Reproductive Management- Focusing on the Heifer/Cow
Cow Reproduction Demonstration

Coordinators: Dr. Bruce Carpenter
Dr. Tom Hairgrove
Dr. Ky Pohler
Dr. Rodolfo Cardoso

Sponsors

Genetic tools for reproduction: importance of management and environment

Milt Thomas, Ph.D. and Professor
Texas A&M AgriLife Research, Beeville
361-358-6390
milton.thomas@ag.tamu.edu

Important History of Reproductive Management

- Wiltbank, 1968
- Willams and Randel, 1990
- Beef Reproduction Task Force, 2023.

https://beefrepro.org

Foundations of Reproductive Management:

- Body Condition Score
- Heifer development (breed)
- Young cow management
- Breeding and calving seasons
- Culling
- Nutrition
- Genetics

Which Bull is Best?

Achieving Breeding objective (Goal):

- **Artificial Selection (numerous tools)**
- **Natural Selection**

Tools of Selection:

- **Breed**
- **Pedigree**
- **Performance (h^2)**
- **EPD**
- **DNA (single genotype vs genomics)**
- **Index**
- **eye^2**

***Art + Science Balanced in an Environment.**

Realities of beef cattle breeding:

- **Genetic change always occurs.**
- **Difficult and slow.**
- **Few simple (qualitative) traits.**
- **Lots of important polygenic (quantitative) traits.**
- **Beef cattle genetic improvement depends on business relationships.**
- **Art + science balanced in an environment.**

Breeds

Humped
Bos indicus

Hump-less
Bos taurus

Advantages of Crossbreeding

- **Hybrid Vigor (heterosis)**
- **Breed complementarity**

American Breeds (Composites)

BEEFMASTER BREEDERS UNITED

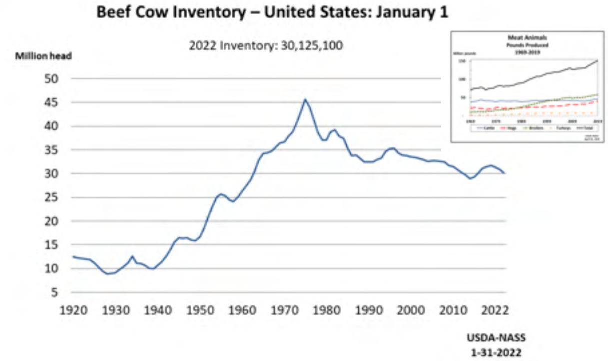
INTERNATIONAL BRANGUS BREEDERS ASSOCIATION

- Ultrablack and UltraRed
- American Red
- Stabilizer (LCOC)
- SimBrah and SimAngus
- Powerline (Genus)
- LimFlex
- Balancer
- Optimizer

SANTA GERTRUDIS
Data Driven. Profit Proven.

UNITED BRAFORD BREEDERS

Beef Cow Inventory – United States: January 1



USDA-NASS
1-31-2022

Genetic Model for Quantitative Traits (Polygenic)

- Phenotype = Genetics + Environment
- $P = \mu + G + E$
- $P = \mu +$ ==BV== $+ GCV + E$
- PD (Progeny Difference) = ==½ BV==

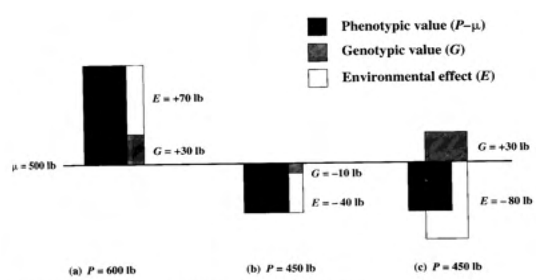


FIGURE 7.1[1] Schematic representation of genetic and environmental contributions to the weaning weights of three calves. Calf (a) weighs 600 lb (100 lb above average), has a higher than average genotypic value (G), and experienced a better than average environmental effect (E). Calf (b) weighs 450 lb (50 lb below average), has a lower than average genotypic value, and experienced a worse than average environmental effect. Calf (c) weighs 450 lb also. His genotypic value for weaning weight is higher than average, but his actual performance is below average due to a very poor environment.

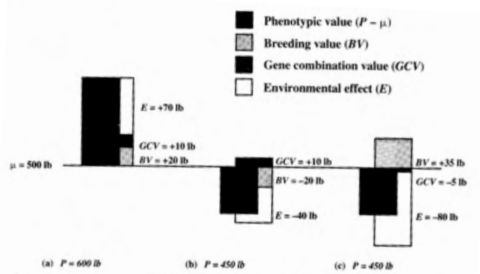


FIGURE 7.4 Schematic representation of the contributions of breeding value, gene combination value, and environmental effect to the weaning weights of the three calves depicted earlier in Figure 7.1. Calf (*a*) weaned the heaviest, but much of his superiority is due to factors that cannot be transmitted to offspring. If heavier weaning weights are desirable, the best breeding animal should be calf (*c*).

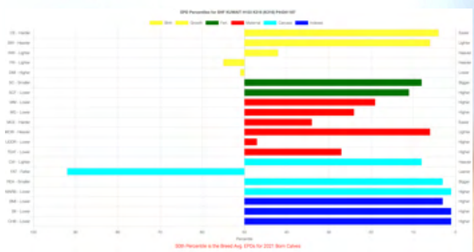
551BN01518 **TOP SHELF** Reg: 10457860 BWCC Top Shelf 468H82 DOB: 10/13/2020 AA A2A2

EPDs June 2023

Active Sire	CED	BW	WW	YW	MILK	TM	CEM	SC	REA	IMF	FAT	HEIF PREG	STAY	COW WT	TERM INDEX	FERT INDEX	BB	NC
EPD	4.1	0.4	39	65	8	28	2.14	1.34	0.64	0.44	0.045	5.48	2.72	0.39	4.06	3.74	1.27	0.15
ACC	0.37	0.45	0.42	0.36	0.28	-	0.29	0.4	0.42	0.49	0.43	0.24	0.13	0.22	-	-	0.2	0.13
% RK	55	50	15	15	55	15	90	4	5	10	>95	25	5	60	10	5	10	4

Note(s):
- Denotes Genomic-Enhanced EPD Result
- Accuracy of 'P' denotes Pedigree Estimate EPD

EPD = +/- number for a trait of how an animal deviates from a base-average.



Accuracy increases with:

- **Animal's performance record**
- **DNA-Genomic testing**
- **Progeny records**

New Tools and Data

Genotypes increase EPD Accuracy

Miss RS 2002

	CE	BW	WW
EPD	5.3	0.8	50
Acc	0.29	0.33	0.25
EPD	8.0	0.1	51
Acc.	0.35	0.45	0.36

Heritability (h^2)

$P = \mu + BV + GCV + E$

$h^2 = BV/P$

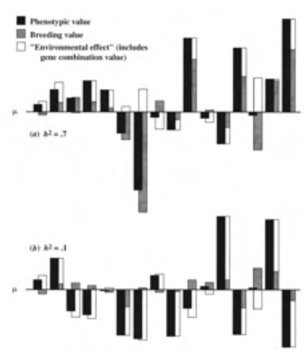
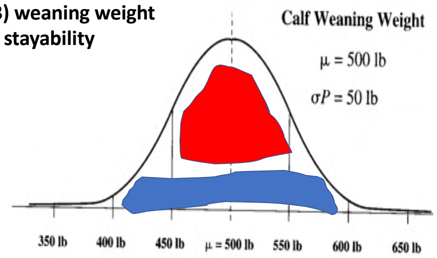


FIGURE 9.1 Schematic representation of animal performance for two traits that differ in heritability. Records for a sample of 16 animals are shown for each trait. Contributions of breeding values and "environmental effects" (environmental effects and gene combination values combined) are shown in the background. Heritabilities (h^2) for the traits depicted in the upper (*a*) and lower (*b*) diagrams are .7 and .1, respectively.

Understanding Heritability (h^2)

- High = (0.4) yearling weight
- Moderate = (0.3) weaning weight
- Low = (0.1) cow stayability



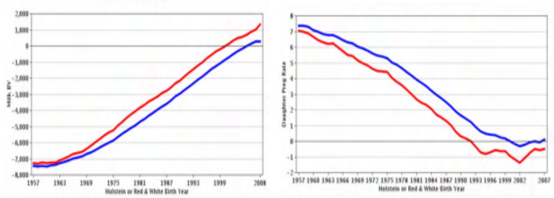
BEEF IMPROVEMENT FEDERATION

https://beefimprovement.org

Reproductive Traits > Growth Traits (10X) Carcass Traits (20X)

Melton B. E. 1995. Conception to consumption: the economics of genetic improvement. In: 27th Proceedings of Beef Improvement Federation, Research Symposium and Annual Meeting, Sheridan, WI; p. 40–47.

Genetic Improvement and Trend From Selection



U.S. Registered Holsteins FOR MAXIMUM PROFIT

Characteristics of Fertility Traits

- Lots of definitions and rules.
- Binary (1 = pregnant vs 0 = not pregnant).
- High/low percent pregnancy success.
- Only recorded on one sex, male or female.
- Late-in-life record.
- Correlated with other traits.
- Cow-age distribution.
- Hybrid vigor or not.
- Total herd reporting system.
- Scrotal circumference relationship to daughters?
- Polygenic and low h^2.
- Slow rate of genetic change relative other traits.

Milt Thomas, J. E. Rouse Chair

Beef Cattle Fertility Traits

- First Service Conception (FSC)
- Heifer Pregnancy (HPG)*
- Age of Puberty (AOP)
- Age of First Calving (AFC)
- 1st Calf Heifer Rebreeding or Breed Back (BB)*
- Stayability (STAY)*
- Longevity (LONG) or Number of calves (NC) *
- Sustained Cow Fertility (SCF)*
- Gestation length

- Scrotal Circumference

- Etc.

*EPD published by a breed association

Beefmaster Brahman SG?

Beef Cattle Fertility Indexes

from breed association gEPD

- BMI$ (AHA; Baldy Maternal Index)
- BII$ (AHA; Brahman-influence Maternal Index)
- Queen (ABBA)
- Cow$ (AGA)
- ProS$ (RAAA)
- API (ASA)
- FI (IBBA)
- $EN (AAA)
- $Ranch (LCOC)
- Balanced (SGBI)
- Cow/Calf (SGBI)
- $M (BBU)
- Etc.

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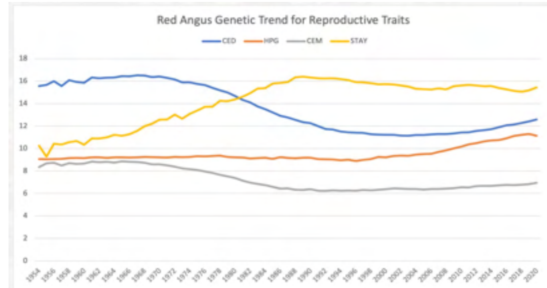


Milt Thomas, J. E. Rouse Chair

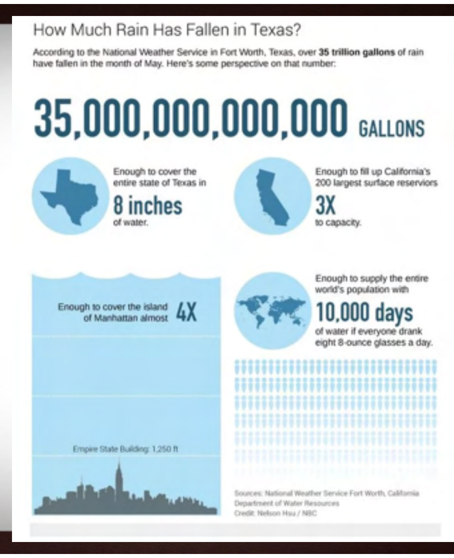
Conclusions

- Genetic trend in global beef industry.
- Cattle breeding is complex; therefore, must understand the tools (i.e., BV vs E).
- Reproductive traits are of low h^2, but extremely important
- Document your breeding objective!

Questions?

