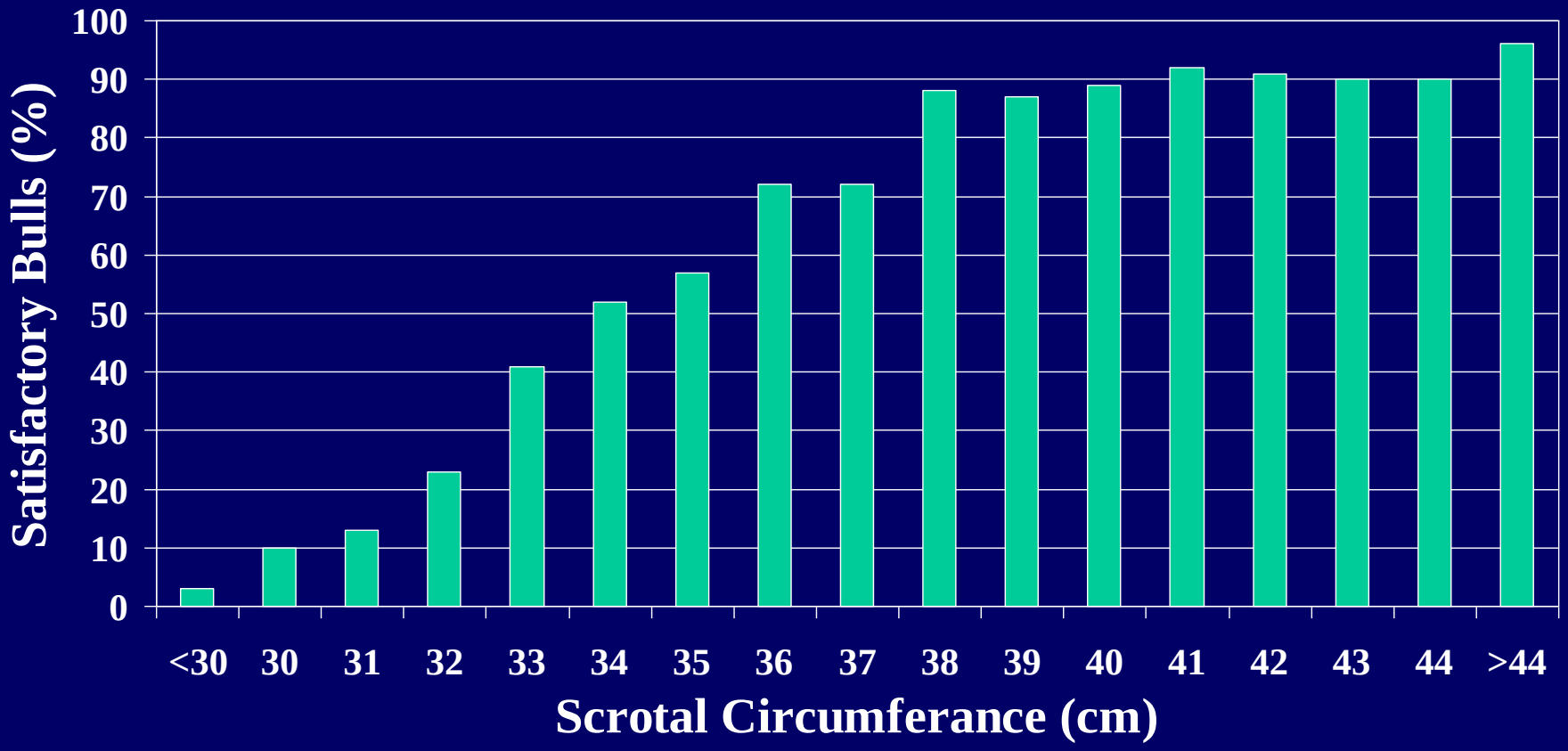
How does scrotal circumference correlate to fertility?

Scrotal Circumference

- Testicular size:
  - –affects sperm quality
  - –affects the number of normal sperm cells
  - –related to age at puberty in bulls
  - –related to age at puberty in a bulls daughter
  - –is easy to measure and highly heritable

Scrotal circumference has both short and long term effects on reproduction in the cow herd!

