Estrus Synchronization Protocols for Heifers

D.J. Patterson, D.C. Busch, N.R. Leitman,
D.J. Wilson, D.A. Mallory, and M.F. Smith

Division of Animal Sciences

University of Missouri

Effective Estrus Synchronization Programs for Beef Cattle

- Facilitate AI & ET
- Reduce time required to detect estrus
- Cycling females conceive earlier in the breeding period
- Induce cyclicity in peripubertal heifers and anestrous postpartum cows

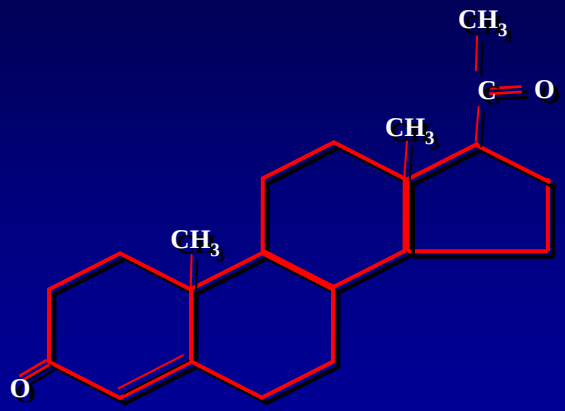
Objective: Development of highly effective & economical estrus synchronization programs

- Peripubertal heifers
- Postpartum cows
  - Anestrus and cycling
- Excellent pregnancy rates
- Reduced AI period and/or fixed-time AI

Products Currently Available

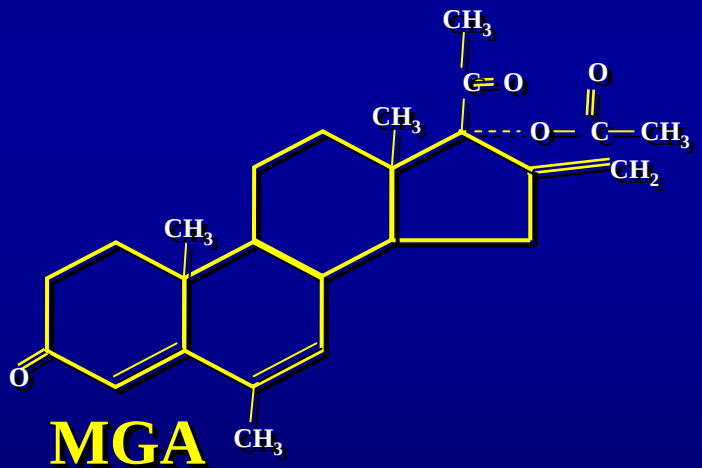
- Prostglandin
  - Lutalyse, Estrumate, ProstaMate, In Synch, EstroPlan
- GnRH
  - Cystorelin, Factrel, Fertagyl, OvaCyst
- Progestins
  - **MGA**
  - **CIDR**

MGA-Based Protocols for Heifers . . .



Progesterone

Pregn-4-ene-3, 20-dione



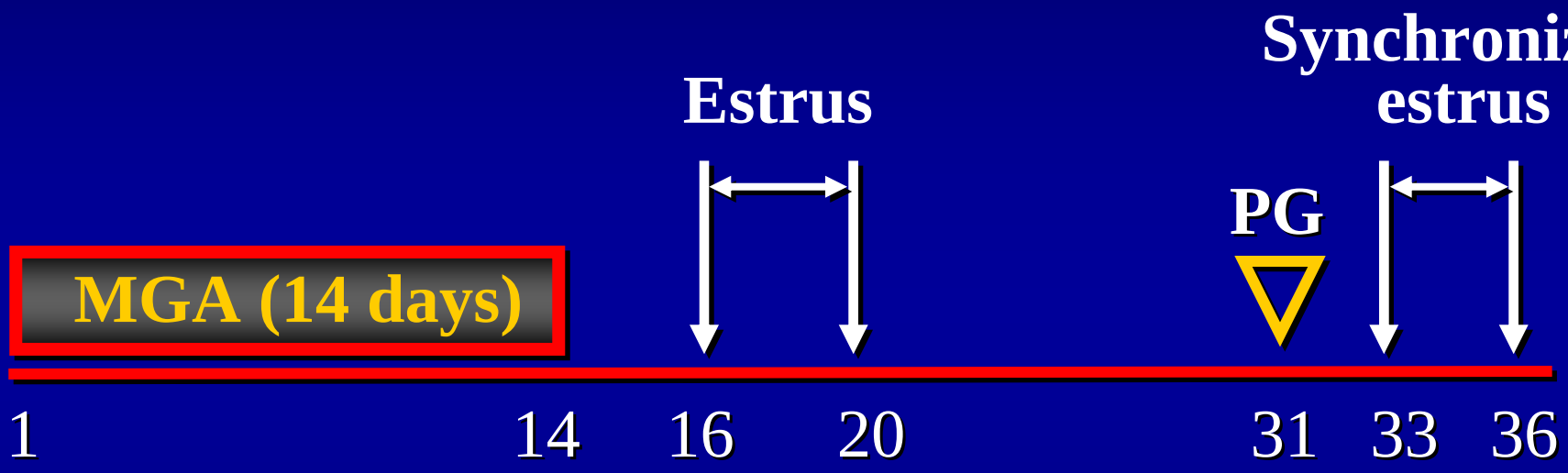
MGA

(melengestrol acetate)

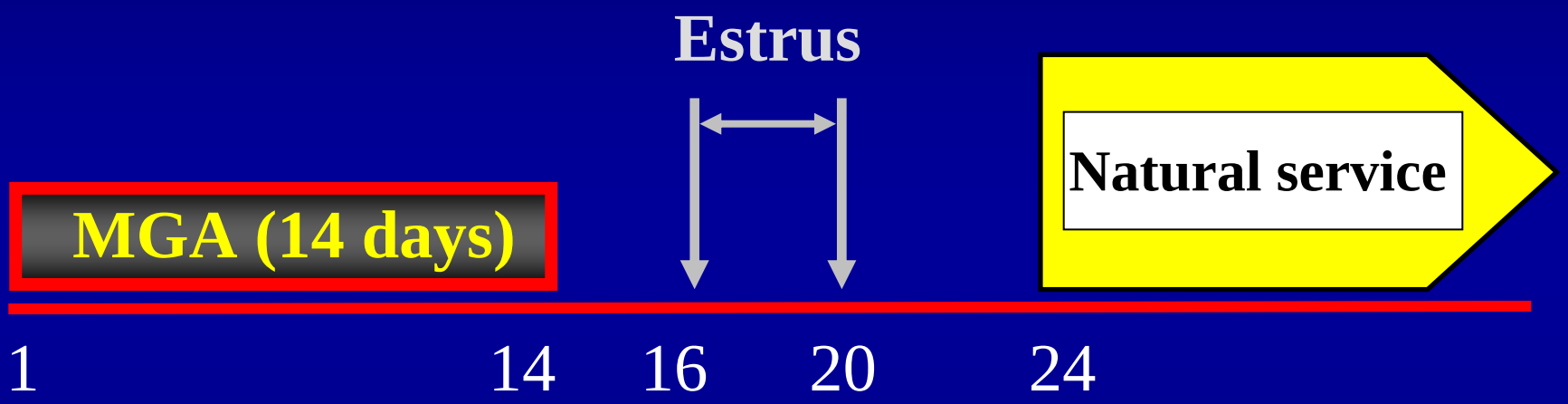
6-methyl-17-alpha-acetoxy-16-methylene-pregn-4, 6-diene-3, 20-dione

What We Know About MGA . . .

- Successfully induces puberty in beef heifers
  (Imwalle et al., 1998)
- Prevents expression of behavioral estrus
  (Zimbelman and Smith, 1966; Imwalle et al., 2002)
- Blocks the preovulatory surge of LH
  (Imwalle et al., 2002)
- Blocks ovulation
  (Zimbelman and Smith, 1966; Imwalle et al., 2002)

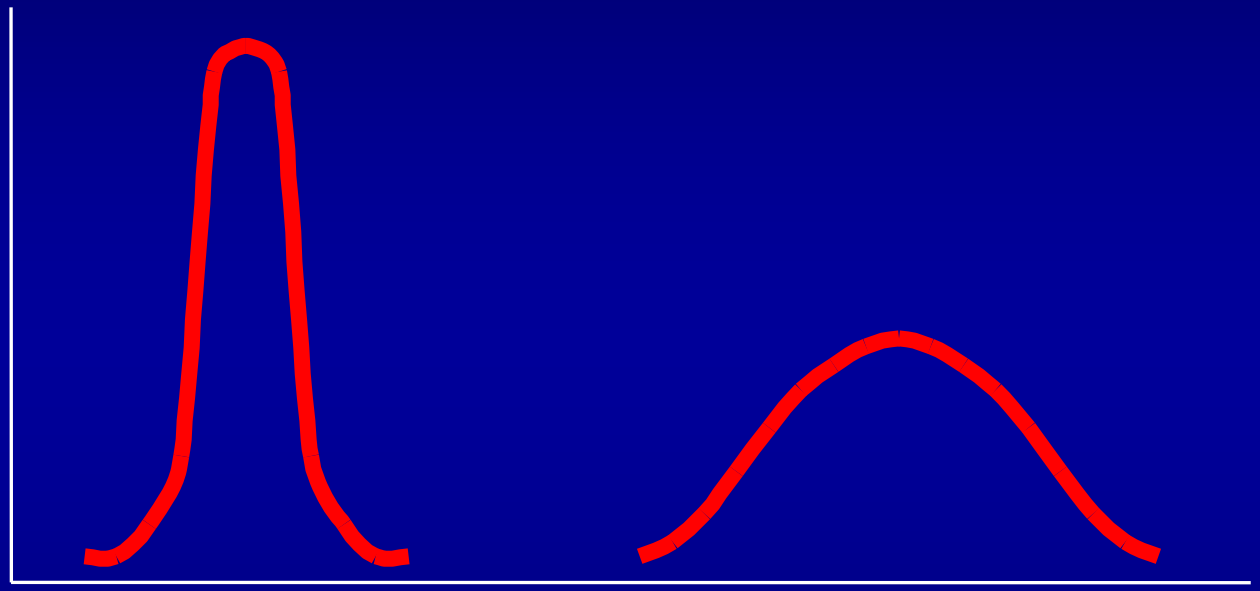


Brown et al., 1988


Estrus
Natural service
MGA (14 days)
1
14
16
20
24
Treatment days

MGA prior to Natural Service or MGA-PG prior to AI

Breeding program	No. heifers	Estrous response	Synchronized conception rate	Synchronized pregnancy rate
Natural service	1749	---	---	1151/1749 66%
AI	4245	3354/4245 79%	2414/3354 72%	2414/4245 57%



MGA-PG (AI)

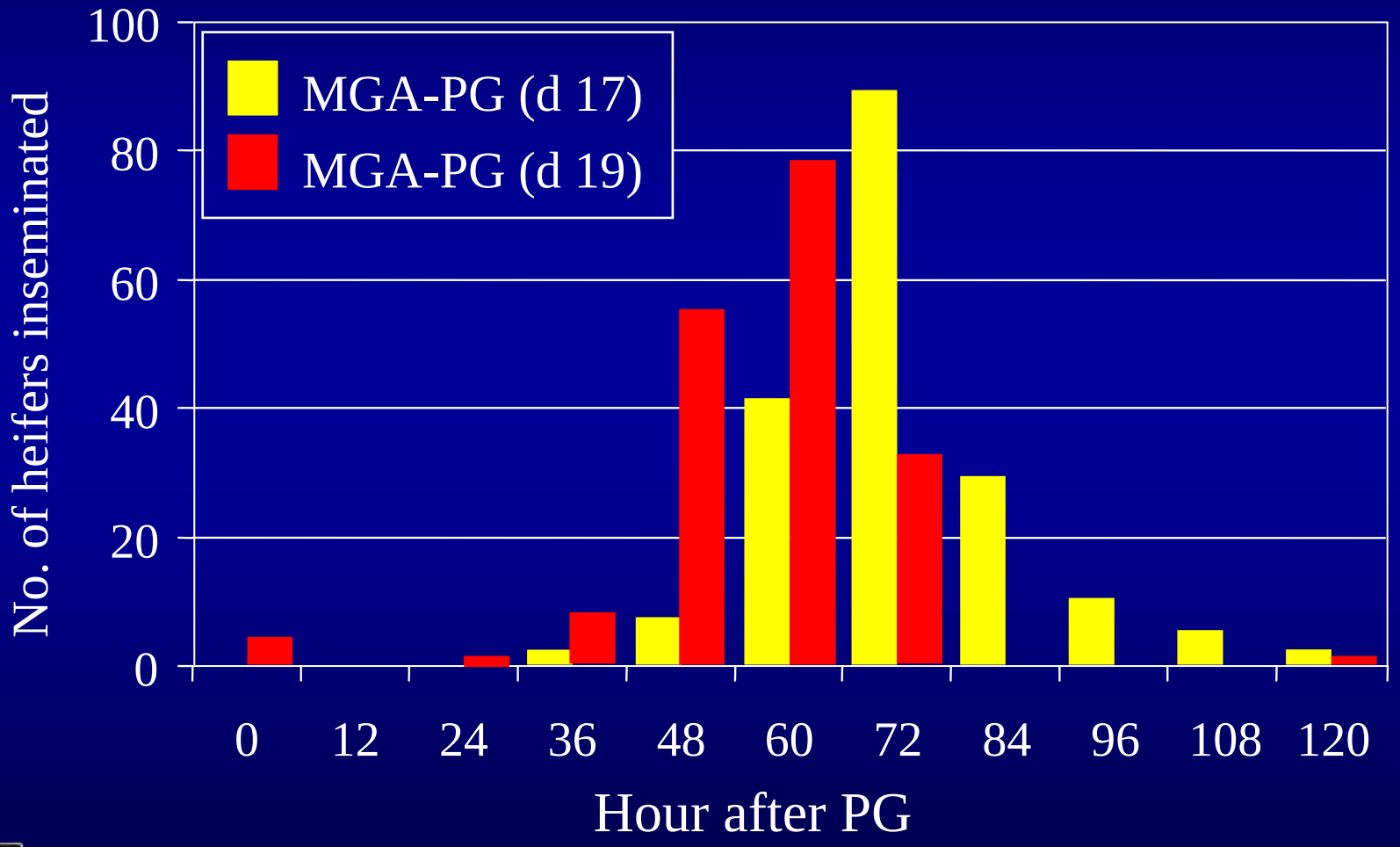
MGA (Natural service)

MGA-PG

14-17 d versus 14-19 d?