Replacement Heifers: Managing Expectations

Bruce B. Carpenter, Professor and Livestock Specialist, Texas A&M AgriLife Extension
Robert J. Hogan, Associate Professor and Economist, Texas A&M AgriLife Extension



Replacement Costs 2015 vs 2023

- 2023 Heifers cost 30% LESS
- 2023 Feed and Grazing 33% MORE

2015	$2021
$ 2021	$ 2085

Background:

- Heifers should have their first calf by 2 years of age
- Puberty in yearlings is determined by two things:
  1. Age – according to breed type
  2. Body Weight – as a percentage of mature weight
- Heifers born in the first ½ of the calving season should be more physiologically mature and more likely pubertal

The Two-Year-Old, First-Calf Heifer

Challenges for Selection

- Known Calving Date

If calving dates are not an option for selecting replacement heifers …..

1. Pick from among the bigger or heaviest heifers at weaning
   - Expect them to be the most mature
   - Expect them to require relatively less feed to reach "target breeding weight"
   - May lead to bigger cows (WW to MW 70% correlated).
2. Keep large numbers and select replacements later, after first breeding season
3. Other……

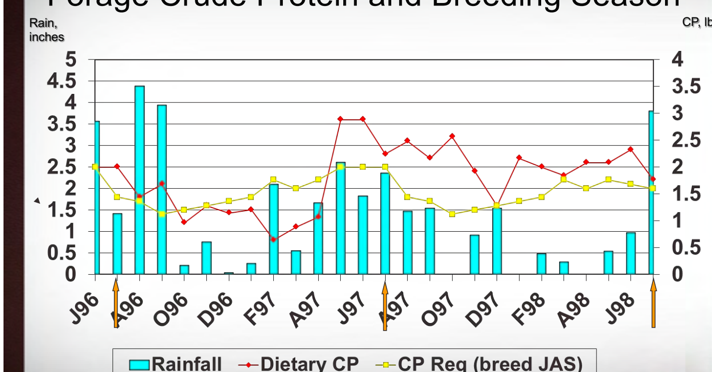
Review of "target weight"

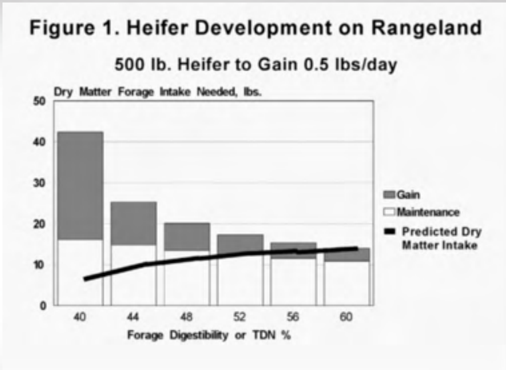
- Research 1960s - 1980s: puberty occurs at a genetically predetermined weight
  - (reviewed: Patterson et al., 1992; Funston et al. 2009; Funston et al. 2012; Endecott et al. 2014).
- Heifers developed to lighter target weights (50 to 57% of mature body wt), were able to reach puberty and breed at acceptable rates (Funston et. al. 2012; Roberts, et. al. 2009)
- Exactly what is "Mature Weight" ?
- The 60% rule might offer some "insurance" against "wrong" guesses ??

Challenges for Development

- Drought – frequent and often over consecutive years
- Seasonal forage changes
- Timing of the breeding season

Marfa, TX: Forage Crude Protein and Breeding Season





From: Sprinkle and Tolleson, 2011

- Pubertal status prior to the breeding season (Roberts et al. 2013, Vraspir et al. 2014)

IMPACT OF NUMBER OF ESTROUS CYCLES EXHIBITED PRIOR TO START OF BREEDING ON REPRODUCTIVE PERFORMANCE IN 1,176 BEEF HEIFERS

A. J. Roberts , J. Ketchum , R. N. Funston , and T. W. Geary

Table 1. Weight, age, and reproductive performance of heifers classified based on number of estrous cycles exhibited before start of breeding

	Number of estrous cycles before start of breeding						
	0	1	2	3	>3	SE[1]	*P*-value[2]
Heifers first season, n	395	205	211	116	249		
BW before start of breeding, kg	305^{a}	319^{b}	319^{b}	325^{b,c}	325^{c}	2.9	< 0.001
Age at start of breeding, d	420^{a}	426^{b}	426^{b}	426^{b}	430^{c}	1.4	< 0.001
★ Heifer pregnancy rate, %	84^{a}	90^{b}	88^{a}	89^{ab}	94^{b}	2.9	< 0.008
Start of breeding to calving, d	300^{a}	297^{b}	295^{b}	295^{b}	296^{b}	1.4	< 0.001
Two-yr-old cows, second season, n	228	144	132	87	190		
★ Second season pregnancy rate, %	62^{a}	71^{b}	73^{b}	83^{c}	86^{c}	4.7	< 0.019

[1] Largest SE.

[2] P-value for effect of estrous cycle category.

[a-c] Means without a common superscript differ ($P \leq 0.05$).

Timing of First Pregnancy and Lifetime Production

- Pregnancy in later years
- Calving date and calving pattern - and thus weaning weights in later years
- Cow longevity
- Average lifetime return on investment

(Lesmeister et. al. 1973; Cushman et. al. 2013, Roberts et. al. 2013, Sprott)

Table 2. Lifetime Average Calf Weight per Female as Affected by Date of Calving as a Two-Year-Old

	Period (by 21 day intervals) of Calving as a two-year-old			
	First 21 days	Second 21 days	Third 21 days	Last 21 d
Herd 1	556 lbs	535 lbs	494 lbs	523 ll
Herd 2	499 lbs	452 lbs	424 lbs	429 ll
Herd 3	519 lbs	475 lbs	430 lbs	423 ll
Herd 4	507 lbs	517 lbs	492 lbs	474 ll
Herd 5	499 lbs	468 lbs	459 lbs	475 ll

Data taken from 5 commercial herds and includes approximately 1500 females that calved annually throughout their life

Sprott, Extension Beef Cattle Specialist and Professor emeritus, Texas A&M AgriLife Extension

Calving Interval Impacts on Replacement Heifers

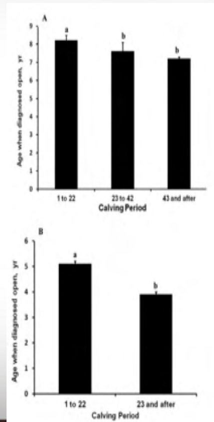
- U.S. Meat Animal Research Center 16,549 heifers
- Avg preg rates by year

Pregnancy	Calving Period 1; n= 11,061	Calving Period 2; n= 4,372	Calving Period 3; n= 1,116 lbs
2nd	93	88	84
3rd	93	90	88
4th	94	92	91
5th	94	92	89
6th	94	93	93

(Cushman, et al 2013), Univ Neb and USDA MARC

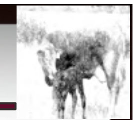
Calving Interval: Age when first open

USDA MARC. Evaluated 16,549 Angus and Angus cross Heifers



Commercial beef herds in SD. 2,195 heifers

Calving Interval: Steer Performance



	Calving Period 1	Calving Period 2	Calving Period 3
Birth date, day of year	73	91	116
Calf birth BW, lbs	81.6	83.8	83.8
Calf WW, lbs (no difference in 205 d)	525	496	450
Final BW, lbs	1300	1279	1239
Hot Carcass Weight, lbs	818	805	778
Marbling Score	569	544	519
USDA choice or better %	79	78	65

Funston et. al. 2012, JAS

Lifetime Average Return on Investment per Female

	1st 21 days	2nd 21 days	3rd 21 days	4th 21 days
Herd 1	14.8%	10.4%	4.7%	8.6%
Herd 2	(-3.2%)	(-10.3%)	(-12.4%)	(-11.2%)
Herd 3	9%	(-13%)	(-16%)	(-9%)
Herd 4	18%	9%	3.6%	(-10%)
Herd 5	14.7%	2%	6%	6%

Data taken from five herds of commercial cows and includes approximately 1,500 calves from females that calved annually throughout their life.

Prepared by L.R. Sprott, Professor, Extension Beef Cattle Specialist and Research Scientist
Texas Cooperative Extension, Texas A&M University

Management Strategies*

Nutritional Plane**

- Range vs. Feedlot Developed heifers (Endecott et al. 2013, NMSU)
  - Range Developed heifers showed compensatory gain on high quality summer forage during the breeding season
  - However, severe diet restriction after only 14 days induced anovulation in 70% of previously (100%) cycling heifers (White, et al. 2001, OSU)

Frequency of Feeding High Protein Supplements to Heifers on NM Rangeland

	Trial 1, 130 d		Trial 2, 146 d	
Times Fed	1 / WK (n=43)	3 / WK (n=40)	1 / WK (n=27)	3 / WK (n=18)
Amt per Feeding	6.9 lb	2.3 lb	10.5 lb	3.5 lb
ADG	0.5 lb	0.47 lb	0.34 lb	0.37 lb
Preg Rate	93%	90%	89%	89%
Cost per Head	$14.10 ($36.15)	$14.10 ($36.15)	$24.09 ($62)	$24.09 ($62)

Based on cost of CS cake @ $220 per ton, 1885-86

Adj for feed cost, 2022 @ $564 per ton

Feeding once per week reduced labor and transportation costs by 60%

Wallace and Parker, NM Cattle Growers Short Course, 1992; JAS 1988, Supp 1, 191

Frequency of Feeding High Energy Supplements vs. Cotton Seed Cake (Wallace and Parker, NMSU)

	Grain Cube 9.4% CP, 84% TDN		CS Cake, 41% CP, 74% TDN
Feedings / week	Twice	Daily	Twice
DM / feeding	6.4 lb	1.83 lb	7.0 lb
TDN / feeding[1]	5.32 lb	1.52 lb	5.32 lb
ADG	-0.03 lb	0.14 lb	0.51 lb
Preg Rate	68 %	94 %	100 %
Cost / hd[2]	$22.84	$22.84	$35.88

[2]Based on cost of gain cubes @ $160 / ton and CS cake @ $230 / ton

Nutritional Plane x RUP Protein

- 1st Priority is RDP (RUP research somewhat limited)
- Metabolizable Protein increased with small amount of RUP in Salt mix for heifers on dormant Southern NM range (Stalker et al 2002).
- Improved glucose metabolism and gain (Hawkins et al. 2000).
- Mulliniks et al. 2013, dormant central NM Range, 6.5% CP
  1) Pasture developed 36% CP supp, 30% RUP (feather meal)
  2) Pasture developed 36% CP supp, 50% RUP (feather meal)
  3)Feed lot developed heifers

Attempts to replicate with corn gluten RUP not as successful

	36RUP	50RUP	Feedlot	P value
Preg Rate (exp 2)	88%	94%*	84%	P=.10
Net Return (exp 2)	$256	$268	$168	
Retention Rate yrs 3 and 4	41%	68%*	43%	P < 0.1

How Do You Know if Nutrient Requirements Are Being Met ?

- Body Weights (1st calf heifers)
- Body condition Scoring (2nd calf heifers)
- Forage Sampling
  - Hay
  - Pasture
- Fecal Sampling (NIRS / NUTBAL)
  - http://cnrit.tamu.edu/ganlab/
- Examine fecal material

So…How Do We Pick Replacement Heifers and How Do We Manage Them to be Early Calvers?

- Oldest ?
- Biggest?
- RTS at breeding?
  - h^2 is 0.32, r^2 with: age*, wt, BCS
- Genomic Testing? (Black Angus)
  - (GENEMAX®, Zoetis).
- Selection Strategies for Early Breeders:

Early Pregnancy Testing

- 25 years ago most people had to use a 40 day breeding season to manage for early puberty and early calvers
- Now, we can do the same thing but still use a more normal 90 or 120 day breeding season.