Scrotal Circumference



Cates, 1975

Yearling Scrotal Circumference

- Must be collected at yearling to be predictive of age at puberty in daughters

- Most bulls at bull sales report current SC
    - 2 year old bulls
    - SC at 2 years is NOT correlated to age at puberty in daughters

Reproductive Tract Scoring

- Subjective estimates of sexual maturity based on:
  - ovarian activity
  - size of the reproductive tract (uterus and ovaries)
- Exam is conducted 30-60 days prior to breeding
  - rectal palpation

Reproductive Tract Scoring

RTS	uterine horns	Ovarian dimensions (mm) length (mm)	height (mm)	width (mm)	ovarian structures
1	immature, <20mm diameter, no tone	15	10	8	no follicles
2	20-25 mm diameter, no tone	18	12	10	8mm follicles
3	25-30 mm diameter, slight tone	22	15	10	8-10mm follicles
4	30 mm diameter, good tone	30	16	12	10mm follicles CL possible
5	>30 mm diameter	>32	20	15	CL present

Anderson et al., 1991

Reproductive Tract Scoring

- Suggested uses:
  - Screening test to determine pubertal status of heifers before breeding
  - Decide which heifers to AI
  - Selection tool for age at puberty
    - Select 3, 4 and 5
  - Culling tool for improving fertility
    - Cull 1 and 2

Adapted from Anderson et al., 1991

Reproductive Tract Scoring

RTS	Total # head	Pregnant first 5 days (%)[a]	Pregnancy rate (%)[b]	Pregnant # head	Average conception date[c]
1	13	0	38	4	35
2	69	23	61	42	25
3	185	32	70	137	17
4	58	55	93	54	15
5	293	54	85	248	13

[a] Heifers were synchronized with either Syncro-Mate B or MGA-PGF2
[b] 60 day breeding season
[c] average days into the breeding season that conception occurred

Brinks, 1994

Reproductive Tract Scoring

RTS	Total # head	Sync. pregnancy rate (%)[a]	Overall pregnancy rate (%)
1	61	34[b]	65[b]
2	278	58[c]	91[c]
3	1103	60[c]	93[c]
4	494	65[c]	93[c]
5	728	66[c]	93[c]

[a] Heifers were synchronized with MGA-PGF2

[b,c,d,e] numbers with different superscripts within each column differ (P<.05)

Adapted from Patterson and Bullock, 1995

Reproductive Tract Scoring

RTS	Total # head	Open # head	Pregnant # head	Pregnants culled	Opens kept
1	61	21	40	40	
2	278	25	253	253	
3	1103	77	1026		77
4	494	35	459		35
5	728	51	677		51
Total	2664	209	2455	293	163

Adapted from Patterson and Bullock, 1995

Reproductive Tract Scoring

- If all RTS 1 and 2 were culled
  - 339 head (13% of heifers kept at weaning)
  - 339 head *$.75/hd/d*120 days=$30,510 cost till preg check
- Of 339 heifers 293 got pregnant
  - Value of cull heifer at yearling $900
  - Value of pregnant heifer at preg check $1,200
  - Difference in value $300
  - $300*293 head=$87,900

- **Lost revenue=$57,390**

Reproductive Tract Scoring

- If only RTS 1 were culled
  - 61 head (2.3% of heifers kept at weaning)
  - 61 head *$.75/hd/d*120 days=$5,490 cost till preg check
- Of 61 heifers 40 got pregnant
  - Value of cull heifer at yearling $900
  - Value of pregnant heifer at preg check $1,200
  - Difference in value $300
  - $300*40 head=$12,000

- **Lost revenue=$6,510**

Reproductive Tract Scoring

RTS	Total # head	Weight (lbs)	Pelvic area (cm^2)	Sync. pregnancy rate (%)[a]	Overall pregnancy rate (%)
1	61	594[b]	152[b]	34[b]	65[b]
2	278	620[c]	158[b]	58[c]	91[c]
3	1103	697[d]	166[c]	60[c]	93[c]
4	494	733[e]	172[d]	65[c]	93[c]
5	728	755[e]	172[d]	66[c]	93[c]

[a] Heifers were synchronized with MGA-PGF2

[b,c,d,e] numbers with different superscripts within each column differ ($P<.05$)

Adapted from Patterson and Bullock, 1995

Age and Weight Relationships to RTS and Pelvic Area in Heifers

RTS	Total # head	Age (days)	Weight (lbs)	Pelvic area (cm2)
1	28	364	623	136
2	193	368	659	155
3	883	374	690	160
4	742	383	736	172
5	556	381	759	176