MGA-PG

14-17 d vs. 14-19 d

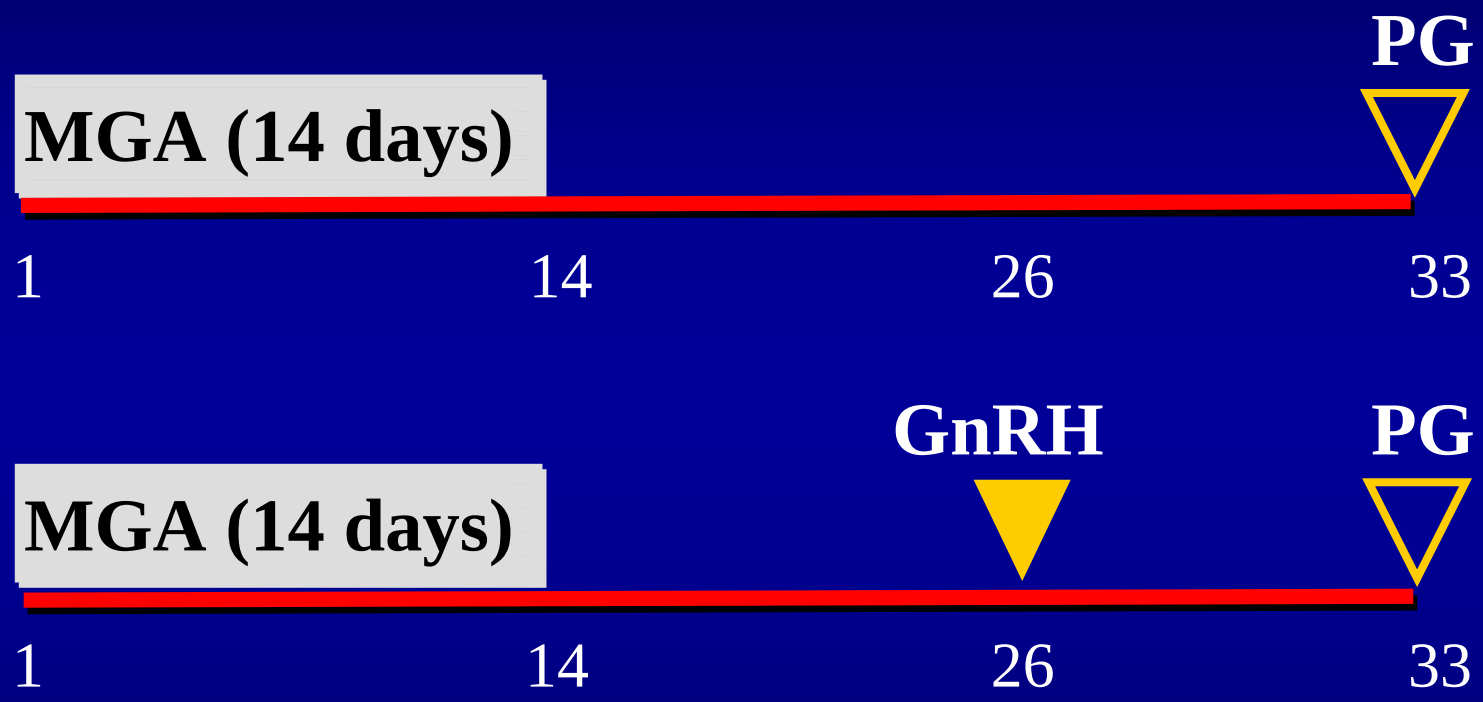


Lamb et al., 2000

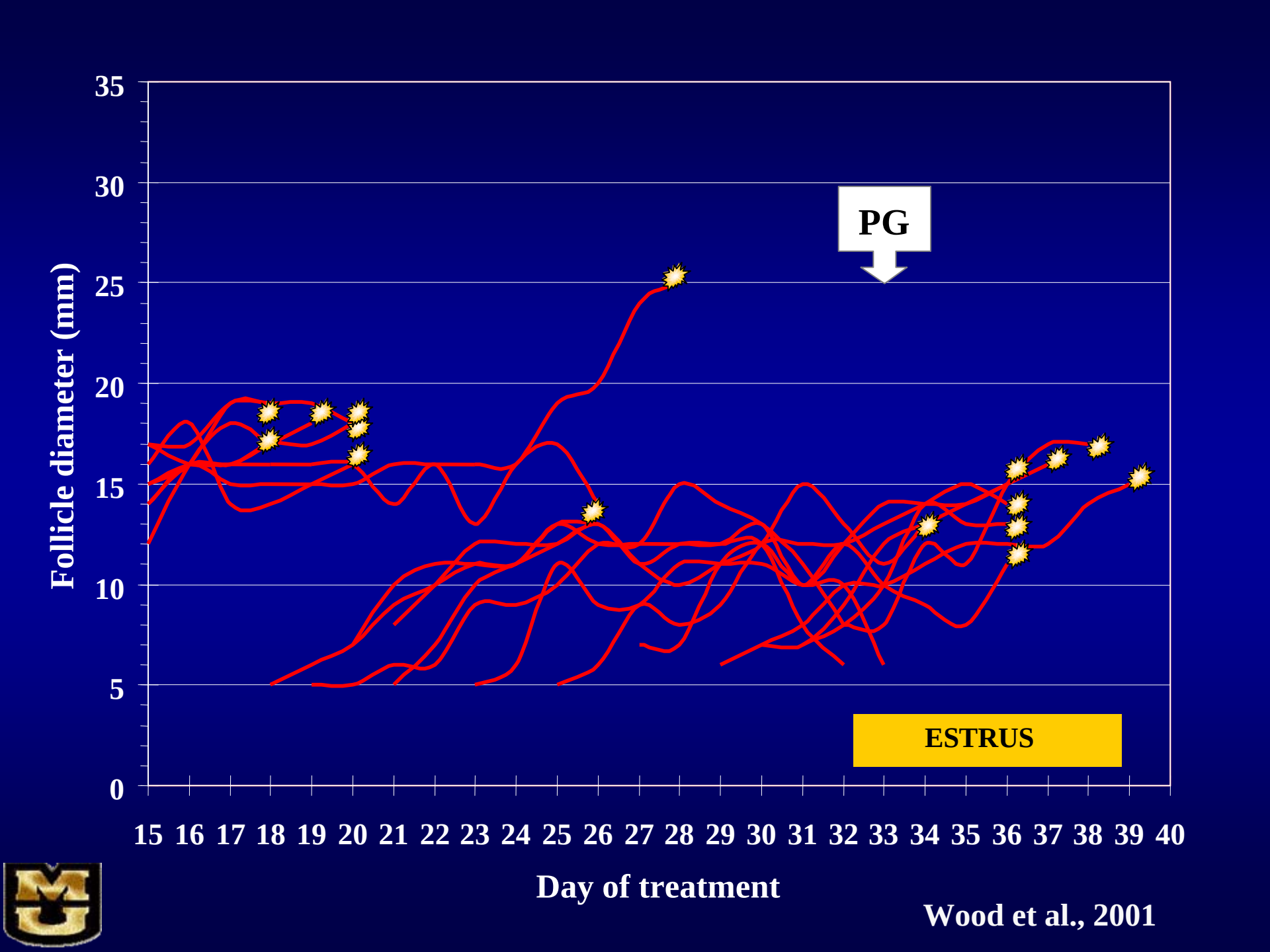
MGA-PG
14-19 d

- Increased estrous response
- Equal fertility
- Improved synchrony

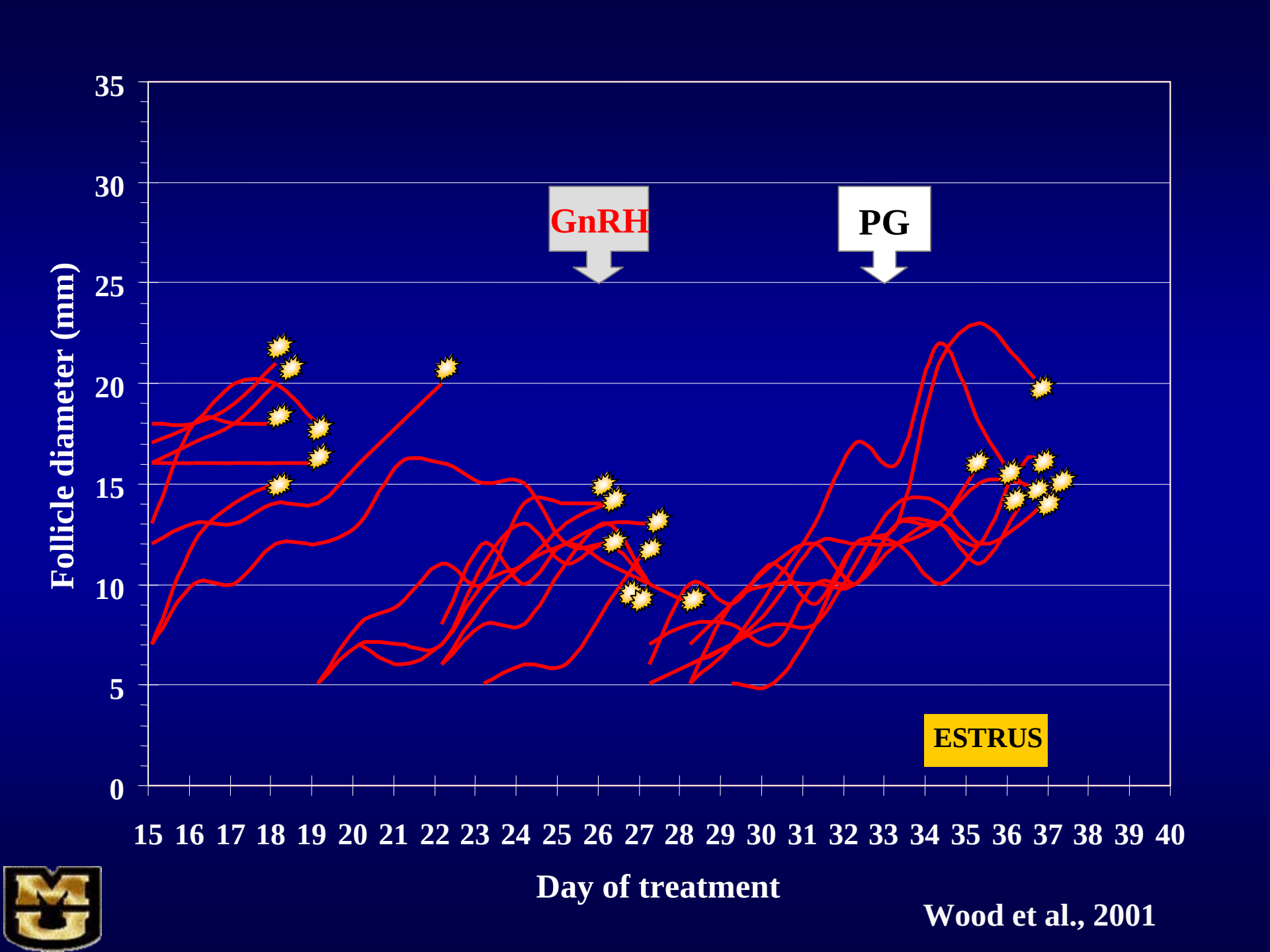
(Deutscher et al., 2000; Lamb et al., 2000)



Wood et al., 2001



Wood et al., 2001



Wood et al., 2001

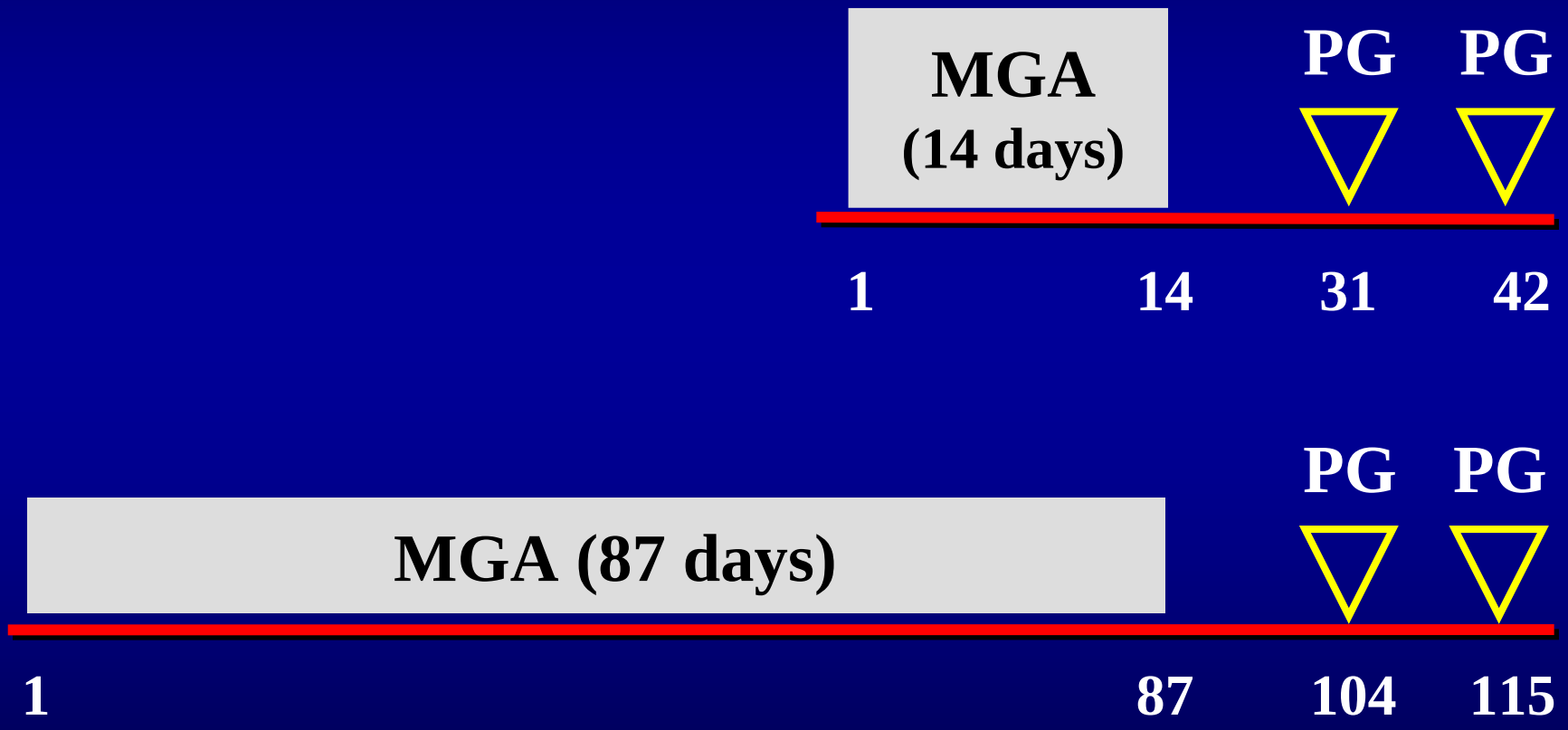
When to Add GnRH to an MGA-PG Protocol for Heifers

- **Consideration of . . . .**
  - **Age**
  - **Weight**
  - **Reproductive tract score (RTS)**
    - **Pubertal status**