Estrus Synchronization

- Has been used for 50 years to tighten up calving seasons and add value to calves

Impact of Fixed-Time AI on Calving and Weaning

	Treatment	
Item	Control	TAI
No. of cows	615	582
Weaning rate, %	78	84
Weaning weight, lb	387[a]	425[b]

[ab] Means within row differ ($P < 0.01$)

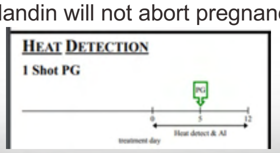
(Rodgers et al., 2011)

Estrus synchronization of cows with natural bull service

- More calves born earlier in the season
- Heavier weaning weights
- More valuable carcass
  - greater carcass weights, marbling scores, and yield grades (Larson et al. 2009; Larson et al. 2010)

339 Commercial Heifers on 3 Ranches

- La Pryor, South TX (n=100), Beefmaster bulls x Black, Red Angus 80d breeding season
- Canadian, TX Panhandle (n=100), Blacks and Red Angus (some Hereford X), 103 day breeding season
- Valentine, Far-West TX (n=112), Black Angus Some Hereford X, 90 d breeding season
- Estrus Synchronized on day 4.5 after bull turn-in
  - 2cc Prostaglandin Shot (Estrumate®)
  - Prostaglandin will not abort pregnancies less than 6 days



- Blood PregnancyTest (BioPryn®) on day 40 after bull turn-in

This Protocol ID'd Heifers That Were:

1) ***Pubertal*** at the start of the breeding season
- either cycled naturally on days 1-5
- or responded to PG on days 7-12

2) F*ertile* (conceived within that 12 day period).

What about bull power?

Results (to date)

	South Texas	*Panhandle*	*Far West Texas*
1st season Preg Rate %	86 (n=114)	90 (n=106)	91 (n=119)
% Pregnant within 1st 12 days of the breeding season (F12d)	41	54	54
Average Herd Wt. at Breeding (lbs)	798	792	675
Median Herd Wt. at Breeding (lbs)	795	795	680
% Pregnant F12d and Less Than Median Herd Wt. at Breeding	35	60	47
2nd season Preg Rate % (bred early previous year, F12d)	**42%** (n=31)		
2nd Season Preg Rate (bred later previous year)	**38%** (n=37; P = .82)		

Logistics: "Traditional" vs. ES and Early Preg Test

- "Traditional": Pick 15 heifers at weaning
  - 12% replacement rate
  - 80% preg rate on yearlings
  - October 2016, wean 100 hd, Keep 15 head
  - October 2017, Preg test 15 head, sell 3 open, keep 12
- ES and early Preg Test: keep all 100 head at weaning
  - October 2016, wean 100 head, keep all
  - April 2017 ES shots
  - May 2017 Early preg test to ID F12d heifers
  - October 2017, select 12 hd from the pool of 49 F12d. Sell other 37 hd from F12d + 42 pregnant from 2nd preg test + 9 opens

Economic Assumptions:

- Costs
  - Replacement heifer opportunity cost = the value of heifers kept as replacements instead of sold at weaning
  - Cost to run a heifer for a year (developed from Uvalde area AgriLife cow-calf budgets)
- Revenue (Used 2017 cattle prices)
  - Sale of open heifers
  - Actual Sale of pregnant heifers
  - "Sale" of pregnant replacement heifers "to our selves". i.e the value of the 12 heifers we keep in each scenario

Economic Projections: ES and Early Preg Test vs. "Traditional"

	ES, Early Preg Test	**"Traditional"**
Revenue	**$130,847**	**$15,900**
Cost	$105,679	$15,800
Revenue - Cost	$25,168	$3,524
Net Revenue per Head	$251.68	$234.93

Implications

- We anticipated that heifers that conceived within the first 12 days of their first breeding season would have higher pregnancy rates as 2-year-olds (and possibly throughout their lives) vs heifers that conceived later in their first breeding season
- These methods might be a way to identify and select directly for puberty and fertility

Implications

- If body weight and/or frame score at breeding was measured in conjunction with this protocol, breeders would have an option of direct selection for lighter weight heifers, but that are also proven to be pubertal and fertile.
- This protocol adds significant cost because a larger pool of heifers are kept, but it also adds value due to the sale of pregnant heifers
  - This also adds the option of a "stocker" heifer enterprise to help manage stocking rates especially during a drought.

Texas A&M AgriLife Extension

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REPLACEMENT HEIFER SELECTION, DEVELOPMENT, AND REPRODUCTION

Bruce B. Carpenter* and Ronald Gill**

SUMMARY

- Age at puberty influences economic efficiency of beef production through its effects on both age at first calving (2 versus 3+ years of age) and the time that a heifer conceives in her initial breeding season.[1]
  - Heifers of most breeds should have their first calf by 2 years of age.
  - On average, heifers that breed and calve early with their first calf will have higher productivity throughout their lives.
  - Puberty is determined by two things: age, depending on the breed type, and body weight as a percentage of mature weight.
- The risk of re-breeding failure is often highest in 2-year-old, first-lactation cows attempting to breed back for their second pregnancy, especially if their higher nutritional requirements are not met.
  - Nutrient requirements at this age are affected by the interactions of growth, lactation, changing dentition, and a relatively smaller rumen capacity compared to a mature cow.

Age at First Calving (2 versus 3 years) Affects Lifetime Productivity

Heifers that do not calve until they are 3 years old may experience less calving difficulty and wean a heavier calf compared to heifers that first calve at 2 years old.[2] However, total lifetime performance and economic efficiency favor heifers that calve first as 2-year-olds.[2, 3, 4] Also, calving difficulty in heifers of any age can be managed by breeding to lower birth weight bulls. Realize later-maturing Bos indicus—or high-percentage Bos indicus breeds—typically do not reach puberty in time to calve first as 2-year-olds.

*Professor and Extension Livestock Specialist
**Professor, Extension Livestock Specialist – Department of Animal Science

Earliness of Calving Affects Lifetime Productivity

Heifers that become pregnant early in their first breeding season and successfully calve their first calf have been shown to have higher pregnancy rates (Table 1) and weaning weights of calves in later years.[5, 6] Also, early calving heifers have been shown to have increased chances of longevity as cows (Fig. 1) and a higher average lifetime return on investment (Table 2).[6, 7]

Table 1. Calving Period for First-calf Heifers: The Effects on Pregnancy Rates in Later Years[6]

The United States Meat Animal Research Center, 16,549 heifers

Pregnancy	Calving Period 1 n=11,061	Calving Period 2 n=4,372	Calving Period 3 n=1,116
2nd	93	88	84
3rd	93	90	80
4th	94	92	91
5th	94	92	89
6th	94	93	93

Table 2. Period of First Calving: The Effects on Lifetime Average Return on Investment per Female[7]

	1st 21 days	2nd 21 days	3rd 21 days	4th 21 days
Herd 1	14.8%	10.4%	4.7%	8.6%
Herd 2	(-3.2%)	(-10.3%)	(-12.4%)	(-11.2%)
Herd 3	9%	(-1.3%)	(-16%)	(-9%)
Herd 4	18%	9%	3%	(-10%)
Herd 5	14.7%	2%	6%	6%

*Data taken from five commercial herds and includes approximately 1500 calves from females that calved annually throughout their life.
*Prepared by L.R. Sprott, former Professor and Extension Beef Cattle Specialist Emeritus

[1] Day & Nogueria, 2013
[2] Nunez-Dominguez, Cundiff, Dickerson, Gregory, & Koch, 1991
[3] Chapman, Young, Morrison, & Edwards, 1978
[4] Morris, 1980
[5] Lesmeister, Burfening, & Blackwell, 1973
[6] Cushman, Kill, Funston, Mousel, & Perry, 2013
[7] Sprott, n.d.

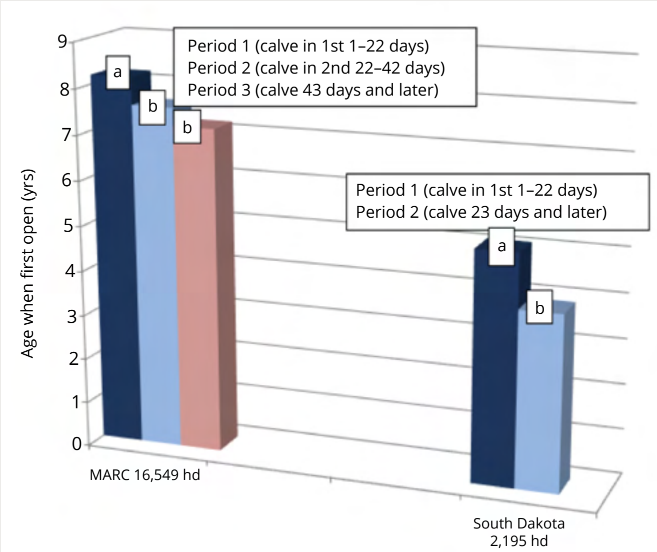

Figure 1. Calving Period for First-calf Heifers: The Effects on Age When First Open in Later Years

Heifer Selection

Most producers select replacement heifers sometime between weaning and the end of their first breeding season. Selection based solely on appearance is not well related to fertility. "Eye appeal" is not related to physiology and is often just one person's opinion.

Selecting heifers at weaning. If heifers are selected at weaning, age is no doubt the most useful criteria. Selecting heifers born in the first half of the calving season results in more mature animals that will require less time to reach puberty when compared to younger herdmates. Thus, calving records—the actual date, or at least the period within the calving season (early, middle, or late)—are the best way to identify these more mature animals. Some producers with extensive or remote pastures may not be able to observe cows during the calving season and may not know the ages of their heifer calves. If they select replacements at weaning, they usually just keep the biggest or heaviest, expecting them to be the oldest, which they often are. However, over time, selecting bigger heifers at weaning can subsequently lead to bigger cows. A correlation of 0.67 to 0.85 between these two traits has been reported.[8] Moderate cow size is necessary for many environments.

Genomic testing of calves to predict their future fertility and overall performance as cows is an emerging technology. Currently, it is limited to the Black Angus breed because of the large database required (GENEMAX®, Zoetis).

Selecting heifers as yearlings. Some producers simply keep a large number (or all) of their heifers at weaning and select replacements from those that get pregnant after their first breeding season. This does add significant cost to development because more heifers than are needed for replacements are being kept and managed. However, the added value of selling surplus heifers that are heavier and/or pregnant as yearlings has the potential to mitigate the extra development cost.[9] This strategy allows pregnancy to be the initial basis for selection.

Selection for puberty and/or early pregnancy. Heifers that have had one or more estrous cycles before, rather than during, their first breeding season have been reported to have higher pregnancy rates both as yearlings and again as 2-year-olds (Table 3).[10] Some strategies used to identify these kinds of pubertal heifers—and to refine the selection process among those that are pregnant—are discussed below.

One strategy is to use a short 45-day breeding season, either with or without artificial insemination (AI). Pregnancy rates will likely be somewhat lower than with longer 60- to 90-day breeding seasons, so plan on retaining an extra 20 to 25 percent more heifers. Heifers that become pregnant are fertile and are set up to begin their reproductive careers as early calvers, the importance of which has been discussed. Open heifers have added value due to older age and heavier weights.

Table 3. The Impact of the Number of Estrous Cycles Exhibited Prior to the Start of Breeding and Reproductive Performance of Heifers[10]

	Number of estrous cycles before the start of breeding				
	0	1	2	3	>3
Heifers first season, n	395	205	211	116	249
Weight before start of breeding (lb)	671[a]	702[b]	702[b]	715[bc]	715[c]
Age at start of breeding, days	420[a]	426[b]	426[b]	426[b]	430[c]
First-season heifer pregnancy percentage	**84[a]**	**90[b]**	**88[a]**	**89[ab]**	**94[b]**
Start of breeding to calving, days	300[a]	296[b]	295[b]	295[b]	296[b]
Weight of calves at weaning (lb)	396[a]	411[b]	414[b]	416[b]	405[b]
2-year-old cows, second season pregnancy percentage	**73[a]**	**85[b]**	**79[a]**	**90[b]**	**92[b]**

Means within a row without a common superscript differ (P <.05)

Pregnancy testing shortly after the end of longer breeding seasons by a skilled individual using either ultrasound or palpation is another way to identify and select early breeders. Another alternative is to blood test all heifers 30 to 50 days into the breeding season. Those identified as pregnant by blood test will have been bred in the first

[8] Kaps, Herring, & Lamberson, 1999
[9] Carpenter & Hogan, 2018
[10] Roberts, Ketchum, Funston, & Geary, 2013 (adapted)

30 to 40 days. A second pregnancy test of negative heifers is required at a later date to identify both later-bred and open animals.