Adapted from Randle, 2000

Reproductive Tract Scoring

- Cost of RTS
  - $5/hd*2664hd=$13,220 (no gathering cost included)
  - Only 13% of heifers were RTS 1 and 2
  - Likely could have identified these with age and or weight (or just look at them)
  - Most of the cost of developing heifers have already incurred at the time of RTS
  - Still had 7% of the RTS 3,4,5 heifers that did not bred and RTS was not a predictor of their infertility

Reproductive Tract Scoring- Overview

- Difficult to do
- $5/hd cost
- Frequency of RTS 1 very low 2-3% of population
- Many of the RTS 1 and 2 heifers will get pregnant (later)
- Age and weight are more valuable predictors
- More value in a AI/ synch program
    - Do not waste semen on RTS 1 and 2

- Subsequent reproduction of RTS 3,4,5 versus RTS 1,2???

Reproductive Tract Scoring- Overview

- Timing of examination very important
  - prior to one year-most heifers will receive a 1 or 2
  - measured too late-most heifers will receive a 4 or 5
  - 25-50% of heifers should be cycling
  - by this time significant heifer development expenses have already occurred
- Not valuable as a selection tool to reduce age at puberty
  - Some false positives = 7%
  - Many false negatives = 86%

If you want fertility why not select for it directly?

Three maturity groups were established by determination of age at first calving.

Maturity Level	age at first calf	n
Early	<800 days	49
Intermediate	800-900 days	32
Late	>900 days	92

Adapted from d'Orey Branco et al 2016

Age (days) at the 2nd, 3rd, and 4th calvings

Maturity Level	age at second calf	age at third calf	age at fourth calf
Early	1257[c]	1661[c]	2028[b]
Intermediate	1387[b]	1836[b]	2206[b]
Late	1501[a]	1918[a]	2303[a]

EM vs IM=178 days
EM vs LM=275 days

[a;b;c] = P<0.05 differences by column.

Adapted from d'Orey Branco et al 2016

Cumulative adjusted (180 d) weaning weight (lb) per year of age.

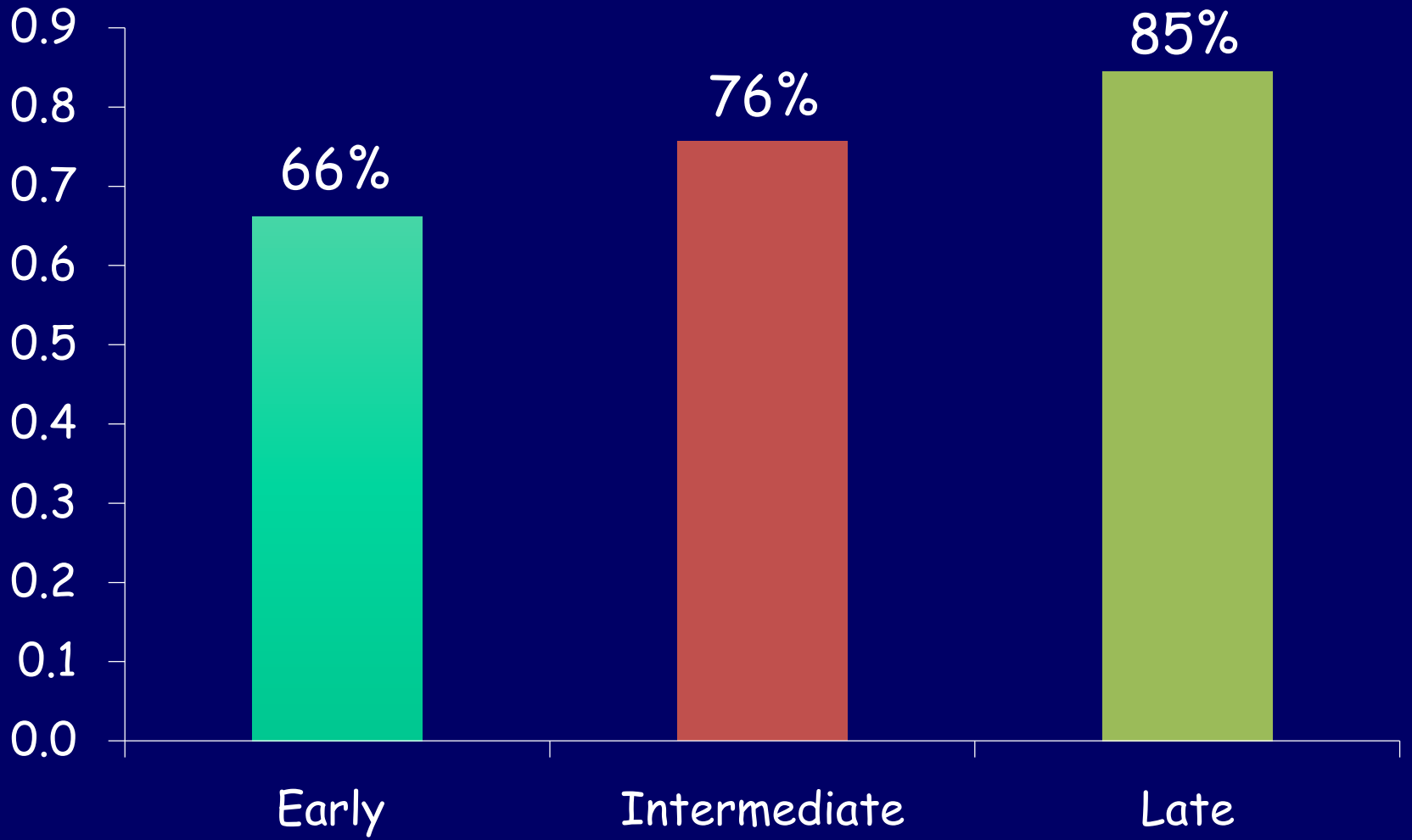
Maturity Level	2 years of age	3 years of age	4 years of age	5 years of age
Early	377[a]	553[a]	882[a]	1184[a]
Intermediate	41[b]	357[b]	761[ab]	1027[ab]
Late	0[c]	401[b]	717[b]	1004[b]