Wood et al., 2000; Kojima et al., 2001

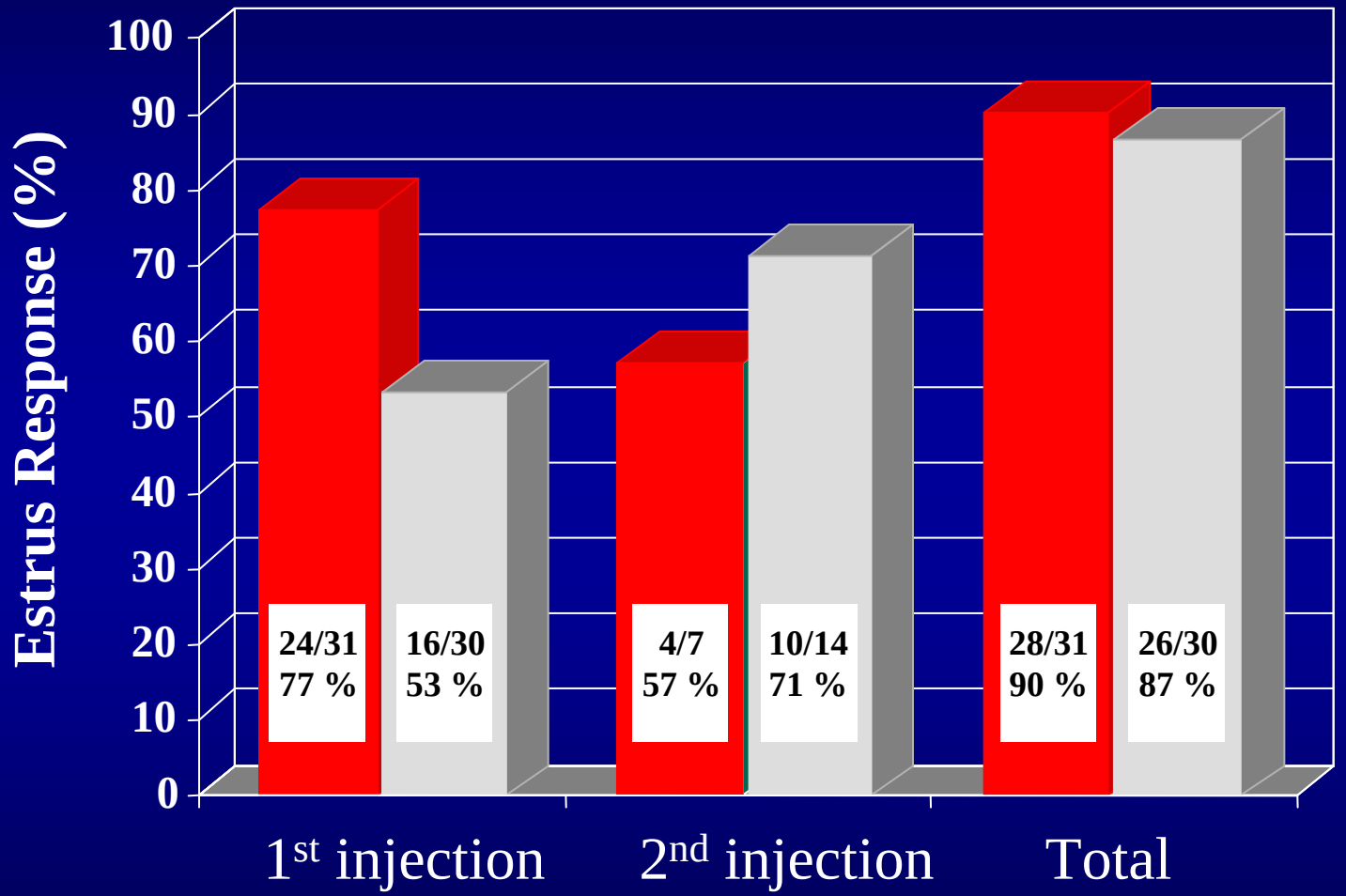
Considerations Regarding Long-term MGA Feeding

Experimental Design



Patterson et al., 1992

Estrous Response

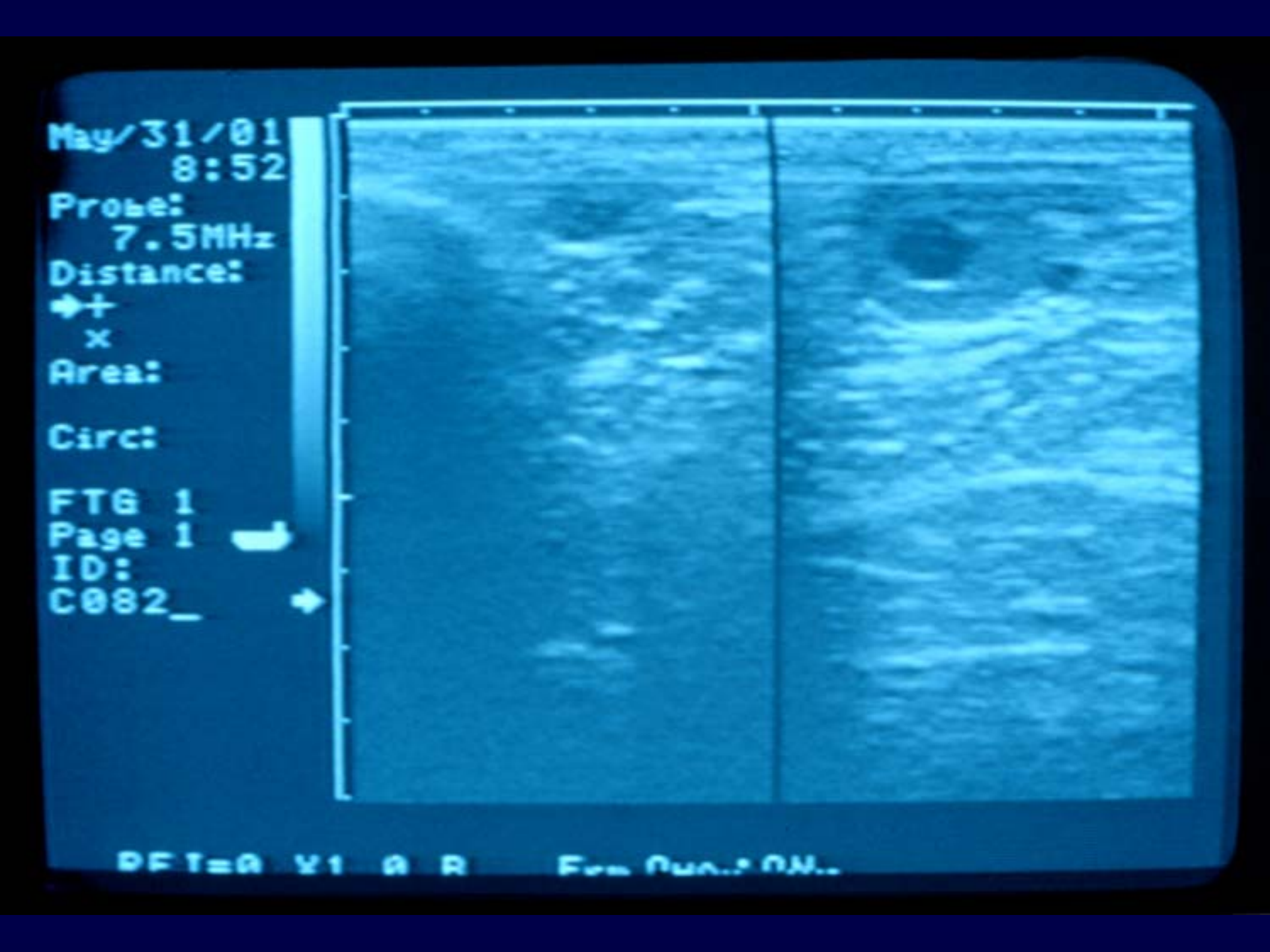


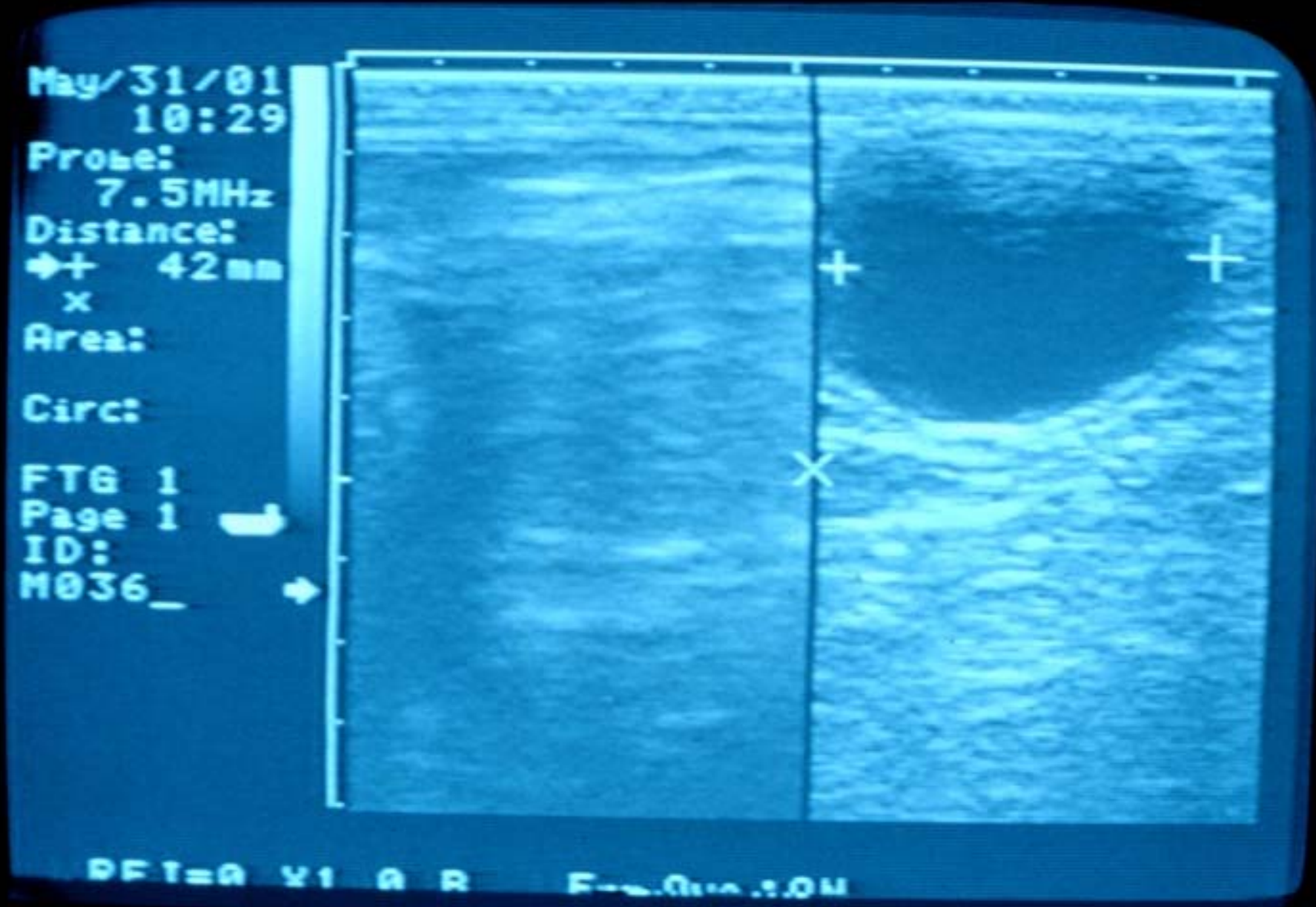
Ovarian Morphology

Treatment	Normal	Abnormal
Short-term MGA	31/31 100 %	0/31 0 %*
Long-term MGA	19/30 63 %	11/30 37 %*