Using estrous synchronization (ES) at the beginning of their first breeding season, either with AI or natural bull service, identifies pubertal animals because the response to ES treatment is dependent on puberty. Therefore, pregnancy to first synchronized estrus signifies both an animal that was already cycling prior to the breeding season—or very close to it—and an animal that is fertile. That is, she was able to conceive at her first breeding opportunity, and she is now set up to begin her reproductive years as an early calver. Using a blood pregnancy test in first-calf heifers at day 30 post-AI is one way to determine conception to AI versus clean-up bulls. To do this, wait to turn in clean-up bulls until day 14 after a single AI mating. Then, blood test all heifers at day 30 post-AI. Only those that conceived to AI (early breeders) will test positive for pregnancy at this stage. All other heifers testing negative at this stage are either pregnant by clean-up bulls or open. Again, all animals in the negative group will need to be pregnancy tested again at the end of that breeding season.

Not all producers are able to use AI. Still, giving a single shot of Prostaglandin $F2_{\alpha}$ (PG) and using a natural bull service on the first day of the breeding season is a well-known and inexpensive way to group cycling females to calve early, as most cycling females will come into heat within 4 days of the shot. However, a small percentage will be unable to respond to that treatment because they are in a stage of their estrous cycle where they do not have a functional corpus luteum on the ovary. Waiting 4 days after turning the bull(s) in to give PG shots is a strategy that may increase the opportunity to identify all—rather than most—pubertal heifers and, therefore, increase the opportunities for early pregnancy in response to that protocol among all pubertal animals.[9, 11, 12] A word of caution: Do not administer prostaglandin **after** day 4 to 5 of bull exposure, as it can cause abortions after this time. Blood pregnancy testing all animals at day 40 of the breeding season can identify those that conceived to natural bull service in the first 12 days and were, therefore, pubertal before the start of the breeding season. Again, the benefits of early puberty, early conception, and early calving have been described.[5, 6, 10] All animals that tested negative for pregnancy at day 40 will need to be re-tested for pregnancy after the end of the breeding season as would normally be done.

Reproductive tract scoring (RTS) has been used to identify mature and pubertal heifers just prior to their first breeding exposure.[13, 14] Additionally, it might be a useful tool to manage even lifetime reproductive performance.[14] RTS is a heritable trait, with an estimate of 0.32.[14] Heifers with higher RTS just prior to their first breeding season had higher pregnancy rates both as yearlings and again as 2-year-olds. In turn, these heifers calved earlier, and because of that, weaned heavier calves.[14] Age, body weight, and body condition score are all positively associated with RTS, and among these three, age was the most highly associated.[14] The main limitation to using RTS to predict puberty, in many areas, is finding qualified people who can palpate and/or ultrasound and then score the reproductive tract accurately (cervix, uterus, and ovarian structures).

Finally, predicting the number of replacements needed is related to culling rate in the cowherd. Cows are culled for reproductive failure, unsoundness, temperament, old age, drought, and other reasons. Overall cull rate and age makeup of the cowherd will thus be a consideration when estimating replacement heifer needs. Under good management, one might reasonably expect an 85 percent pregnancy rate in yearling heifers being bred for their first calf. Under that scenario, heifer retentions would likely need to be about 15 percent higher than whatever the predicted cowherd replacement rates are.

[11]Whittier, Caldwell, Anthony, Smith, & Morrow, 1991
[12]Larson, Musgrave, & Funston, 2009
[13]Anderson, LeFever, Brinks, & Odde, 1991
[14]Holm, Thompson, & Irons, 2009

Heifer Growth, Development, and Puberty

As stated, heifers of most breeds should have their first calf at 2 years old. Puberty is determined by age and weight in concurrence. After weaning, heifers are grown and developed to reach a "target" age that is based on their breed type and an estimated "target" weight for the first breeding. Research conducted during the late 1960s through the early 1980s indicated that puberty occurs at a genetically predetermined weight. Only when heifers reach their target weight can high pregnancy rates be obtained. Age targets are 12 to 14 months for English breeds such as Angus and Hereford, and 15 to 16 months for Continental breeds, such as Charolais or Simmental, and American breeds like Brangus or Beefmaster. Straightbred or predominantly Bos indicus breeds typically reach puberty later and are usually not bred until they are 2 years old in order to calve first as 3-year-olds. The target weight is usually 60 to 65 percent of "expected" mature weight. Some research has reported that heifers developed to lighter target weights (50 to 57 percent of mature body weight) or those that were fed restricted diets were able to reach puberty and breed at acceptable rates.[15, 16, 17, 18] It should be noted that in studies that used mature cow weight, these weights were estimated from extensive databases and were essentially a "known" factor. Most producers can only guess what expected mature cow weight is, given the variation in mature cow weight within most herds. Target weight as a percentage of actual expected mature weight can be difficult to predict accurately. Therefore, the 60 to 65 percent rule probably offers some "insurance" when estimates of mature weight may be off.

If producers are interested in measuring and managing weight gain during development, one methodology might be:

1. Obtain individual heifer body weights at weaning;
2. Determine the correct target age and weight at first breeding for puberty;
3. Calculate the number of days between weaning and first breeding;
4. Calculate the needed average daily weight gain needed to reach the target weight (target weight–weaning weight/number of days);
5. Check-weigh heifers midway through the development phase (some might even prefer to weigh heifers every month); and
6. Adjust the feeding program if weight gain is too low.

[15]Funston & Deutscher, 2004
[16]Funston, Martin, Larson, & Roberts, 2012
[17]Roberts, Geary, Grings, Waterman, & MacNeil, 2009
[18]Endecott, Funston, Mulliniks, & Roberts, 2013

Research has shown that it does not matter if heifers grow at an even weight gain (the same amount each day) or at an uneven rate (low to high or high to low), as long as they arrive at the correct target weight for puberty.

Some producers may begin breeding yearling heifers 21 days prior to the start of breeding for their mature cows. In some environments, this may increase the chances of rebreeding as 2-year-olds. The trade-off is that there will be 21 fewer days to reach target weight for their first breeding as yearlings.

In summary, nutritional management of heifers is critical between weaning and the first breeding season. It can also be a factor during pre-weaning as well. Therefore, it is the overarching factor that influences age at puberty in heifers.[1] Nutrition is similarly critical prior to and after the birth of their first calf in order for successful re-breeding to occur.

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Evaluating Replacement Female Alternatives

By Ronald Gill, Stan Bevers and William Pinchak*

Ranchers should consider every alternative that fits their operation each year.

Selection of replacement females can be one of the most frustrating and risky management decisions ranchers make. Small errors in estimations of production potential, future prices, and annual costs can cause long-lasting financial hardship. To effectively evaluate alternatives, all available strategies must be considered. An objective approach to evaluation of alternatives and their potential contribution to production efficiency and financial sustainability is essential.

Under normal conditions the most common female replacement decision is whether to retain raised heifers or purchase replacement females from outside the herd. The decision to retain heifers is normally based on known price and availability of quality females, perceived or real advantages in genetic and production potential, and the total costs of developing retained heifers. Additional considerations should be given to herd biosecurity and the predictability of production potential when making the decision to buy versus retain ownership of heifers.

Other situations where the purchase of females commonly occurs are during initial stocking of an operation or restocking following drought or financially necessary herd reductions. In these situations, the availability of quality replacement heifers from the existing herd is insufficient to meet immediate stocking demand. Often the situation exists where a ranch realizes that its current genetic base, although predictable, is not capable of producing enough genetically superior females. Therefore, it may be quicker and less expensive to purchase the desired genetics than to change the genetic base of the herd through alterations in the breeding program.

Once the decision to purchase replacements has been made, there are 15 alternatives to consider. Each is listed below with a brief description.

1. Heifers less than 700 pounds—Open heifers that require development and breeding for their first calf.
2. Heifers more than 700 pounds—Open that heifers require breeding for their first calf.
3. Bred heifers—Heifers that are palpated pregnant.
4. First-calf pairs—Heifers with their first nursing calf at their side that are not exposed for rebreeding.
5. Three-in-ones (2 years old)—Heifers with their first calf at their side that are bred safely for a second calf.
6. Bred cows (3 to 6 years old)—Cows that are palpated pregnant.
7. Pairs (3 to 6 years old)—Cows with a nursing calf at their side that are not exposed for rebreeding.

8. Three-in-one's (3 to 6 years old)—Cows with a nursing calf at their side that are bred safely for the next calf.
9. Bred cows (7 years old or older)—Aged cows that are palpated pregnant.
10. Pairs (7 years or older)—Cows with a nursing calf at their side that are not exposed for rebreeding.
11. Three-in-ones (7 years or older)—Cows with a nursing calf at their side that are bred safely for the next calf.
12. Opens (2 years old)—Young females, which may or may not have had a calf.
13. Opens (3 to 6 years old)—Cows in good condition that are not bred.
14. Opens (7 years or older)—Cows in good condition that are not bred.
15. Stocker cows—Thin cows that are of unknown pregnancy or age.

Each operation may identify additional alternatives or eliminate choices to fit its individual circumstances. In addition to selecting the alternatives, there are at least 11 genetic, economic, and management factors to consider within each alternative (Table 1).

Availability of quantity and quality

Within a similar production environment, determine if enough target-quality females are available within each alternative to warrant consideration. If not, determine the cost of additional sources for adequate supplies. Environmental adaptability should be considered when broadening the search for replacements. Lower the expectations for production potential if replacements are not adapted to the environment where they will be managed.

Often there are mismatches of quantity and quality. There may be an adequate supply of heifers (alternatives 1 to 3) with undesirable quality. Very good pairs (4, 7, and 10) may be available in limited numbers. After supplies are identified, cost calculations can begin.

Initial investment expense

The initial investment expense is the total cost for each available alternative delivered to your operation. Consider all costs including travel, commission, trucking, inspection fees, processing fees, permits, health certificates, and the actual purchase price.

When considering the 15 alternatives, the classes with the greatest initial investment would normally be pairs (4, 7, and 10) and three-in-one packages (5, 8, and 11), particularly in the younger-aged classes. Bred females (3, 6, and 9) can normally be purchased at moderate prices. One exception might be bred heifers (3) of perceived excellent quality, which would result in high prices.

The lowest initial cost would normally be associated with young open heifers (1 and 2) or older open cows (14). Open 3- to 6-year-olds (13) would be considered in the low to moderate range. They are rarely a viable economic alternative unless the origin and culling circumstances are known.

Table 1. Summary of 16 Female Replacement Alternatives and 11 Genetic, Economic and Management Factors for Each[1]

	Q/Q Avail	Initial Invest.	Devel. Phase	Rebrd. Potent.	Market Flex.	Genetic Potent.	Potent. Long.	Dyst/ Death	Wean Wts.	Nutrtn. Reqts.	Cull Rate
Retain Heifers	H	M/H	Long	M	H	H	H	M	M	H	M
1) Heifers < than 700 pounds	H	L	Long	L	H	L	H	H	L	H	H
2) Heifers > than 700 pounds	H	L	M	L	H	M	H	H	L	H	H
3) Bred heifers	M	M/H	None	L	L	M	H	H	L	H	H
4) First calf pairs	M	H	None	L	L	M	H	H	L/M	H	H
5) Three-in-ones, 2 years old	L	H	None	L/H	L	M	H	M	M	H	M
6) Bred cows, 3 to 6 years old	L	M/H	None	M/H	L	M	M/H	L	H	L	L/M
7) Pairs, 3 to 6 years old	L	H	None	M/H	L	M	M	L	H	L	L/M
8) Three-in ones, 3 to 6 years old	L	H	None	H	L	M	M	L	H	L	L/M
9) Bred cows, 7 years or older	M	M	None	M	L	M	L	L	M/H	L	M/H
10) Pairs, 7 years or older	M	M/H	None	M	L	M	L	L	M/H	L	M/H
11) Three-in-one, 7 years or older	M	H	None	M	L	M	L	L	M/H	L	M/H
12) Open, 2 year olds	L/M	L/M	M	M	L	M	H	M	M	M	M
13) Open, 3 to 6 year olds	L	L/M	M	H	M	M	L	L	H	L	M
14) Open, 7 years or older	M	L	M	M	M	M	L	L	M/H	L	M/H
15) Stocker cows	H	L	M	L	M	M	L	M	L	M	H

[1] Unless otherwise stated H=High, M=Moderate and L=Low

Development phase

Considering the development phase is critical. The development phase, as far as this evaluation is considered, is from the time an open, non-lactating animal (1, 2, 12, 13, and 14) is purchased until it is palpated pregnant for the first time. Any development phase adds to the cost of an animal and increases the reproduction risk (the risk of her not breeding, calving, and weaning a calf).