EM vs LM=180 lbs

[a;b;c] = P<0.05 differences by column.

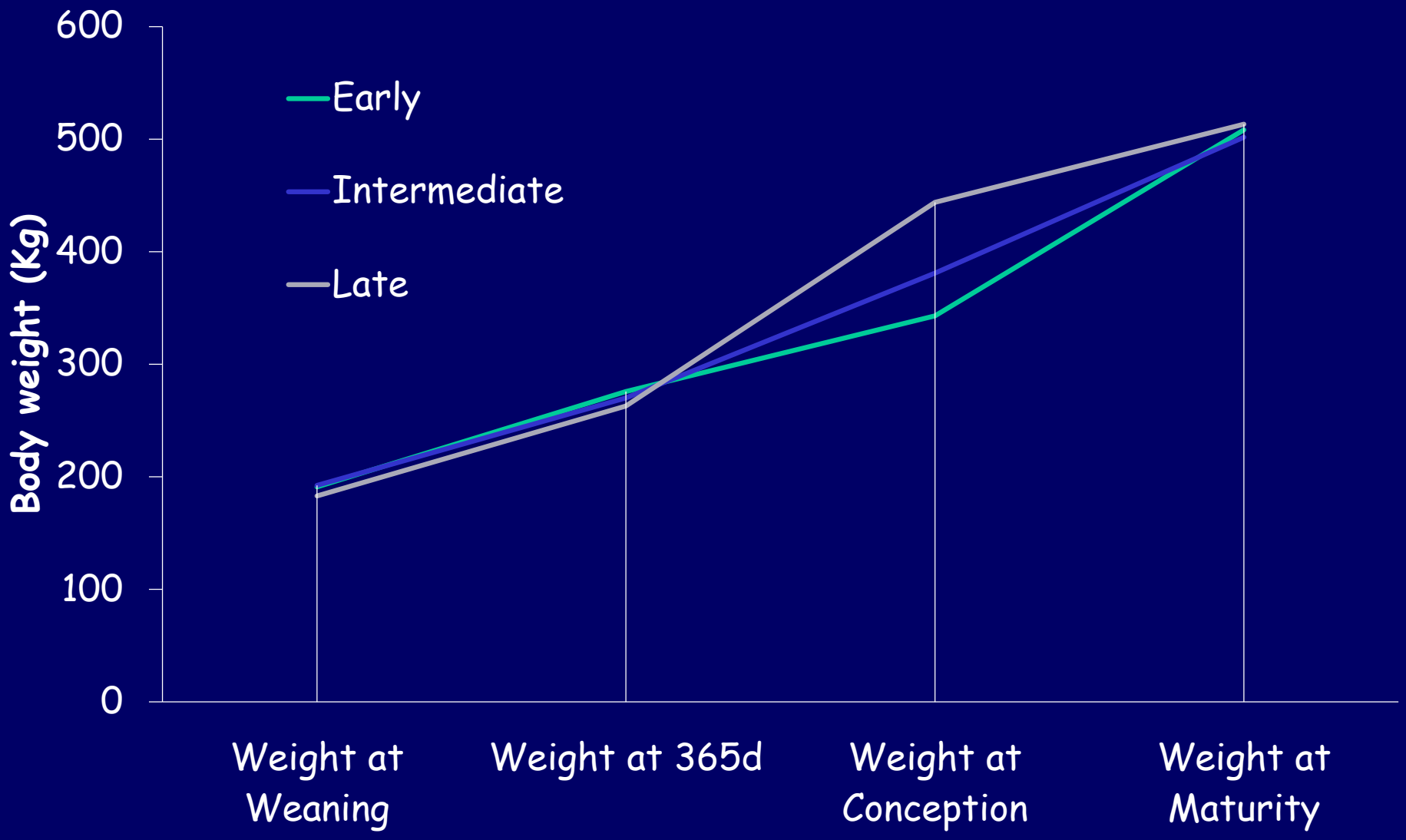
Adapted from d'Orey Branco et al 2016

Percentage of Mature BW at Conception



P<0.0001 differences by column.

Adapted from d'Orey Branco et al 2016


600
500
400
300
200
100
0
Body weight (Kg)
Early
Intermediate
Late
Weight at Weaning
Weight at 365d
Weight at Conception
Weight at Maturity

Summary TX Trial

- The EM cattle were able to produce their fourth calf 178 days earlier than the IM group and 275 days earlier than the LM group.

- The EM group also produced 180 lbs of cumulative weaned calves at 5 years of age compared to the later calving groups.

It is possible to select Brahman cattle capable of calving at 27 months of age or less, leading to an overall increase in reproductive performance and productivity.

Calving First at 2 Years of Age

- Advantages
  - shorter interval to a return on investment
  - increased lifetime production per cow
  - increased output per year on a herd or cow basis
  - fewer groups to manage
  - Placing selection pressure on FERTILITY

- Disadvantages
  - increased cost associated with early breeding
  - increased cost associated with calving difficulty
  - lower re-breeding rates for 2 year olds
  - fewer and smaller calves weaned from 2 year olds
  - difficult to do with high *Bos indicus* percentage

Calving First at 2 Years of Age

- Life time average calf crop of 1589 heifers mated to calve as two year olds:

Produced a calf from their first breeding season	Did not produce a calf from there first breeding season
87%	55%

Cull heifers that are managed correctly and of sufficient age but still fail to bred initially

(Sprott, 2000)

Calving First at 2 Years of Age

- Lifetime production is increased by about .7 calves by calving heifers as 2 year olds rather than as 3-year olds. (Morris, 1980)
- On an annual basis the first calf of a 2 year old heifer was lighter but no differences were observed in subsequent years (Nunez-Dominquez et al., 1985)

Negative Genes Impacting Fertility

- Genes that may have a negative effect on fertility
  - Deletion on chromosome 5 that impacts the fertility of *Bos indicus* *Psaros et al., 2015*
  - 1 SNP with strong association
  - 6 SNP with suggestive association *McDaneld et al.,2014*
- This technology would allow for detection of subfertility early in life. *Adapted from Snelling et al 2012,*

Heifer Selection

- Retain as many heifers as you can afford and let them cull themselves (10-25% more heifers than the replacement rate requires)
- Select the oldest, heaviest (actual weaning weight) heifers-born in first half of calving season
- Crossbred to improve fertility

Heifer Selection

- When your cows are large enough and production level is high enough (WW) one might be better off to select from the middle third of heifers in size and place more emphasis on age.
    - Make sure that the heifers you keep were born in the first ½ of your calving season
    - Sell the large end of the heifers as replacements