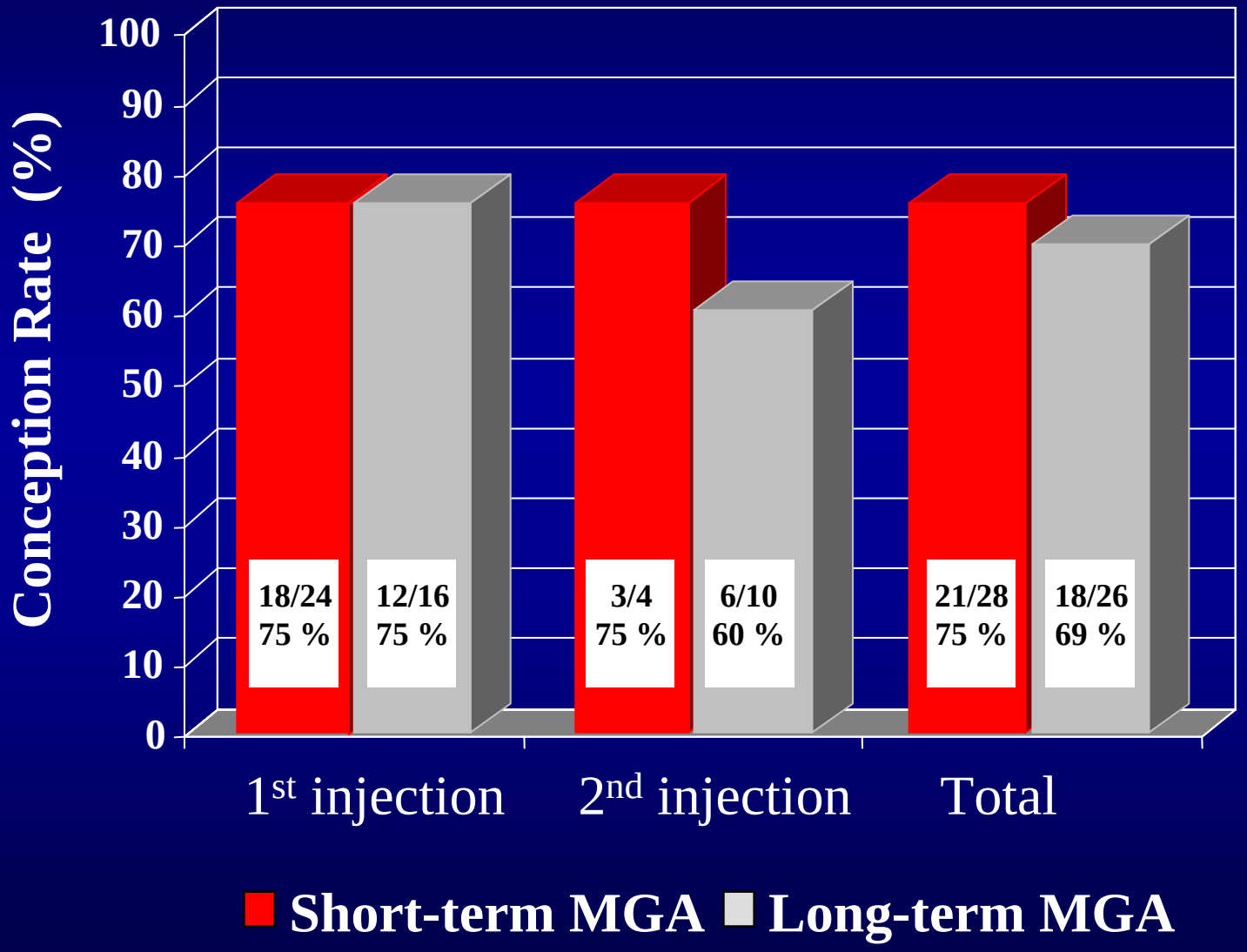
Abnormal = Luteinized follicular cyst

* P < 0.01

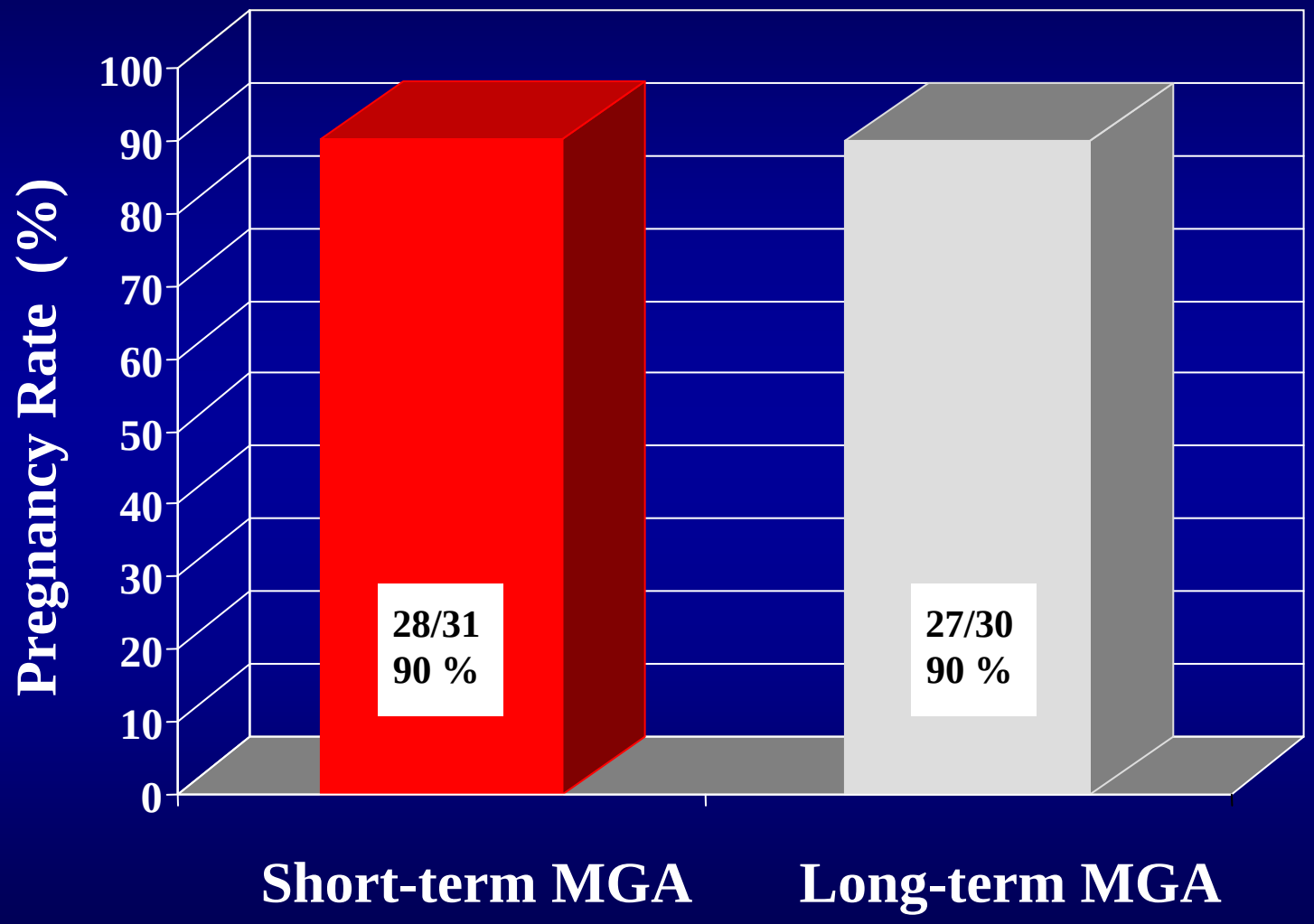

May/31/01
8:52
Probe:
7.5MHz
Distance:
Area:
Circ:
FTG 1
Page 1
ID:
C082_


May/31/01
10:29
Probe:
7.5MHz
Distance:
42mm
Area:
Circ:
FTG 1
Page 1
ID:
M036_

Conception Rate



Pregnancy Rate



CIDR-Based Protocols for Heifers

Efficacy of the CIDR Insert and PG for Synchronizing Estrus in Beef Heifers

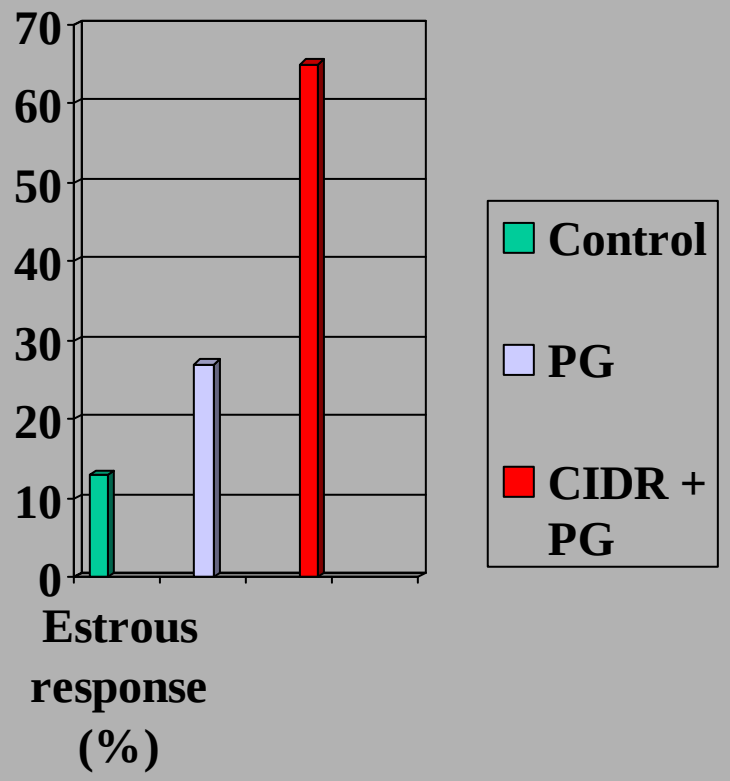
Lucy et al., 2001

Experimental treatments
(Lucy et al., 2001)

- **Untreated control**
- **Single injection of PG**
- **CIDR + PG**
  - **CIDR inserted for 7 days**
  - **PG administered on day 6**

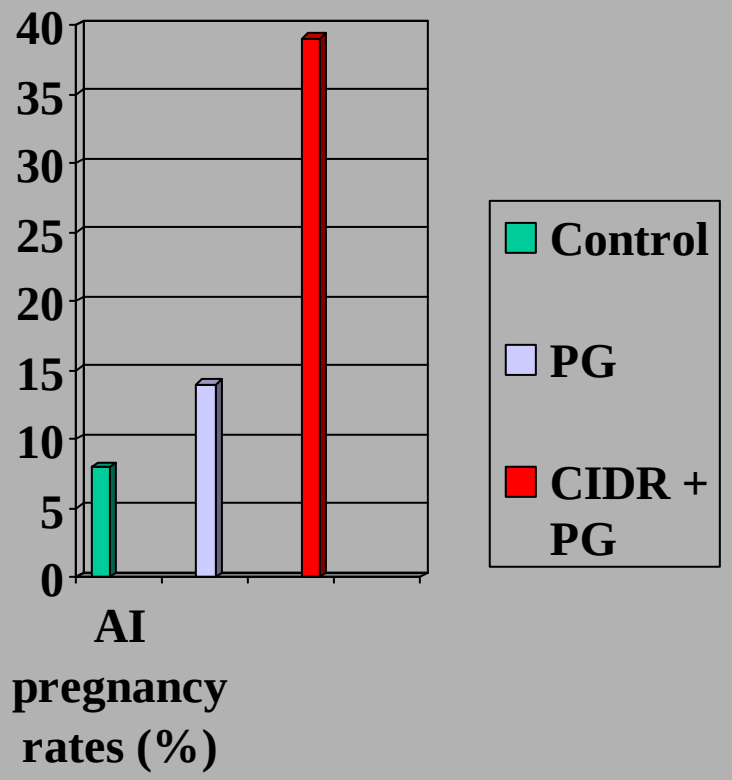
Estrous Response
Lucy et al., 2001

- Control
  - 33/251 (13%)
- PG
  - 67/252 (27%)
- CIDR + PG
  - 143/221 (65%)



AI Pregnancy Rates
Lucy et al., 2001

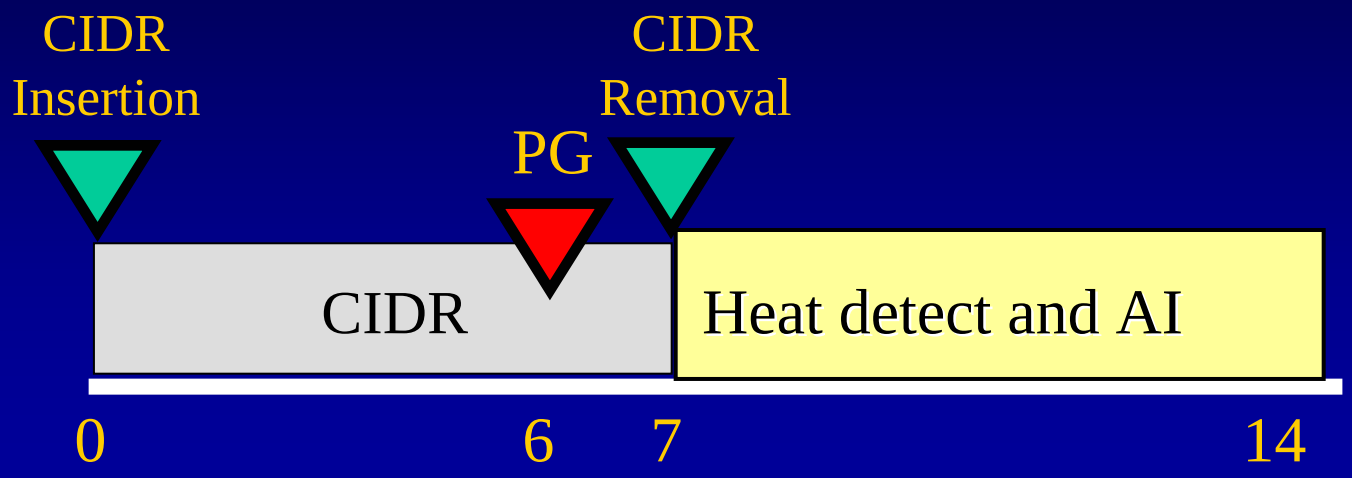
- **Control**
  - 19/251 (8%)
- **PG**
  - 35/252 (14%)
- **CIDR + PG**
  - 86/221 (39%)

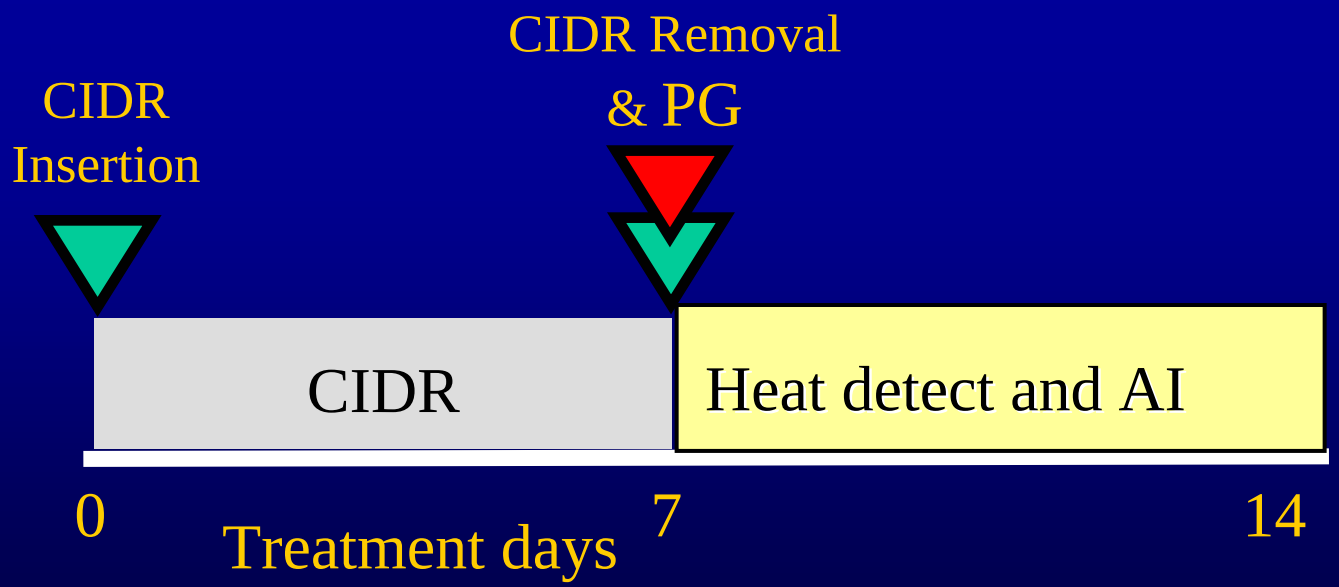


Lucy et al., 2001

- CIDR successfully induced cylicity in prepubertal heifers
- CIDR + PG improved estrous response over control and PG treated contemporaries
- CIDR + PG improved pregnancy rates during the synchronized period over control and PG treated contemporaries