If the development costs are considered, purchasing a higher valued package with no development phase may be more economical. Bred, pairs, and three-in-one alternatives (3 through 11) have greater initial investment cost, but no development phase cost. Replacements with a moderate development phase are open females ready to be exposed for breeding. Females with a long development phase are those in any open class that require time to grow or regain body condition in order to be bred.

Rebreeding potential

The single greatest risk factor after purchases are females that fail to rebreed. Any purchased female under 3 years of age (1 through 5) should be assumed to have a lower rebreeding potential. If conception rates are expected to be lower than 90 percent, the potential rating should be considered low. Thin cows would also be considered a high risk for low rebreeding rates.

Cows that have already gone through their second successful breeding can be considered at least a moderate potential for rebreeding. Those that might be considered moderate to high would be the 3- to 6-year-old group (6, 7, 8, and 13).

Flexibility in marketing of extras or culls

Flexibility in marketing is rarely considered in most evaluations. However, it makes a significant difference in the actual cost of cattle left in inventory. If the extras or culls can be sold for a profit, it decreases the true cost of those remaining in the herd. If the extras or culls are sold for a loss, the expense needs to be allocated to those remaining in order to arrive at their true purchase cost.

This consideration has significant differences within and among classes. Young open heifers (1 and 2) have greater resale potential and marketing flexibility than any other class. Those that don't breed can be marketed as feeders or retained through the feedlot. Extra bred heifers can usually be marketed as replacements with increased profit potential.

Nearly all other classes have limited marketing flexibility. Bred cattle that lose a pregnancy or a calf prior to weaning can rarely be disposed of profitably. The loss potential is high. For example, a set of 100 heifers (3) is purchased short-bred (two to three months). Expected pregnancy loss is around 2 %. Calf-death loss at calving averages between 2 and 3 percent in heifers. Death loss in heifers is normally 1 to 2 percent. Calf loss from birth to weaning is usually 2 percent. Rebreeding rates on first calf heifers being exposed for their second pregnancy may be as low as 50 percent or as high as 90 percent. For comparison's sake, use an average conception rate of 75 percent on purchased bred heifers of unknown genetic background.

In this example, only 94 will wean a calf (2 percent pregnancy loss, 2 percent calf-death loss, and 2 percent calf loss from birth to weaning). Two heifers die at calving and only 74 rebreed (98 head x 75 percent).

Assume the heifers were purchased bred for $1,800 dollars. Monetary losses include:

Death loss (2 @ $1,800)	$3,600
Lost income due to calf loss; (6 @ $1250)	$7,500
Loss on sale of opens (24 x ($1800 - $1200)	$14,400
Total Loss	$25,500
Average loss per remaining heifer ($25,500 / 74)	$345

The true cost of 74 heifers is $ 2,145. This does not include vet bills, medicine, feed, labor, interest, or opportunity cost. If pairs could have been purchased for less than the total cost, they should have been seriously considered. Do not get locked into traditional approaches or sources. Consider all options.

Predictability of genetic potential

A primary reason to retain heifers is the predictability of their production potential. When purchasing cattle of unknown origin, predicting their genetic potential is difficult. When purchasing cattle already in production, whether it be as bred or pairs (3, 4, 6, 7, 9 and 10), it can be assumed that they are at least capable of conceiving and delivering a calf.

On the other end of the spectrum is the purchase of lightweight heifers (1). Their ability to gain weight, cycle, conceive, and deliver is unknown, not to mention their ability to rebreed, maintain body condition, and milk sufficiently to wean an acceptable calf. Three-in-one packages (5, 8, and 11) are the only class that gives any indication of their total production capabilities.

Purchasing cattle from a known source over an extended period of time can also help in achieving some level of predictability. These relationships should be sought when the decision to purchase replacement heifers is made.

Potential longevity

The potential for longevity in the herd is an important consideration in purchasing decisions. Current economic analyses indicate that females with a $1,000 purchase cost will have a five- to seven-year payout. Potential longevity is difficult to predict in cattle from an unknown origin. The longer a female stays in the herd, the greater the opportunity for her to be profitable.

The greatest potential for longevity is in younger females. However, younger cattle (1 through 5) also have the greatest chance of not rebreeding or not weaning a calf, increasing their probability of being culled. The classes with the least potential longevity are the 7 years and older females (9, 10, 11, and 14). If purchased, these females will not remain in the herd for an extended period of time. As such, their purchase value must be nearer to their cull value than in the case of purchasing younger cattle. Moderate longevity is expected in 3- to 6-year-old cows (6 through 8). Similar to genetic potential, ranchers must know why these cattle are being sold.

Dystocia/death loss

Heifers purchased with an unknown genetic background or calf sire should be considered to have a greater risk of dystocia and death loss. Older cows (6 through 15) can normally deliver without trouble. One exception might be small cows bred to high-birth-weight bulls. Stocker cows should be considered at moderate risk of experiencing dystocia or death when calved out after grazing lush pastures in the last trimester of pregnancy.

Weaning weight of first calf

Weaning weights should be considered light for most heifers (1 through 5) and 3-year-olds when compared to cows. Any females bred to unknown sires or having unknown milking ability should not be considered more than moderate quality. Take into account death losses as discussed earlier when projecting average weaning weights and actual head weaned. In addition, lower weaning weights would be expected from thin-condition cows. Calf weaning weights can be up to 60 pounds lower for each Body Condition Score below 5 (average flesh).

Nutritional requirements

Rarely is this adequately considered when budgeting for replacement female purchases. Requirements for quality pastures and supplements will be highest in younger classes (1 through 5), especially first-calf heifers on through their third pregnancy. The additional requirements through the third pregnancy must be budgeted. Moderate levels of nutrients will be needed for open 2-year-olds (2) and stocker cows (15). Most other classes can be considered low except when purchased in a thin condition. Requirements in this situation may range from high to moderate depending upon the amount of time until their next breeding season.

Cull rate

Cull rates will be highest for cattle under three years of age (1 through 5 and 12) and stocker cows (15). Normally, the lowest cull rates would be for mid-aged cows (6, 7, 8, and 13) and moderate rates for cows more than 7 years of age (9, 10, 11, and 14). Cull rates are one of the most difficult numbers to estimate in a budget.

Most projections grossly underestimate cull rates of purchased females. In most cases, only 50 to 60 percent of the cattle purchased will remain in the herd after three production years. Initial cull rates of 25 to 30 percent should be expected in the first year. This will include cows culled for failing to rebreed, poor udders, structural unsoundness, health-related problems, disposition, and any possible death loss.

Cull rates of 15 to 20 percent should be expected in the second year. In some cases, cows that should have been sold for poor performance will be held for this second year, ultimately lowering weaning weights again. Structure, udder, and rebreeding considerations will remove the majority of these cows in the second year. By the third year, normal cull rates of 10 to 15 percent for rebreeding are expected. In the case of older purchased females, age becomes a factor.

Summary

There is no easy answer to the question of which replacement alternative should be chosen. Carefully consider all of the factors mentioned above and build a three-year budget projection for each alternative. This gives the females the opportunity to achieve a “static” production level. Static production is defined as the point in a female's life where her production risk and potential are comparable to the remaining mature females in the herd.

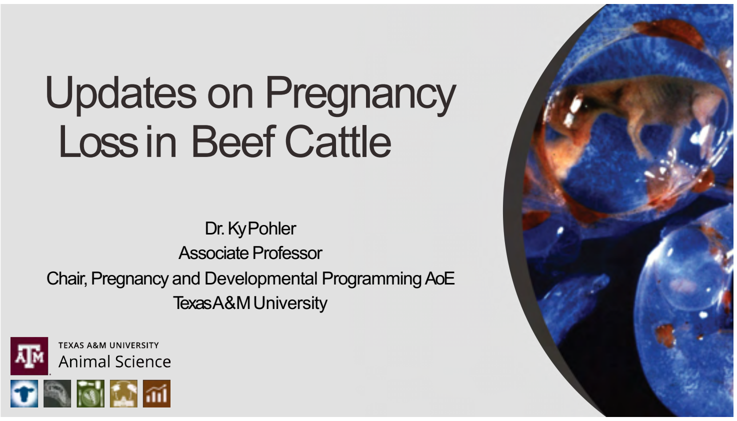
Budgets need to be developed until all cattle are palpated pregnant for at least the third time following purchase. This will allow for the inclusion of all the culling factors discussed as well as reduced weaning weights on the first two weaned calves.

In addition to carrying this plan through to the third pregnancy, the budget analysis for any development phase must be completed as accurately as possible. A true reflection of accumulated cost is a must if this type of alternative evaluation is to be successful.

Careful consideration of alternatives and evaluations of all factors in the decision process are critical for a sound budget projection for replacement females. Due to its complexity, this is not an easily managed problem. Table 1 summarizes each alternative and their considerations. Consult with others who have gone through similar scenarios. Capitalize on their experience and rely on sound professional advice.

Do not get locked into one option. Consider each alternative that could fit your operation every year. Market changes may affect the most feasible scenario from year to year. Once the budget process is in place, quick analyses of options are possible.

Do not hesitate to purchase a seemingly expensive alternative up front if it has the greatest potential for long-term economic benefit. Likewise, do not purchase expensive alternatives when they clearly will not produce the desired economic returns and sustainability of the ranching enterprise.


Updates on Pregnancy Loss in Beef Cattle
Dr. Ky Pohler
Associate Professor
Chair, Pregnancy and Developmental Programming AoE
Texas A&M University
TEXAS A&M UNIVERSITY
Animal Science