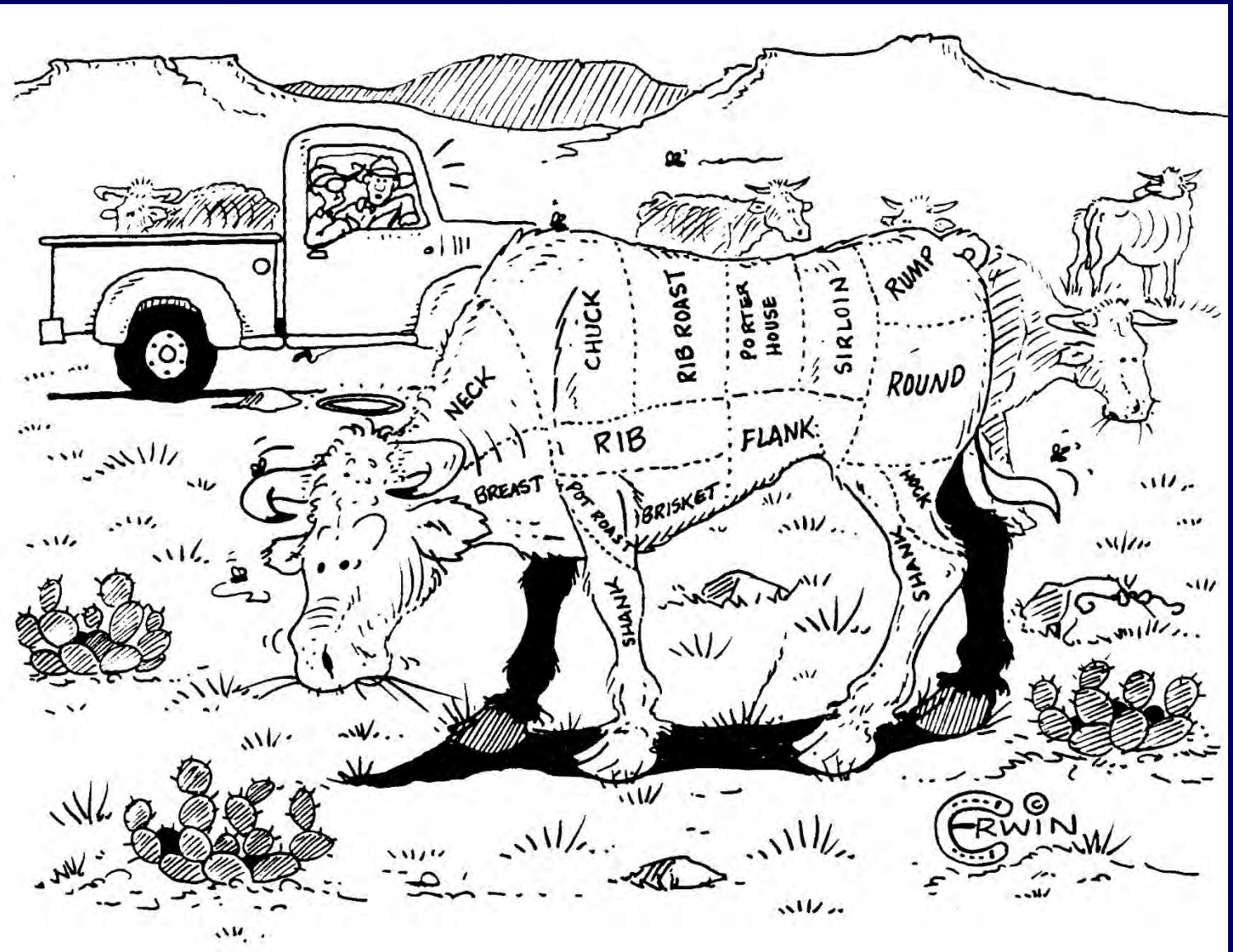
Heifer Selection

- Expose heifers for a short duration (90 days)
    - AI if appropriate
- Pregnancy test and sort heifers based on days pregnant
    - Keep only the early bred heifers
    - Sell the late bred heifers
- Sell the open heifers (or rebreed but don't keep)

Use the Bull to Tell You Which Ones Will Reproduce…..

…but make him do it in short order and force the heifers to do it at an early age

Demand that they reproduce or talk to them about their other options!



"He aint wrecked any fences or jumped one cattle guard since we discussed his career choices"