CIDR-PG Protocol

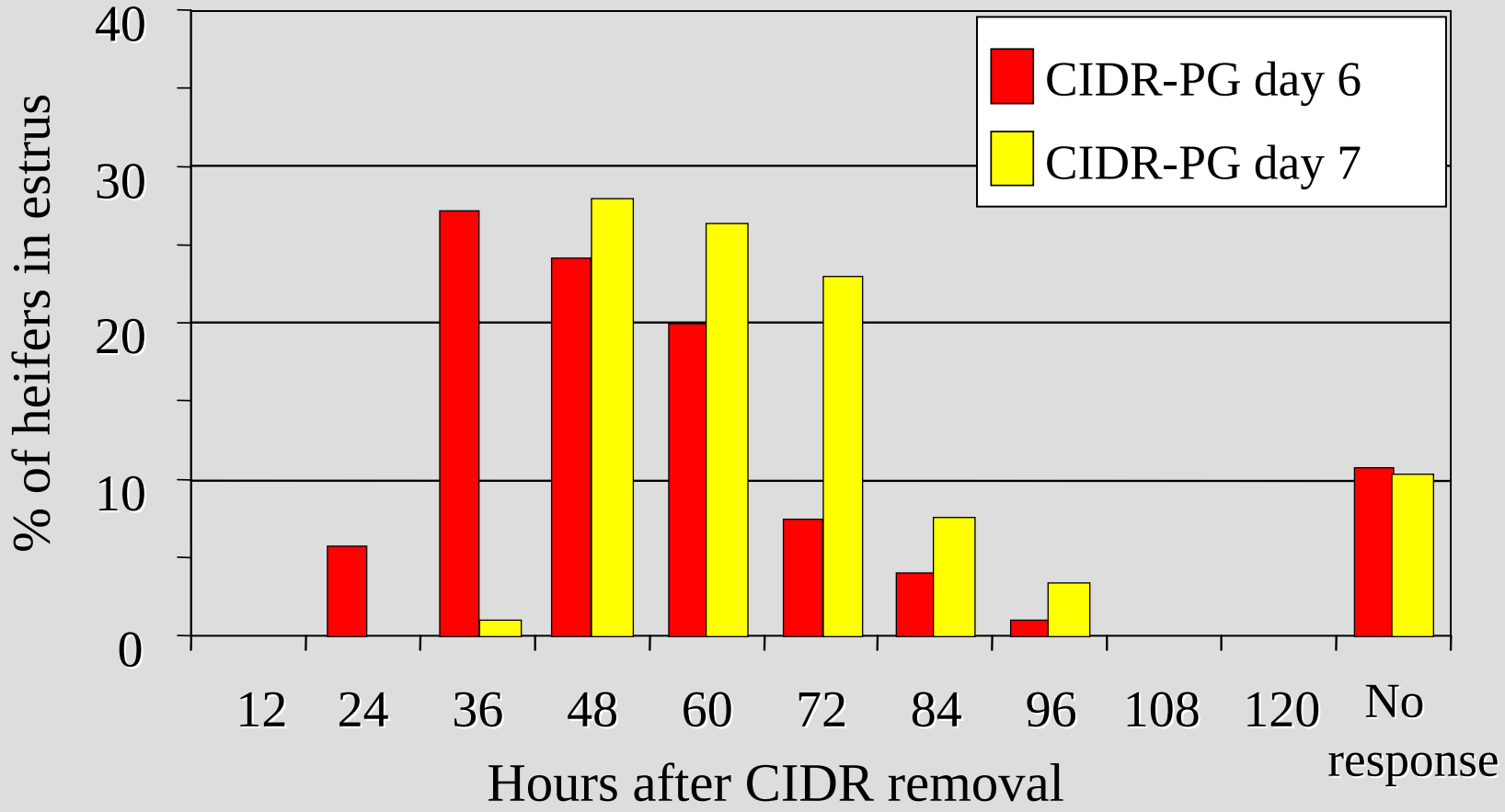




DeJarnette et al., unpublished data

CIDR-PG Protocol

Estrous Response

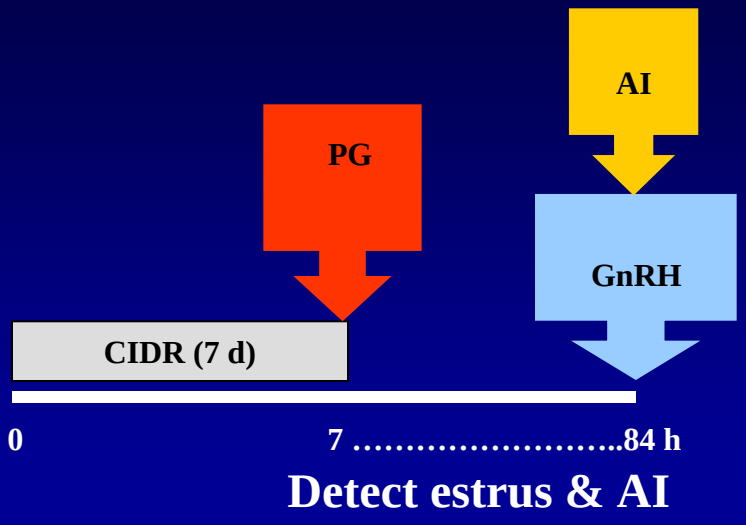


- PG injection on day 6 or 7 altered the timing of estrus after CIDR removal

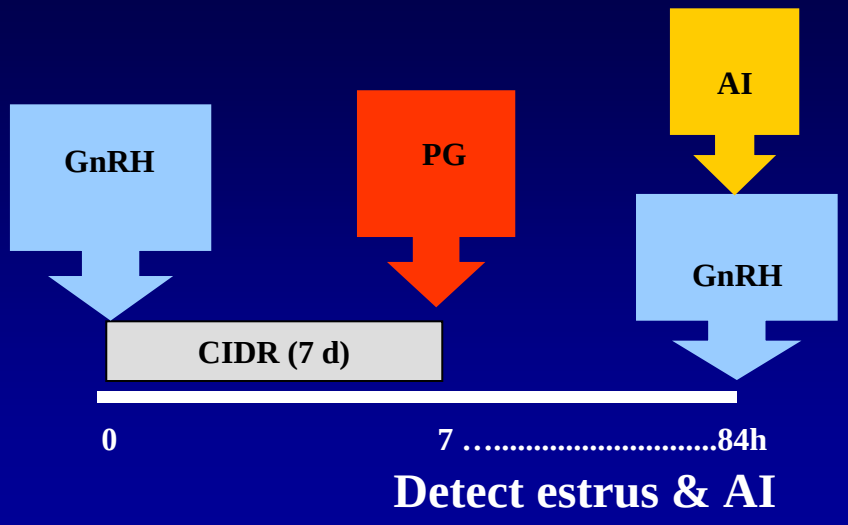
DeJarnette et al., unpublished data

The Multi-State CIDR Trial

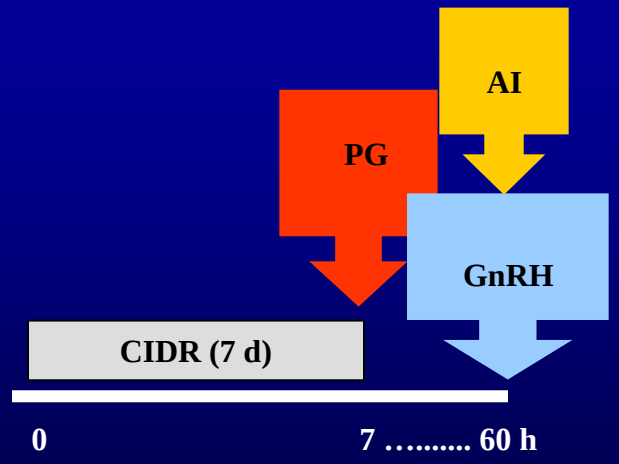
Lamb et al., 2006



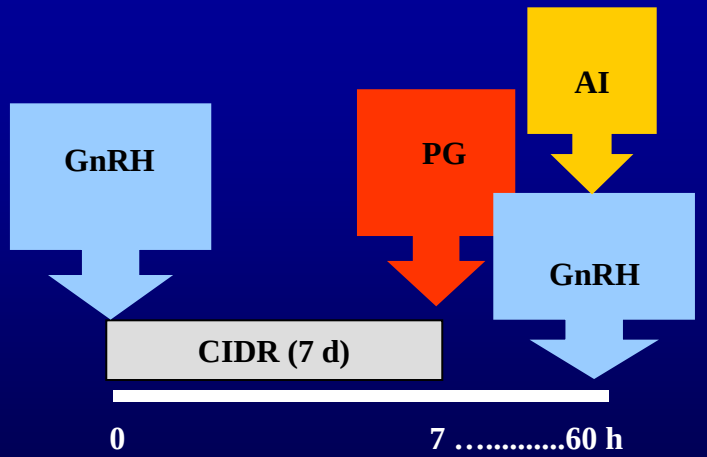
Detect estrus & AI



Detect estrus & AI



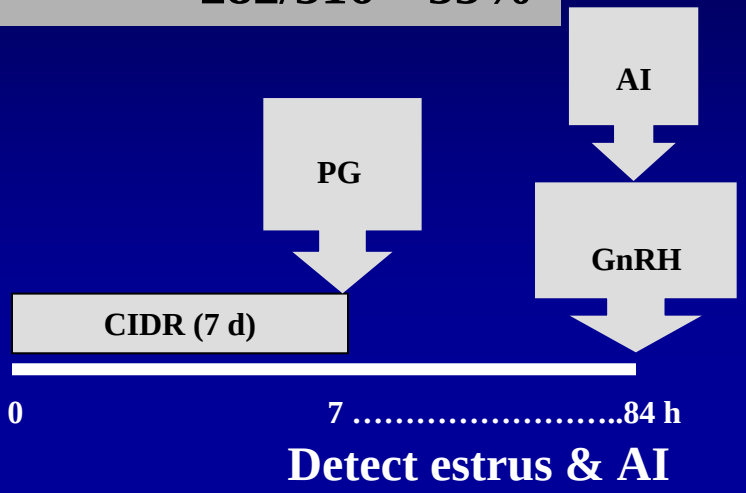
FTAI



FTAI

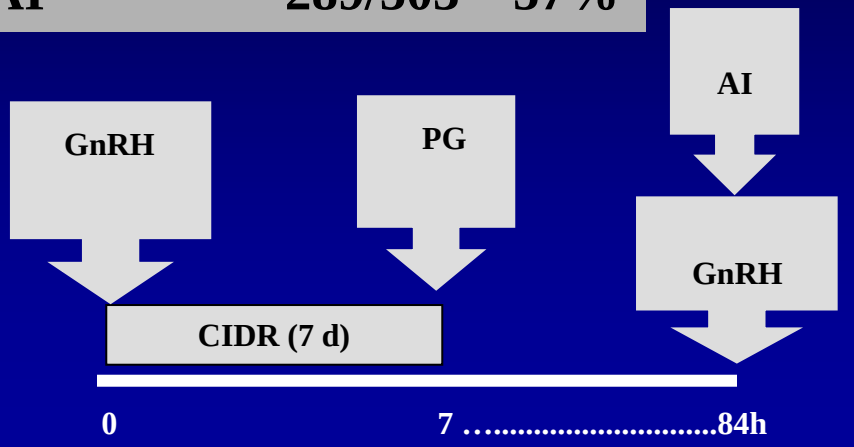
Lamb et al., 2006

Estrus	233/383	61%
FTAI	50/133	37%
AI	**282/516**	**55%**

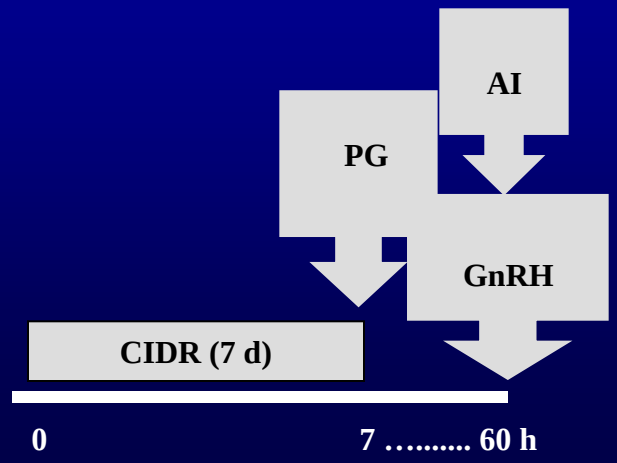


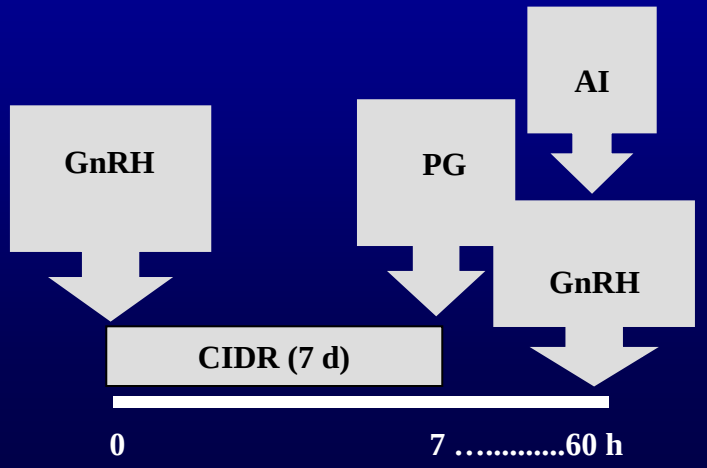
Detect estrus & AI

Estrus	236/372	63%
FTAI	51/131	39%
AI	**289/503**	**57%**

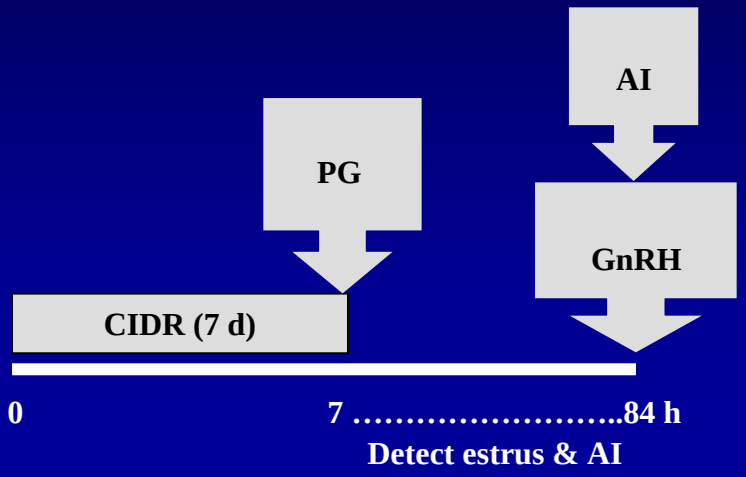


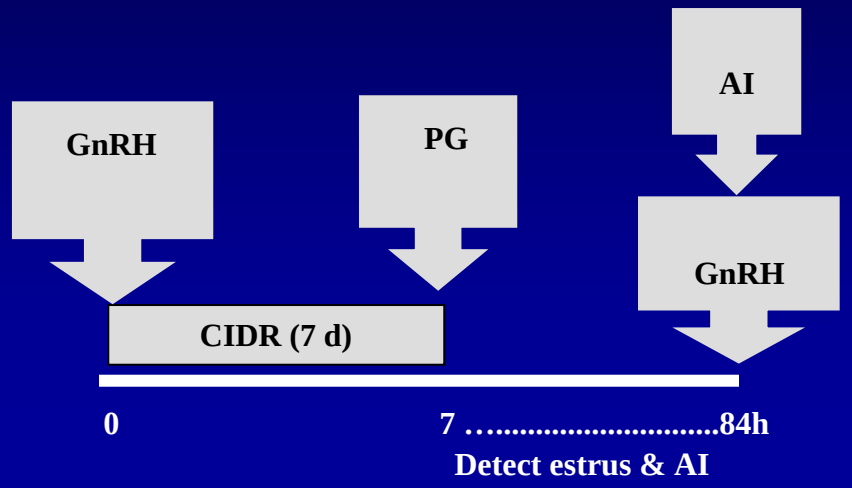
Detect estrus & AI





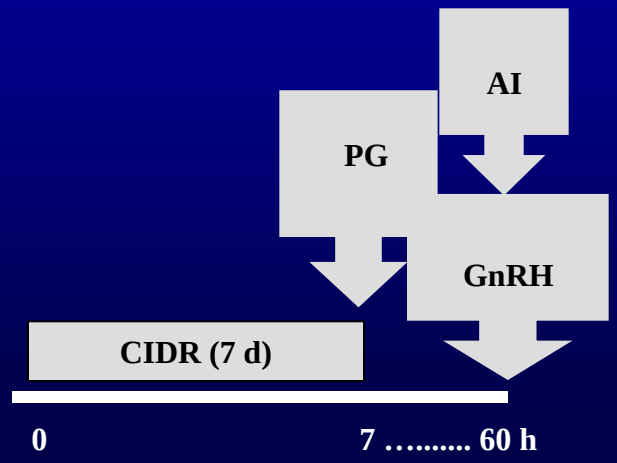
Lamb et al., 2006

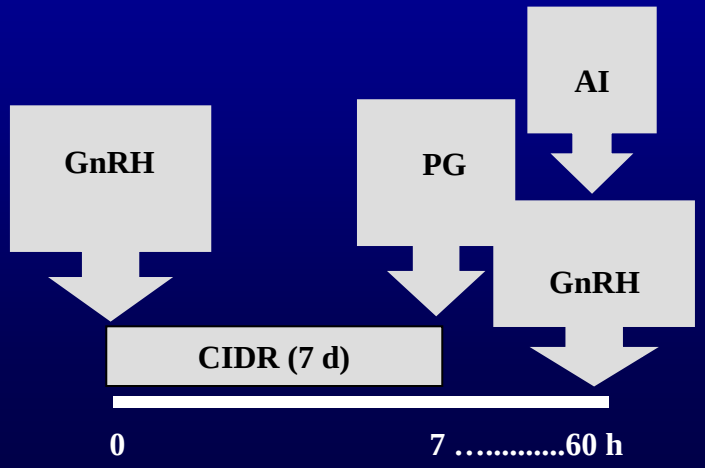




FTAI 259/525 49%

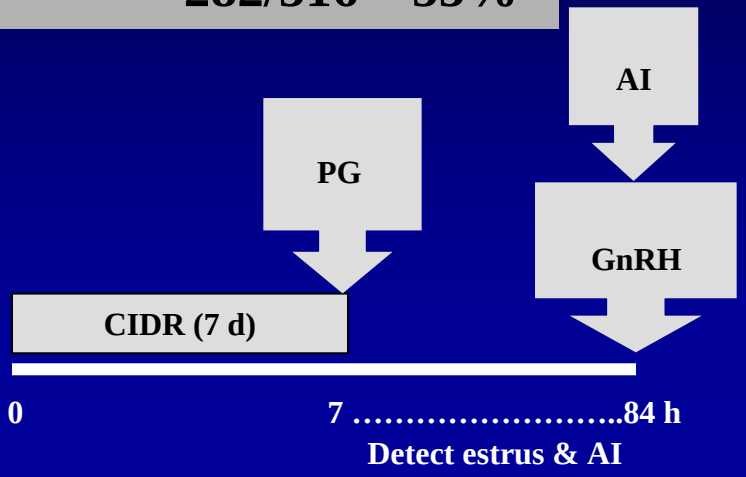
FTAI 282/531 53%