Genetic Goals
1
2
3
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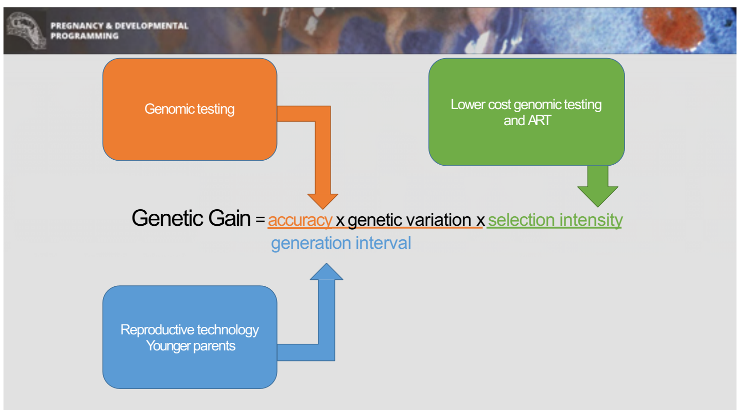
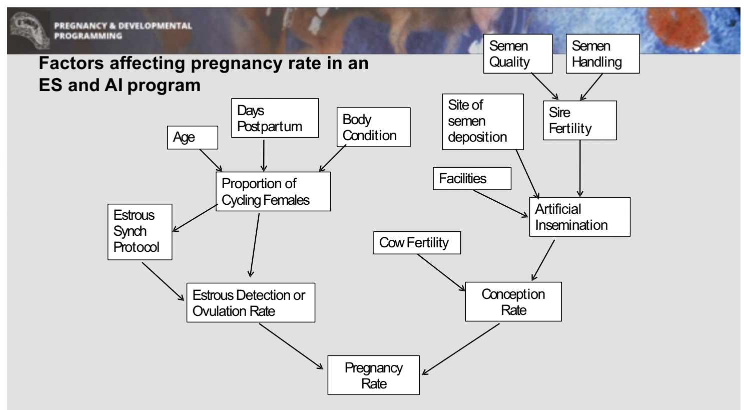
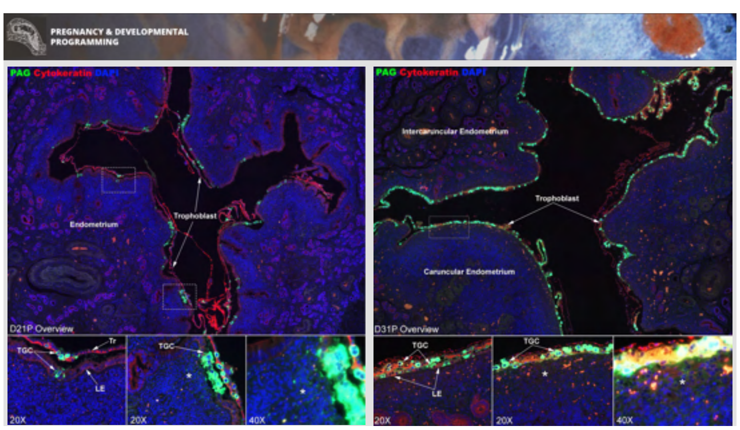
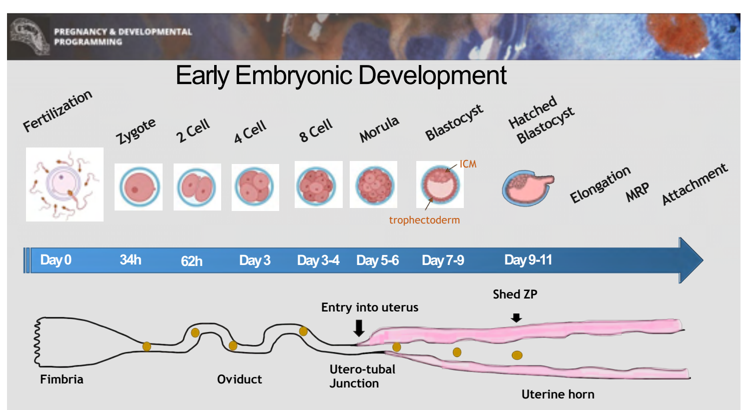
7
8


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Genomic testing
Lower cost genomic testing and ART
Genetic Gain = accuracy x genetic variation x selection intensity
generation interval
Reproductive technology
Younger parents


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Factors affecting pregnancy rate in an ES and AI program
Semen Quality
Semen Handling
Days Postpartum
Body Condition
Age
Site of semen deposition
Sire Fertility
Facilities
Proportion of Cycling Females
Estrous Synch Protocol
Artificial Insemination
Cow Fertility
Estrous Detection or Ovulation Rate
Conception Rate
Pregnancy Rate


PREGNANCY & DEVELOPMENTAL PROGRAMMING
PAG Cytokeratin DAPI
Endometrium
Trophoblast
D21P Overview
Intercaruncular Endometrium
Caruncular Endometrium
D31P Overview
TGC
LE
Tr
20X
40X


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Early Embryonic Development
Fertilization
Zygote
2 Cell
4 Cell
8 Cell
Morula
Blastocyst
Hatched Blastocyst
ICM
trophectoderm
Elongation
MRP
Attachment
Day 0
34h
62h
Day 3
Day 3-4
Day 5-6
Day 7-9
Day 9-11
Entry into uterus
Shed ZP
Fimbria
Oviduct
Utero-tubal Junction
Uterine horn

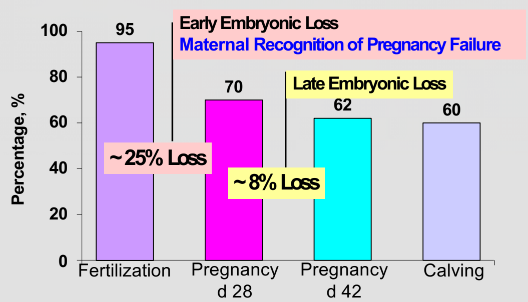
Why Does Reproductive Efficiency Matter?

- Over $1 billion annually (NASS 2014)
- Reproduction = 5 x calf growth (Lamb et al., 2010)

They All Cost The Same To Maintain!

	Bred TAI (baseline)	Early Embryo Loss	Late Embryo Loss	Never Calved
Day of Calving	0	21	60	N/A
Weaning Weight (age * 2lbs/day)	**550 lbs**	**508 lbs** (-42)	**430 lbs** (-120)	**0 lbs** (-550)
Calf Value (weight* $1.60/lb)	**$880**	**$812** (- $68)	**$688** (- $192)	**$0** (- $880)

Fertility of a Single Service in Beef Cattle



Objective

To review available data and use a systematic review process to obtain an accurate prediction of embryonic failure during multiple periods of pregnancy development in beef cattle

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Selection criteria

Inclusion

- Cows or heifers of predominantly beef breeds
- Published after 1978
- Day of gestation of pregnancy diagnosis, subspecies, location, parity, and/or breeding method was listed

Exclusion

- Induced twinning
- Study treatments that were detrimental to pregnancy success
- First pregnancy diagnosis was after day 32 of gestation
- Animals of Holstein or other dairy breed origin

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Moderators

Parity

Subspecies

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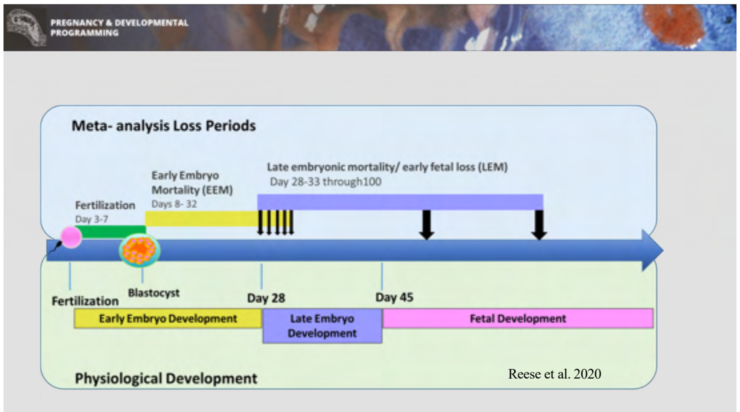
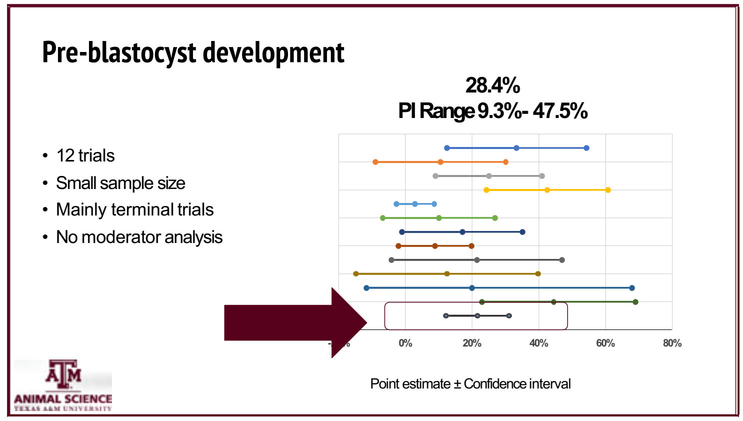
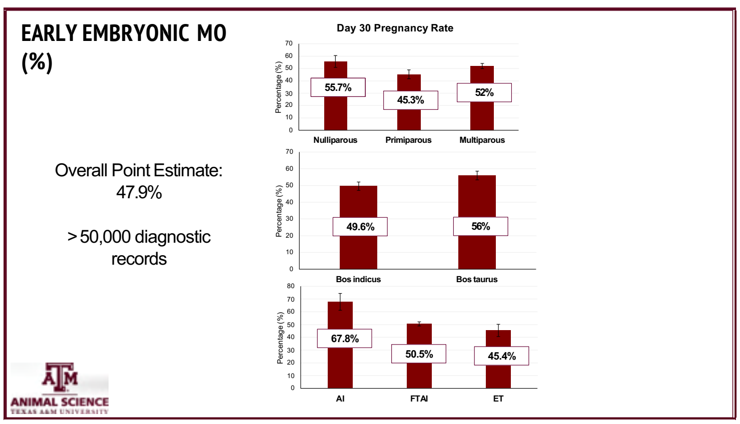

PREGNANCY & DEVELOPMENTAL PROGRAMMING
Meta- analysis Loss Periods
Early Embryo Mortality (EEM)
Days 8- 32
Late embryonic mortality/ early fetal loss (LEM)
Day 28-33 through100
Fertilization
Day 3-7
Fertilization
Blastocyst
Day 28
Day 45
Early Embryo Development
Late Embryo Development
Fetal Development
Physiological Development
Reese et al. 2020


Pre-blastocyst development
28.4%
PI Range 9.3%- 47.5%
• 12 trials
• Small sample size
• Mainly terminal trials
• No moderator analysis
0%
20%
40%
60%
80%
Point estimate ± Confidence interval
ANIMAL SCIENCE
TEXAS A&M UNIVERSITY


EARLY EMBRYONIC MO
(%)
Overall Point Estimate:
47.9%
> 50,000 diagnostic records
Day 30 Pregnancy Rate
55.7%
45.3%
52%
Nulliparous
Primiparous
Multiparous
49.6%
56%
Bos indicus
Bos taurus
67.8%
50.5%
45.4%
AI
FTAI
ET
Percentage (%)
ANIMAL SCIENCE
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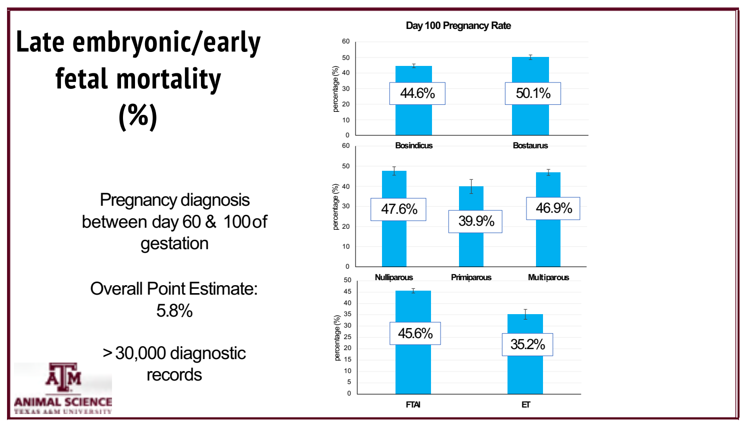
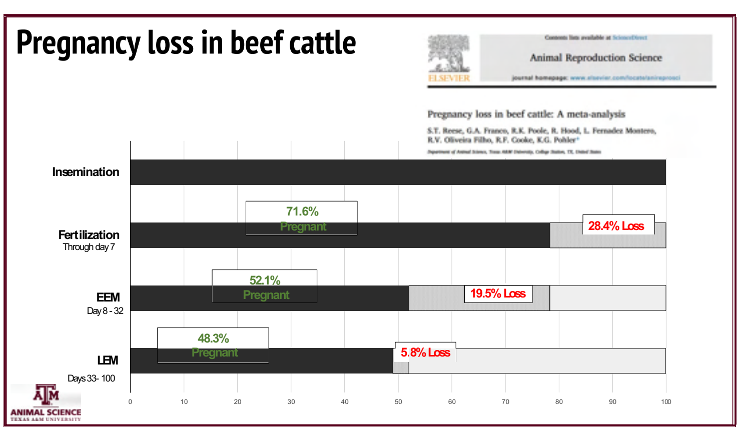
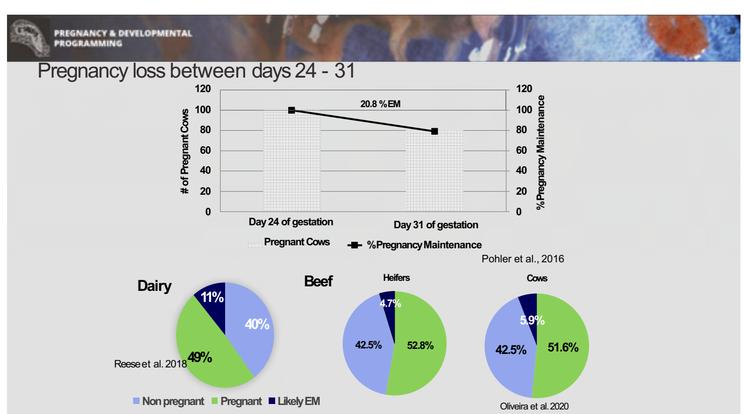
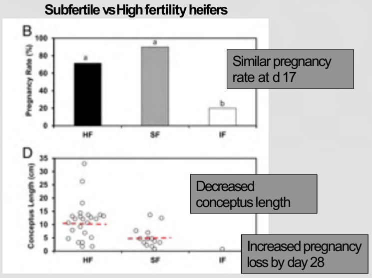