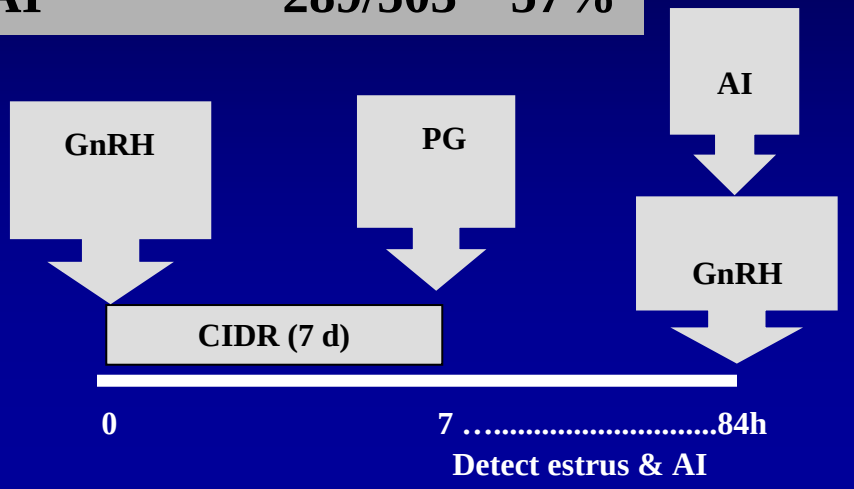


Lamb et al., 2006

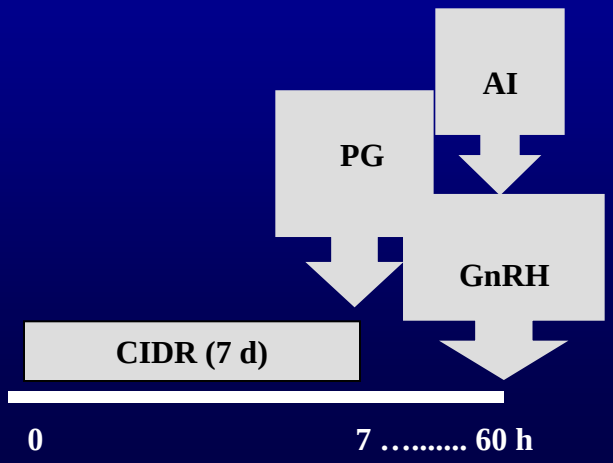
Estrus	233/383	61%
FTAI	50/133	37%
AI	**282/516**	**55%**



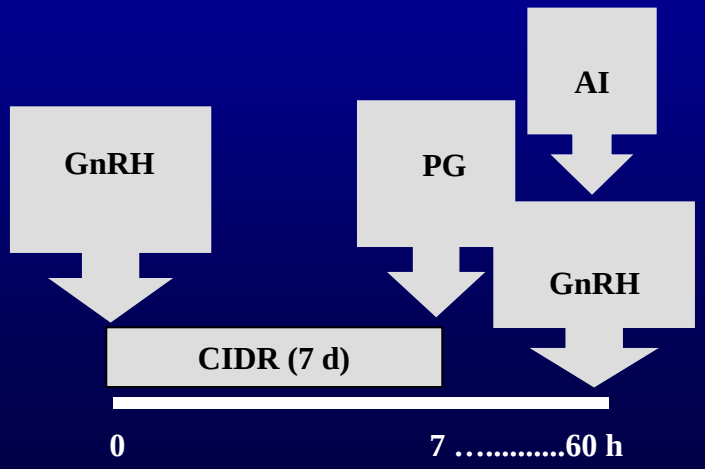
Estrus	236/372	63%
FTAI	51/131	39%
AI	**289/503**	**57%**



FTAI	**259/525**	**49%**



FTAI	**282/531**	**53%**



Lamb et al., 2006

Multi-state CIDR Trial

- GnRH at CIDR insertion did not improve pregnancy rates after FTAI
- GnRH at CIDR insertion did not alter the percentage of heifers detected in estrus or the distribution of estrus after PG
- A combination of detecting estrus and AI before clean-up AI enhanced pregnancy rates over FTAI

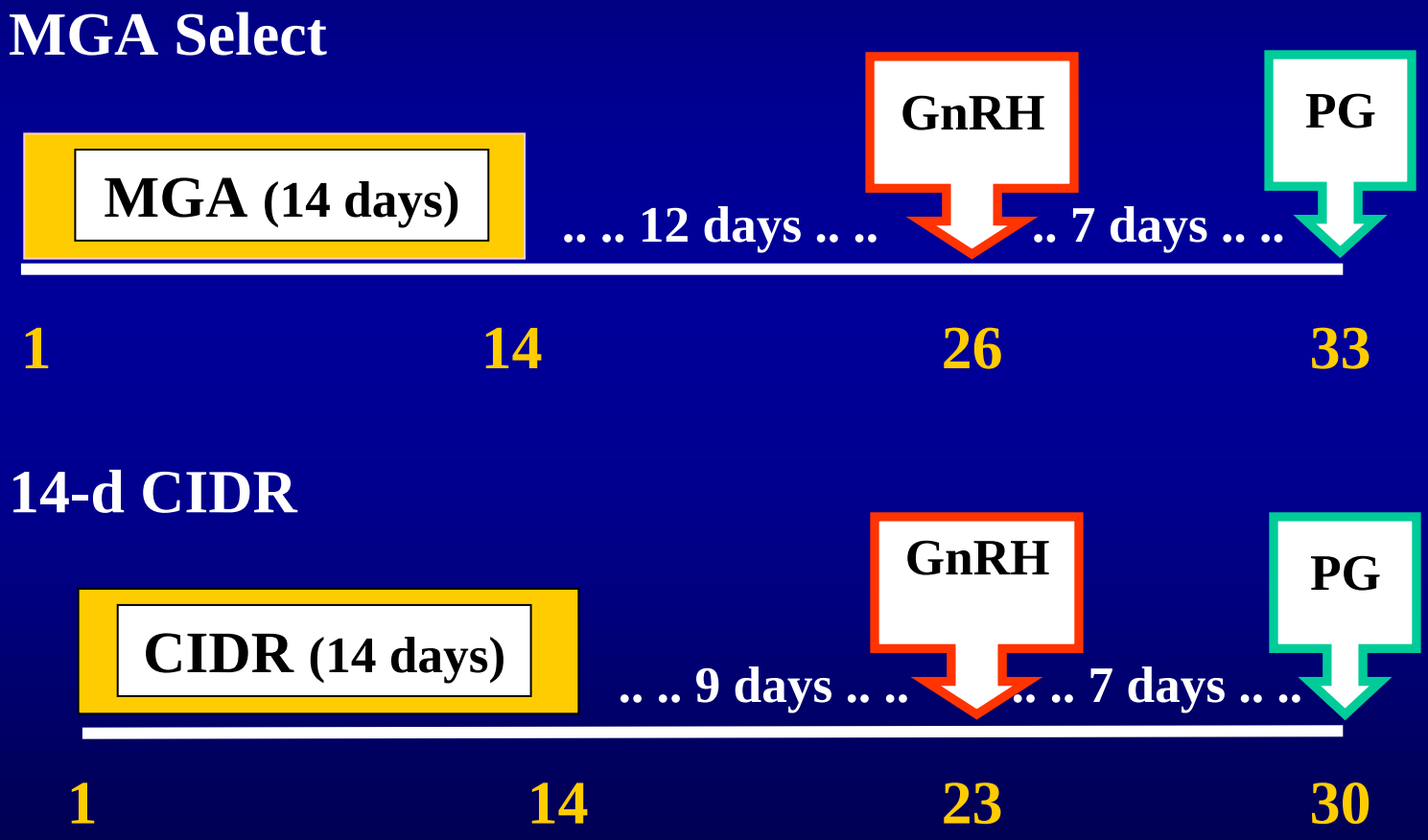
Lamb et al., 2006

How do MGA- and CIDR-based protocols compare in heifers?

Observations with MGA-based programs in yearling beef heifers . . .

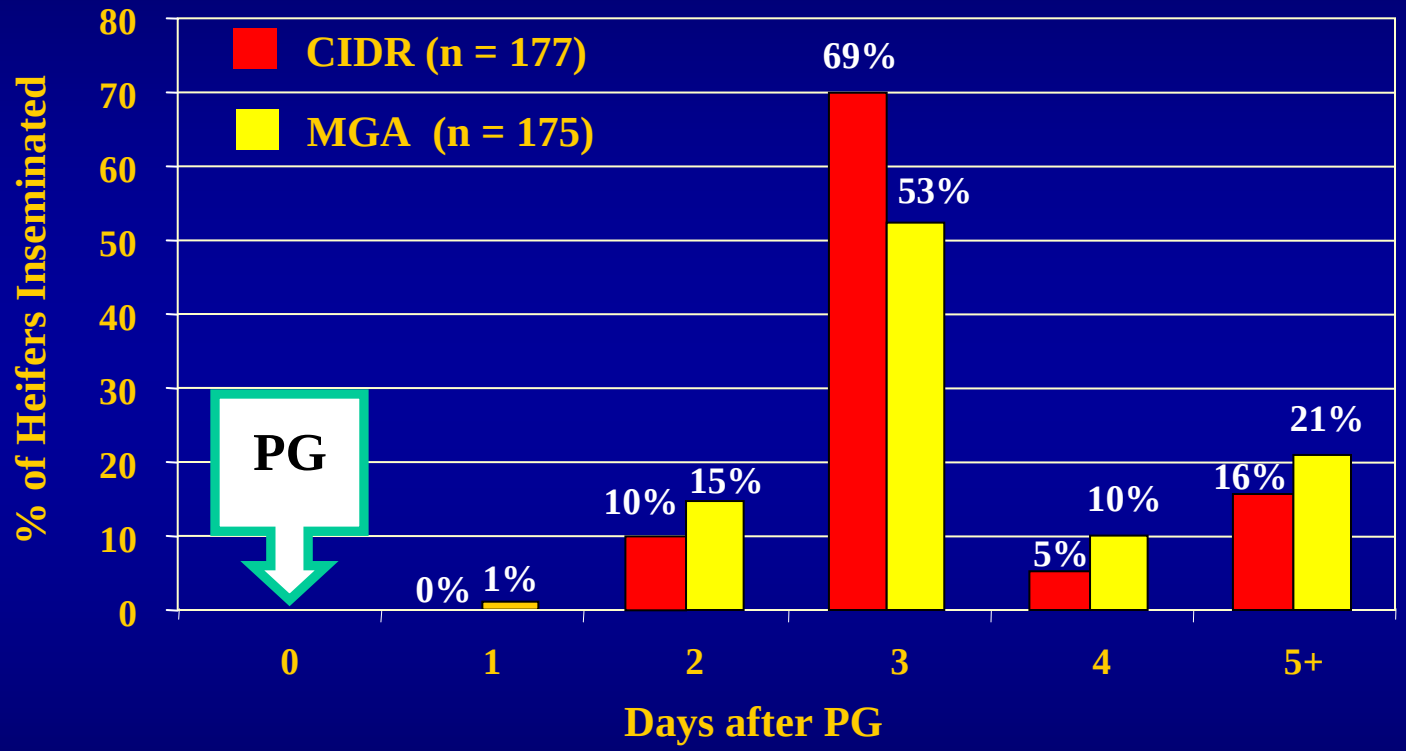
- Increasing number of reports that pregnancy rates resulting from MGA-based estrus synchronization protocols are declining in yearling age heifers . . . . . .
  - Higher rates of estrous cyclicity
  - Heavier weight and conditioned heifers

Experimental Protocols



Kojima et al., 2004

Summary for Timing of AI



- No treatment x location effect (P > 0.10); therefore, data were pooled
- Distribution of AI dates were different between MGA- and CIDR-treated heifers (P < 0.02)

Kojima et al., 2004

Estrous Response, AI Pregnancy, and Final Pregnancy Rates

	Estrous Response	AI Pregnancy	Final Pregnancy
CIDR	154/177 (87 %)	112/177 (63 %)[a]	164/177 (93 %)
MGA	147/175 (84 %)	83/175 (47 %)[b]	159/175 (91 %)
Total	301/352 (86 %)	195/352 (55 %)	323/352 (92 %)
Diff.	+ 3 %	[a, b] P = 0.01 + 16 %	+ 2 %

Kojima et al., 2004

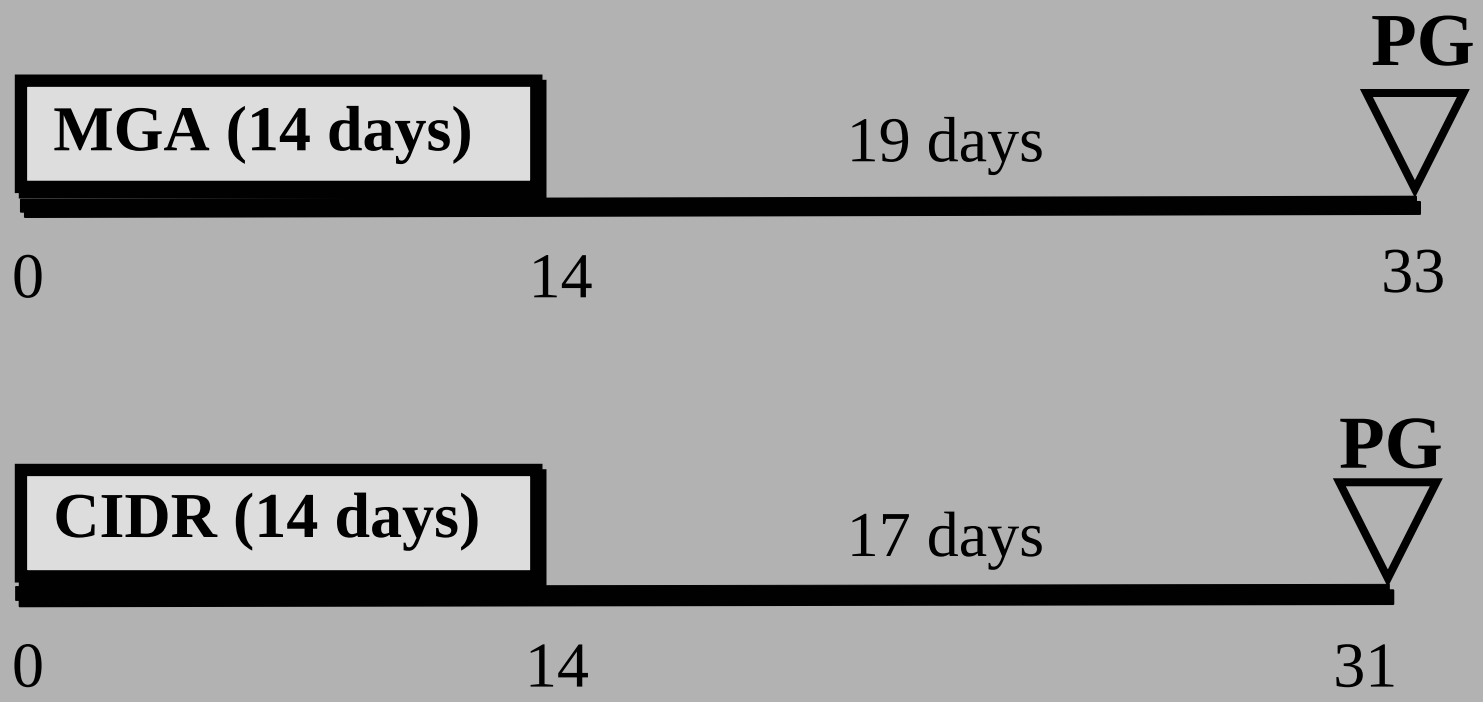
14-day CIDR vs MGA Select

- No difference in estrous response during the synchronized period
- Improved synchrony of estrus
- Improved conception & pregnancy rates during the synchronized period
- No difference in final pregnancy rate at the end of the breeding period

Kojima et al., 2004

CIDR-PG versus MGA-PG

Tauck et al., 2007



Tauck et al., 2007

CIDR-PG versus MGA-PG

	CIDR	MGA
Number of heifers	77	79
Inseminated 12 hr after estrus	91%	67%
Preg rate (heat detection)	67%	71%
Preg rate (FTAI @72 after PG	25%	54%
Overall AI preg rate	62%	66%

Tauck et al., 2007

How do long-term and short-term CIDR-based protocols compare in heifers?

Response to GnRH in estrous cycling beef heifers based on day of the estrous cycle GnRH was administered

Day of treatment	**1st GnRH (no. & % responding)**	
Day 2	0/14 0%	
Day 5	12/13 92%	
Day 10	4/13 31%	
Day 15	8/13 62%	
Day 18	2/10 20%	

Atkins et al., 2005

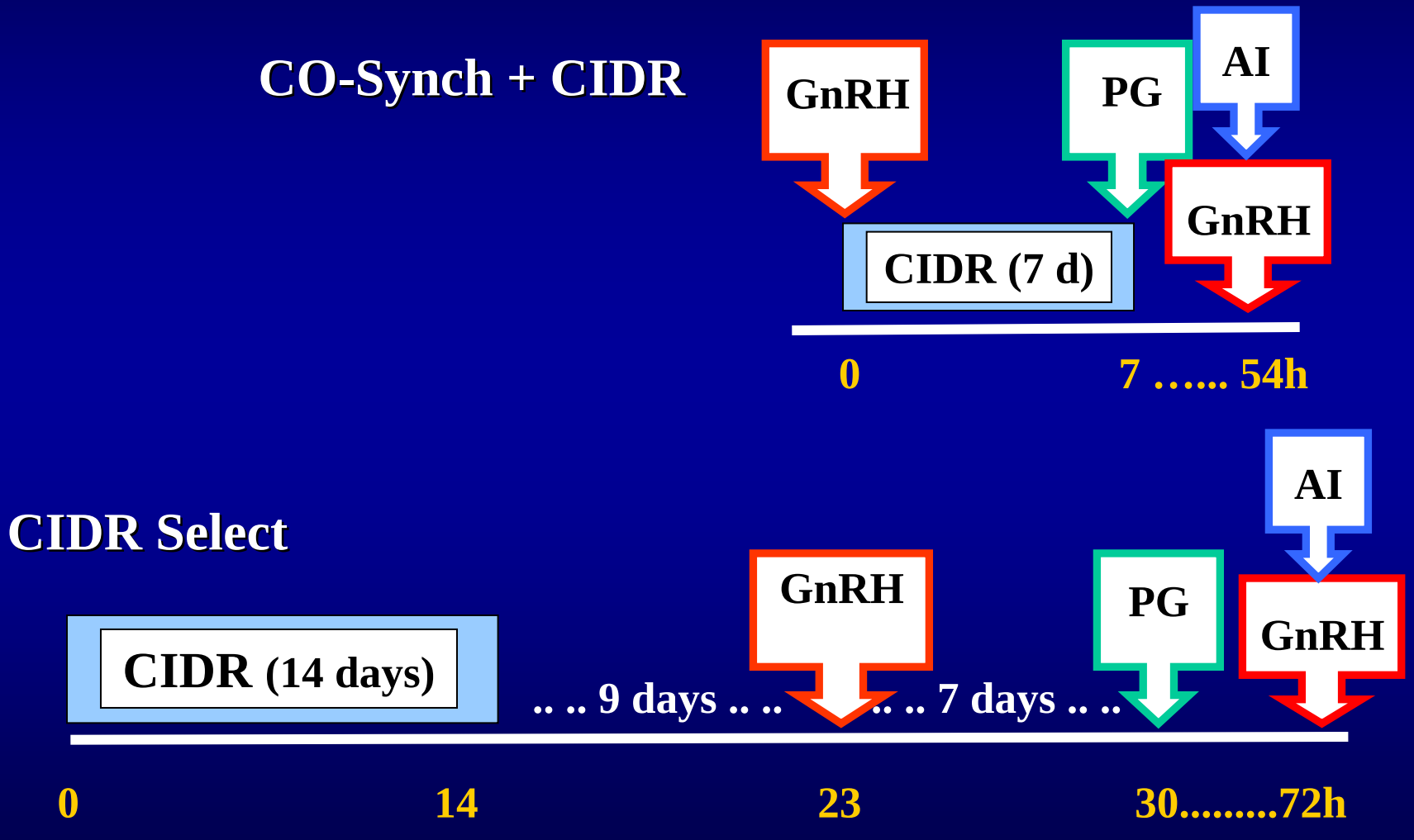
Response to GnRH in beef heifers synchronized with the 14-day CIDR based on day of the estrous cycle GnRH was administered

Day of the cycle GnRH was administered	No. & % responding	
Day 3	1/2	50%
Day 4	0/1	0%
Day 5	5/5	100%
Day 6	7/7	100%
Day 7	23/27	85%
Day 8	24/27	89%
Unknown	8/10	80%

Schafer et al., 2006

Until recently, there have been no comprehensive studies in estrous cycling and pre/peripubertal beef heifers comparing the long-term CIDR protocol (CIDR Select) and short-term CIDR-based protocols.

CO-Synch + CIDR w/ TAI at 54h vs CIDR Select w/ TAI at 72h

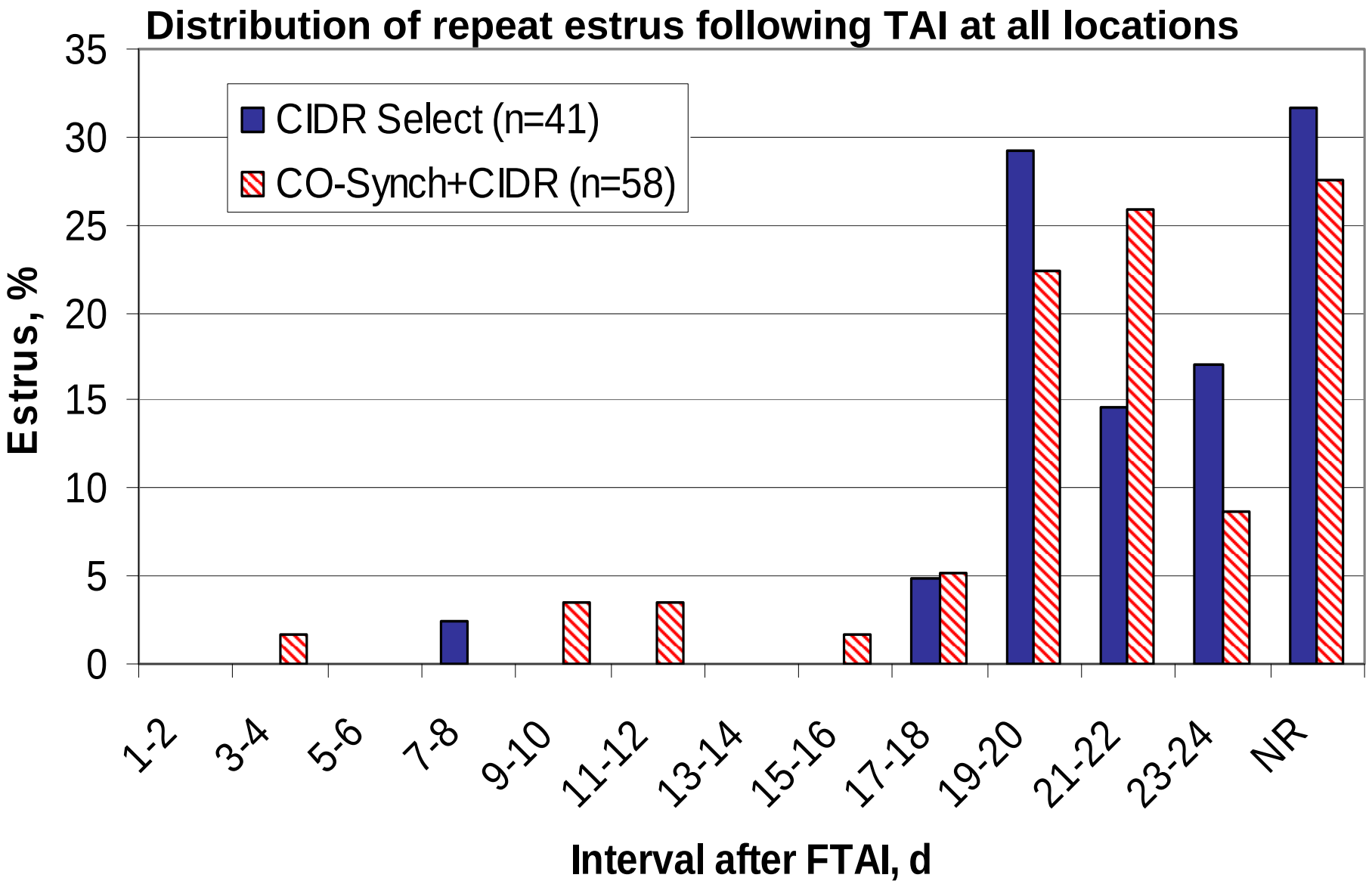


Busch et al., 2007

AI pregnancy

	Fixed-time AI pregnancy rate		
	Pre/peri-pubertal	Estrous cycling	Combined
CIDR Select	13/21 (62%)	54/87 (62%)[x]	67/108 (62%)[x]
CO-Synch + CIDR	11/23 (48%)	40/86 (47%)[y]	51/109 (47%)[y]
Total	24/44 (55%)	94/173 (54%)	118/217 (54%)
Diff.	+ 14 %	+ 15 % [x,y] P= 0.03	+ 15 % [x,y] P= 0.02

Busch et al., 2007



Busch et al., 2007

Return to estrus after TAI

	Observed in estrus	Mean interval to estrus (mean ± SE)	Synchrony of estrus (mean ± SD)
CIDR Select	**28/108 (26%)**	**20.2 ± 0.7 d**	**20.2 ± 3.0 d**
CO-Synch + CIDR	**42/109 (39%)**	**19.2 ± 0.6 d**	**19.2 ± 4.3 d**
Diff.	**+ 13 % P= 0.05**	**P = 0.26**	**F-test P < 0.05**