Late embryonic/early fetal mortality
(%)
Pregnancy diagnosis between day 60 & 100 of gestation
Overall Point Estimate:
5.8%
> 30,000 diagnostic records
Day 100 Pregnancy Rate
44.6%
50.1%
Bos indicus
Bos taurus
47.6%
39.9%
46.9%
Nulliparous
Primiparous
Multiparous
45.6%
35.2%
FTAI
ET
percentage (%)
ANIMAL SCIENCE
TEXAS A&M UNIVERSITY


Pregnancy loss in beef cattle
Animal Reproduction Science
Pregnancy loss in beef cattle: A meta-analysis
Insemination
Fertilization
Through day 7
71.6%
Pregnant
28.4% Loss
EEM
Day 8 - 32
52.1%
Pregnant
19.5% Loss
LEM
Days 33- 100
48.3%
Pregnant
5.8% Loss
0
10
20
30
40
50
60
70
80
90
100
ANIMAL SCIENCE


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Pregnancy loss between days 24 - 31
20.8 % EM
# of Pregnant Cows
% Pregnancy Maintenance
Day 24 of gestation
Day 31 of gestation
Pregnant Cows
% Pregnancy Maintenance
Pohler et al., 2016
Dairy
11%
40%
49%
Reese et al. 2018
Beef
Heifers
4.7%
42.5%
52.8%
Cows
5.9%
42.5%
51.6%
Oliveira et al. 2020
Non pregnant
Pregnant
Likely EM

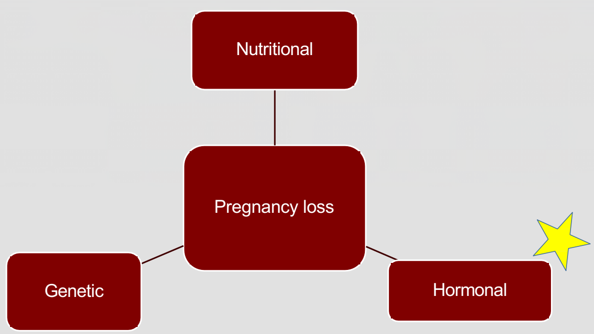
Early embryonic loss- before or after maternal recognition of pregnancy

Subfertile vs High fertility heifers



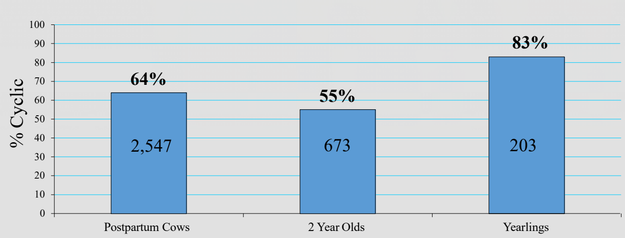
Moraes et al. 2018

Maternally Driven Pregnancy Loss



Anestrus

Incidence of Anestrus in US Beef Cattle

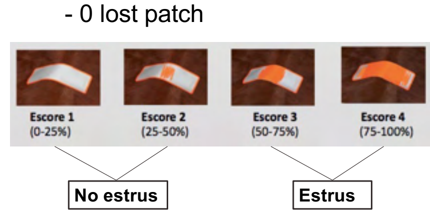


Lamb et al., 2003; Stevenson et al., 2003

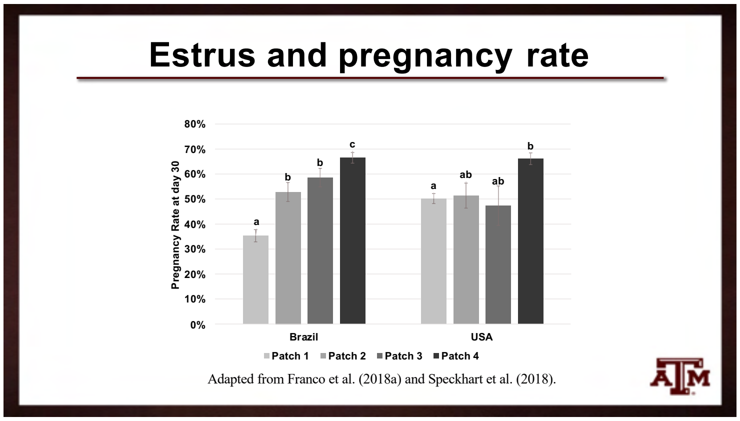
Estrus prior to TAI

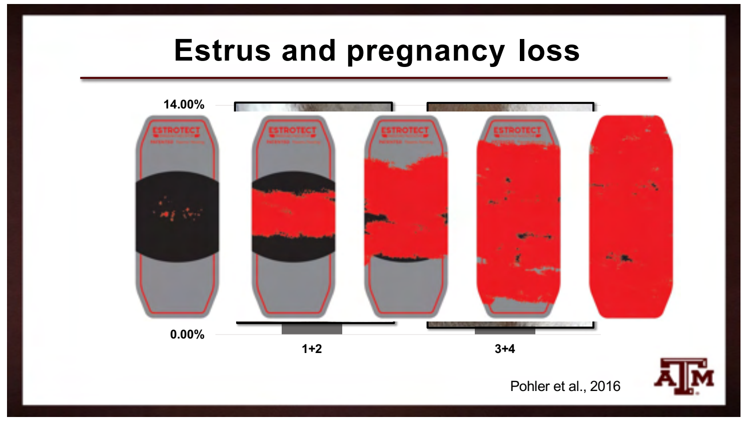
Patch score from 0 to 4

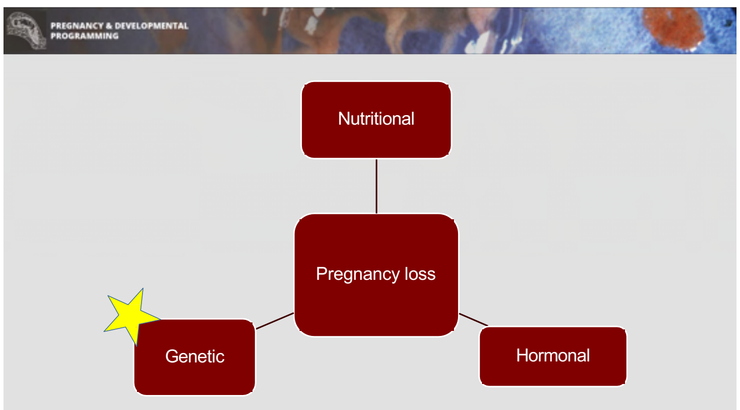
- 0 lost patch

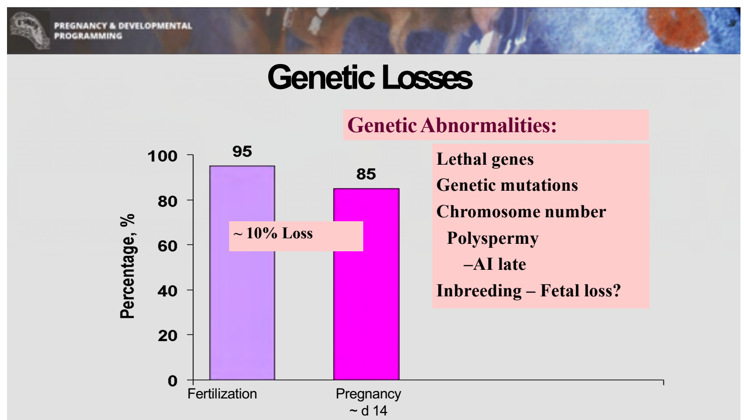


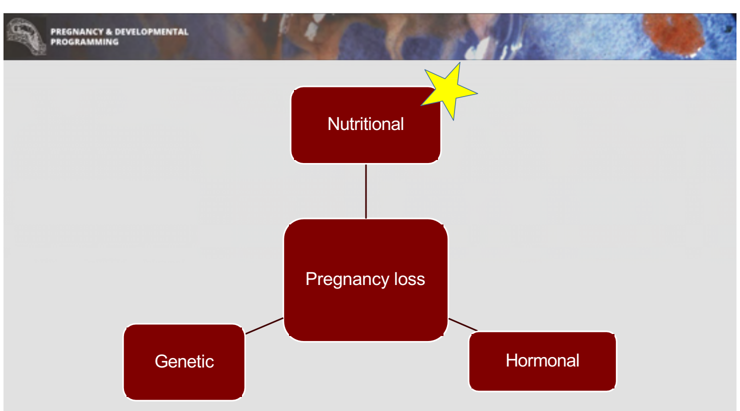
Pohler et al., 2016

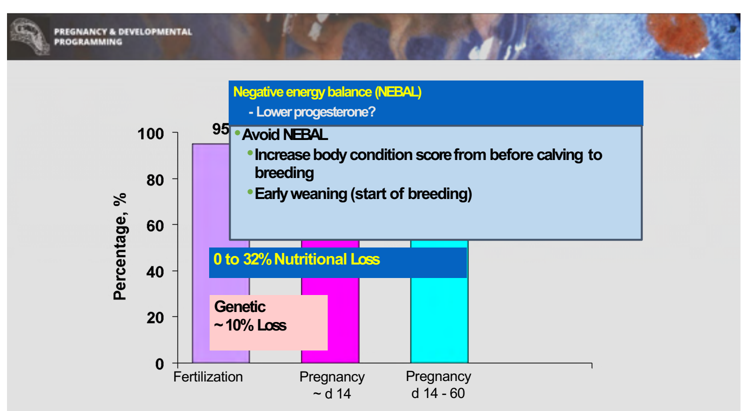

Estrus and pregnancy rate
Pregnancy Rate at day 30
80%
70%
60%
50%
40%
30%
20%
10%
0%
a
b
b
c
a
ab
ab
b
Brazil
USA
Patch 1
Patch 2
Patch 3
Patch 4
Adapted from Franco et al. (2018a) and Speckhart et al. (2018).


Estrus and pregnancy loss
14.00%
0.00%
1+2
3+4
Pohler et al., 2016


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Nutritional
Pregnancy loss
Genetic
Hormonal

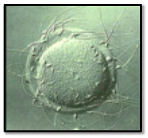

PREGNANCY & DEVELOPMENTAL PROGRAMMING
Genetic Losses
Genetic Abnormalities:
Lethal genes
Genetic mutations
Chromosome number
Polyspermy
–AI late
Inbreeding – Fetal loss?
Percentage, %
100
80
60
40
20
0
95
85
~ 10% Loss
Fertilization
Pregnancy
~ d 14


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Nutritional
Pregnancy loss
Genetic
Hormonal


PREGNANCY & DEVELOPMENTAL PROGRAMMING
Negative energy balance (NEBAL)
- Lower progesterone?
Avoid NEBAL
Increase body condition score from before calving to breeding
Early weaning (start of breeding)
0 to 32% Nutritional Loss
Genetic
~ 10% Loss
Percentage, %
100
80
60
40
20
0
95
Fertilization
Pregnancy
~ d 14
Pregnancy
d 14 - 60

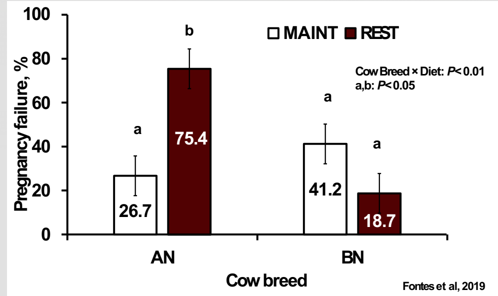
Effect of weight loss on early embryonic development in beef heifers

- Heifers were fed to gain weight (1.5 lb/hd/day) or lose weight (80% of NRC requirements).
- At embryo collection (day 7 after AI) heifers that lost weight had embryos that were less developed and of lower quality.



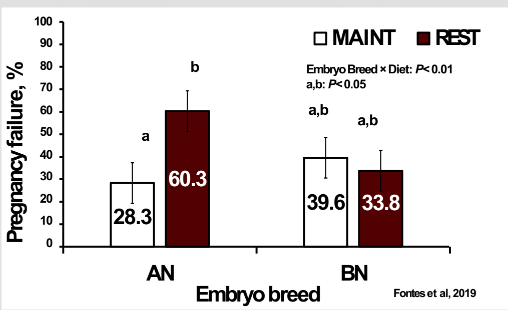
PREGNANCY & DEVELOPMENTAL PROGRAMMING

Effects Of Cow Breed And Diet On Pregnancy Failure



PREGNANCY & DEVELOPMENTAL PROGRAMMING

Effects Of Embryo Breed And Diet On Pregnancy Failure

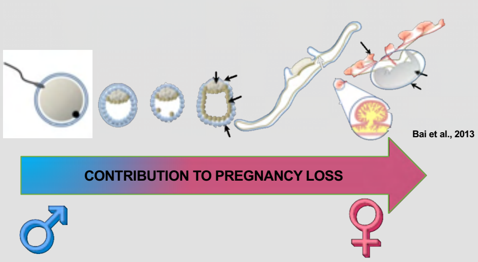


PREGNANCY & DEVELOPMENTAL PROGRAMMING

What Controls Pregnancy Loss?

PREGNANCY & DEVELOPMENTAL PROGRAMMING

Parental Contribution To Pregnancy Loss



PREGNANCY & DEVELOPMENTAL PROGRAMMING

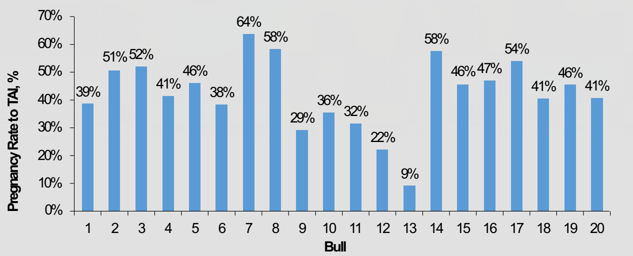
The Sire's Role: Just Fertilization…Right?

~20% Loss (Beef) ~6% Loss (Beef)

Sire	EEM (%)	EEM Classification	LEM (%)	LEM Classification
1	3.7 ± 5.2	Low EEM	5.1 ± 4.0	Low LEM
2	20.0 ± 6.0	High EEM◄	3.4 ± 4.6	Low LEM
3	11.1 ± 4.0	High EEM◄	9.9 ± 3.5	High LEM♦
4	11.7 ± 4.6	High EEM◄	2.5 ± 3.9	Low LEM
5	10.5 ± 6.2	High EEM◄	3.3 ± 4.5	Low LEM
6	5.7 ± 4.6	Low EEM	12.6 ± 3.6	High LEM♦
7	2.8 ± 4.6	Low EEM	2.3 ± 3.7	Low LEM
8	3.0 ± 3.0	Low EEM	11.0 ± 3.4	High LEM♦

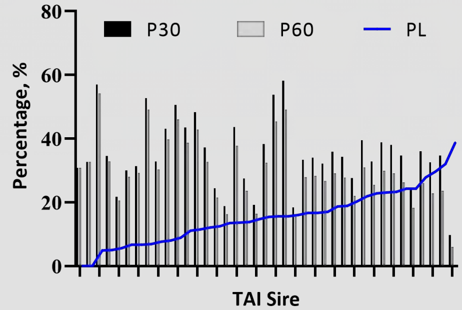
Franco et al, 2020

Sire Contribution To Pregnancy Failure



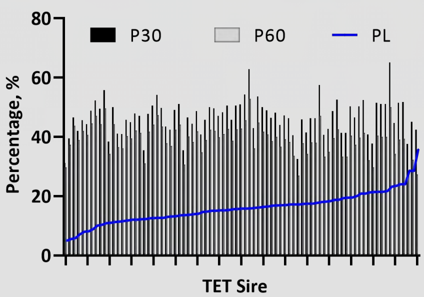
Pohler et al., 2012

Reproductive Parameters Variance By Sire



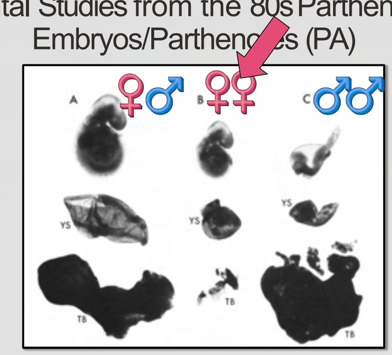
Franco et al., 2021

Reproductive Parameters Variance By Sire



Franco et al., 2021

Uniparental Studies from the 80s Parthenogenetic Embryos/Parthenogenotes (PA)



Barton et al., 1984

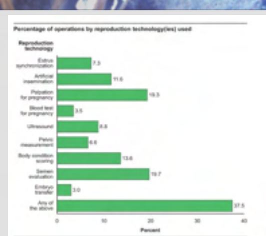
Technology Adoption

C.2.a. Percentage of operations by reproduction technology(ies) used, and by herd size:

Percent Operations

Herd Size (number of beef cows)

	Small (1-49)		Medium (50-199)		Large (200 or more)		All operations	
Reproduction technology	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error	Pct.	Std. error
Estrus synchronization	4.8	(0.8)	12.2	(1.5)	24.9	(2.6)	7.3	(0.7)
Artificial insemination	8.7	(1.1)	17.7	(1.8)	29.4	(2.8)	11.6	(0.9)
Palpation for pregnancy	14.2	(1.4)	29.3	(2.1)	53.6	(3.3)	19.3	(1.2)
Blood test for pregnancy	2.8	(0.7)	5.6	(1.0)	5.8	(1.2)	3.5	(0.5)
Ultrasound	4.7	(0.9)	16.0	(1.7)	39.4	(3.1)	8.8	(0.8)
Pelvic measurement	4.4	(0.8)	12.8	(1.7)	15.0	(2.2)	6.6	(0.7)
Body condition scoring	10.7	(1.3)	19.8	(1.9)	30.6	(3.0)	13.6	(1.0)
Semen evaluation	14.5	(1.4)	31.0	(2.2)	50.5	(3.3)	19.7	(1.1)
Embryo transfer	2.5	(0.6)	4.4	(1.0)	5.5	(1.2)	3.0	(0.5)
Any of the above	30.4	(1.8)	53.3	(2.3)	78.1	(2.6)	37.5	(1.5)



- Pregnancy is 5X more profitable or important than any other measurable trait

Alertys OnFarm Test

- Detects pregnancy as early as 28 days postbreeding
- Finds open animals in minutes
- Easy to read results
- Highly sensitive test
- Measures maternal PAG concentration

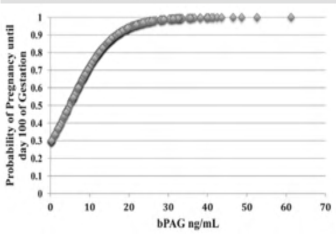
Open

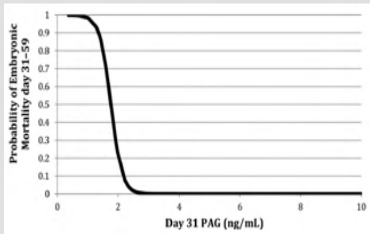
Failed Test

Pregnant

IDEXX LABORATORIES

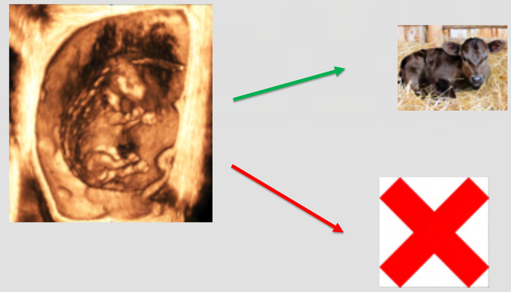
PAG as Predictor of Pregnancy Success





Pohler et al. (2016 a,b)

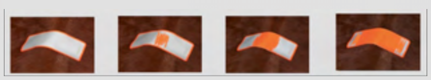
How Can We Decrease Pregnancy Failure?



Estrus Intensity Prior to AI

Patch score from 0 to 4

- 0 lost patch

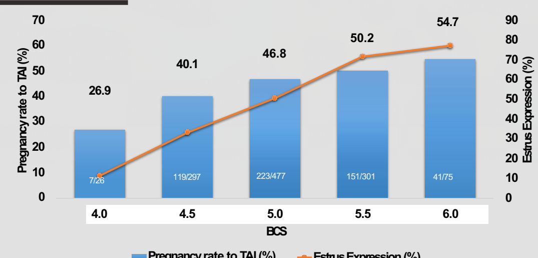


Score 1 (0 – 25%) | Score 2 (25 – 50%) | Score 3 (50 - 75%) | Score 4 (75 – 100%)

No estrus | Estrus

Pohler et al., 2016

BCS at TAI



Oliveira Filho et al., 2019

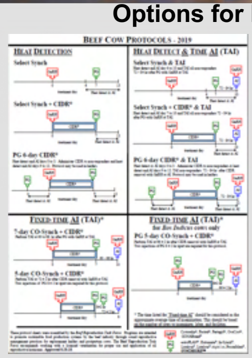
PREGNANCY & DEVELOPMENTAL PROGRAMMING | ANIMAL SCIENCE TEXAS A&M UNIVERSITY

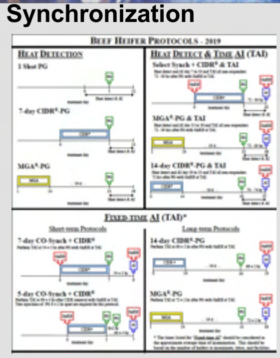
Temperament Interaction with Reproduction

Item	EXC	ADQ	SEM	P =
Reproductive results	n = 227	n = 726	-	-
First AI, %**	41.0	47.2	3.5	0.10
Second IA, %	39.2	43.1	5.1	0.56
Final PR, %	75.3	79.0	2.1	0.23
Calving rate, %	66.9	74.9	2.4	0.02
Pregnancy loss, %	11.4	6.4	1.6	0.04
Weaning results				
Calf weaning BW, kg	449	462	5	0.04
Weaning rate, %	63.9	69.4	2.4	0.09
Calf weaned/cow exposed, kg	286	321	10	0.04
Weaning return/cow, $	515	578	22	0.01

Cooke et al. (2016)

Options for Estrus Synchronization

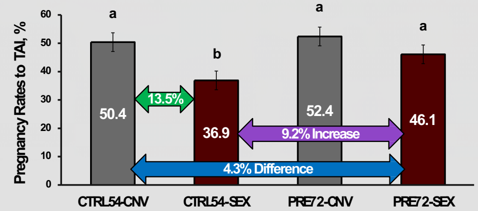


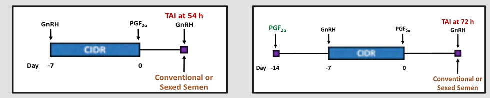


Materials and Methods

- 2,855 *Bos taurus* heifers
- 23 locations
- 11 states
- 24 different sires
  - Sexed semen and conventional semen from same bull(s) at each location
- 8 Treatment Groups
  - Presynchronized with PGF or not
  - TAI at 54 or 72 hours
  - Conventional vs. Sexed Semen

Pregnancy Rates to TAI





a,b Bars with different superscripts differ ($P<0.05$)

Conclusions

- **Genetic selection of high fertility females**
- **Help make management decisions**
  - Nutrition
  - Marketing plans
- **Evaluate reproductive efficiency of your breeding program**
  - Bull/semen quality
  - Synchronization or resynchronization protocols efficiency
- **Identify how much pregnancy loss is happening and when**

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QUESTIONS?

ky.pohler@ag.tamu.edu