Busch et al., 2007

Conclusion

Synchronizing replacement beef heifers with the CIDR Select protocol resulted in:

- Significantly higher TAI pregnancy rates ($P = 0.02$)
- Reduced variance associated with the interval from TAI to subsequent return to estrus ($P < 0.05$)

Busch et al., 2007

CIDR Select with heat detection results

Herd	No. Pregnant	Total No.	Percentage
1 (F02)	50	79	63%
2 (S03)	27	42	64%
3 (S03)	35	56	63%
4 (S04)	26	48	54%
5 (S04)	49	79	62%
13 (S05)	10	16	63%
14 (S05)	8	10	80%
15 (S05)	41	81	51%
16 (F05)	25	33	76%
17 (F05)	12	18	67%
18 (F05)	23	51	45%
Totals	**499**	**830**	**60%**

CIDR Select with Heat Detection

830 Total Females at 18 Locations

Average % Synchronized Pregnancy = 60%

CIDR Select with TAI at 72 hrs results

Herd	No. Pregnant	Total No.	Percentage
1 (F04)	71	117	61%
2 (S05)	44	67	66%
3 (S05)	7	9	78%
4 (S05)	42	82	51%
9 (F05)	50	81	62%
10 (S06)	23	39	59%
11 (S06)	44	69	64%
12 (S06)	32	50	64%
13 (S06)	24	32	75%
Totals	**518**	**853**	**61%**

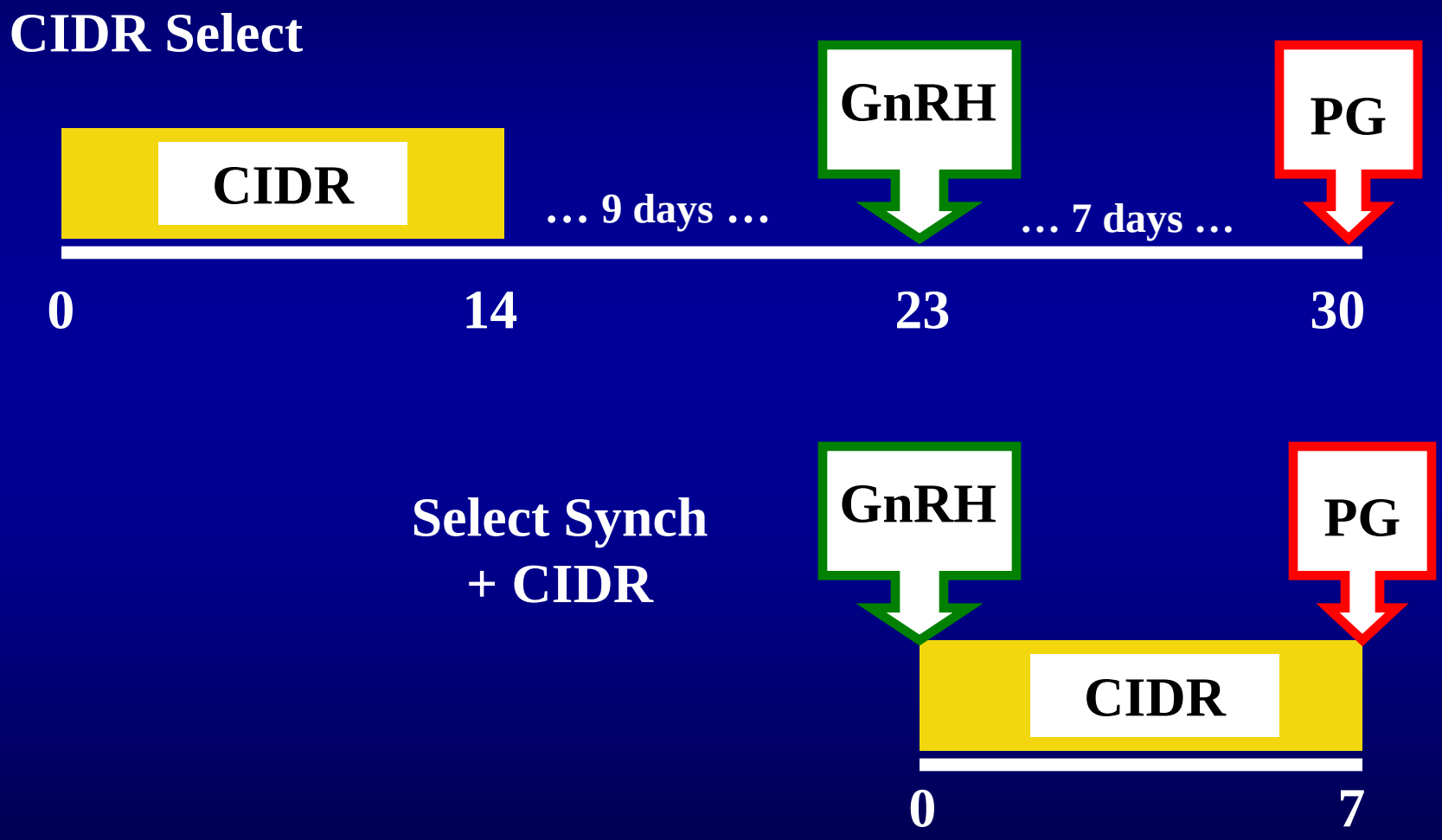
CIDR Select with Timed AI @ 72 hrs.

853 Total Females at 13 Locations

Average % Synchronized Pregnancy = 61%

- Results from Leitman et al. (2008) were analyzed to compare the CIDR Select and Select Synch + CIDR protocols among mixed groups of estrous cycling and prepubertal beef heifers.

Treatments



Leitman et al., 2008

Objectives

- Characterize
  - Follicular dynamics the day preceding and the day of GnRH
  - Response to GnRH
  - Estrus distribution after CIDR removal and PG
  - Time of ovulation following each synchronization protocol

Leitman et al., 2008

Prepubertal and estrous cycling heifers

	CIDR Select	Select Synch + CIDR
Response to GnRH	21/26 81%*	9/23 39%*
Estrous response	23/26 88%	19/23 83%

*P<0.01

Leitman et al., 2008

Prepubertal and estrous cycling heifers

- Variance for interval to estrus differed between CIDR Select and Select Synch + CIDR

	CIDR Select	Select Synch + CIDR
Interval from PG to estrus	**52** ± 1.4h **42–70h (28h)**	**47** ± 3.9h **29–105h (76h)**
Variance from PG to estrus	**45.6***	**285.6***

Leitman et al., 2008

*P<0.001

Prepubertal and estrous cycling heifers

- Variance for interval to ovulation differed between CIDR Select and Select Synch + CIDR

	CIDR Select	Select Synch + CIDR
Interval from PG to ovulation	**82** ± 1.6h **68–100h (32h)**	**75** ± 4.3h **55–131h (76h)**
Variance from PG to ovulation	**51.3***	**331.2***

*P<0.001

Leitman et al., 2008

Comparison of variances within treatment

	Cycling	Prepubertal	P-value
CIDR Select			
Estrus	38.9	61.2	**P>0.10**
Ovulation	35.3	79.3	**P>0.10**
Select Synch + CIDR			
Estrus	390.8	102.2	**P<0.06**
Ovulation	435.4*	99.8*	***P<0.05**

Leitman et al., 2008

Summary

- The CIDR Select protocol improved synchrony of estrus and ovulation compared with Select Synch + CIDR.

- There was more variance associated with the interval from PG to estrus ($P<0.06$) and ovulation ($P<0.05$) between prepubertal and estrous cycling heifers synchronized with the Select Synch + CIDR protocol compared to CIDR Select.

Leitman et al., 2008

Summary

- Differences in variances for interval to estrus and ovulation between CIDR Select and Select Synch + CIDR treated groups help to explain differences in pregnancy rates resulting from fixed-time AI among CIDR Select and CO-Synch treated heifers.

Leitman et al., 2008

Management Considerations Related to Estrus Synchronization and Fixed-Time AI

Choosing a progestin-based protocol

- The feeding of MGA is specifically approved for estrus synchronization in heifers only.

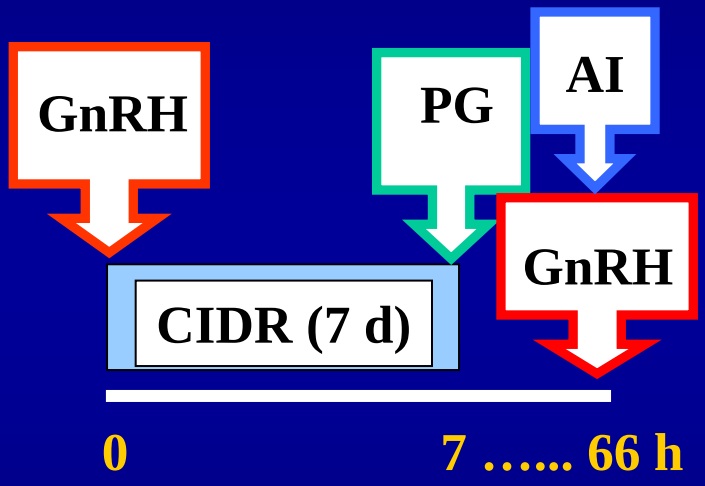
- Use of MGA as part of any estrus synchronization protocol in beef cows constitutes an extralabel use of medicated feed that is prohibited by the Animal Medicinal Drug Use and Clarification Act.

- Producers that have used MGA to synchronize cows in the past should transition to CIDR to comply with FDA regulations concerning extralabel use of medicated feeds.

Currently…….

- Success rates using fixed-time AI in postpartum beef cows warrant an organized effort to increase application and successful use.

CO-Synch + CIDR

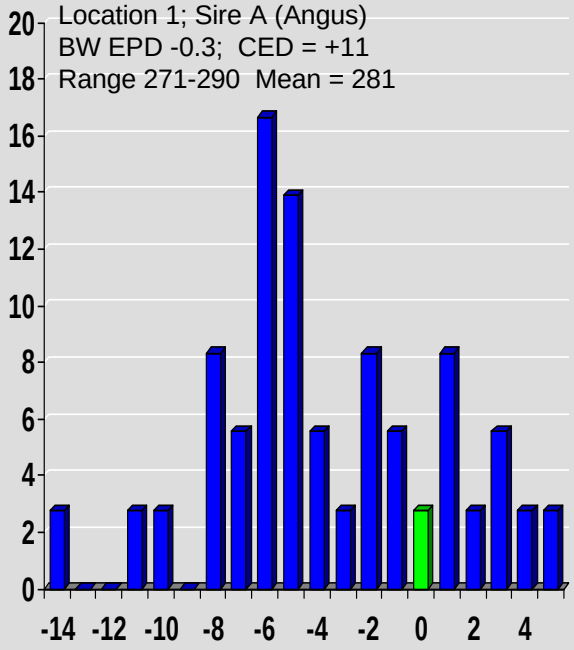


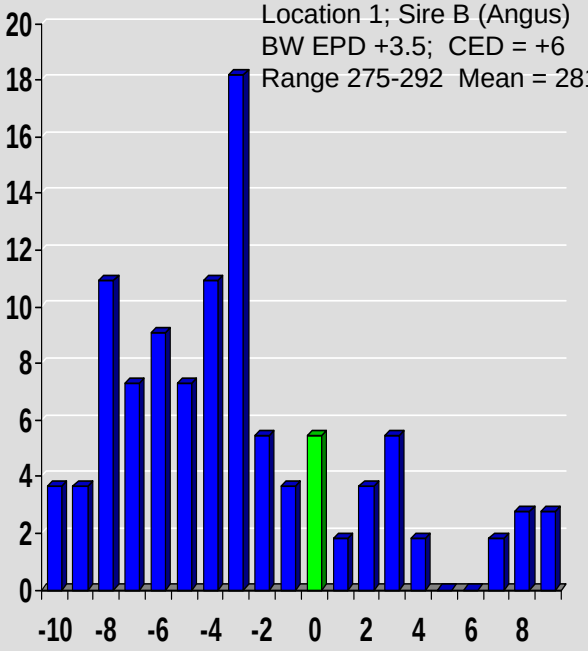
*Only 2 of the 63 herds realized pregnancy rates < 50% resulting from fixed-time AI.

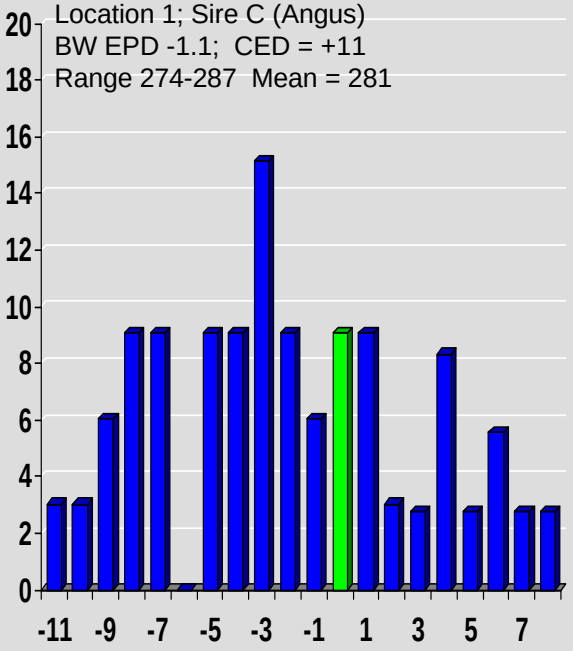
CO-Synch + CIDR with fixed-time AI @ 66 hrs after PG and CIDR removal				
	No. Herds	**No. Cows**	**AI Preg. Rate (%) Range**	**AI Preg. Rate (%) Mean**
Fixed-time AI results	**63**	**6437**	**38-86%***	4009/6437 **62%**

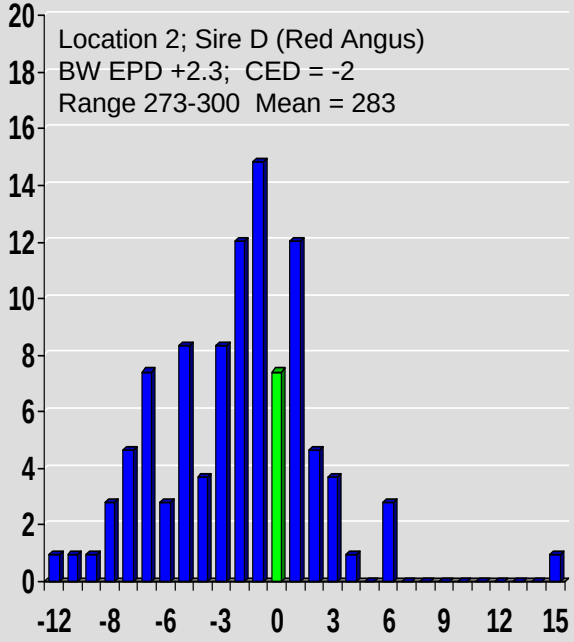
*Only 2 of the 63 herds realized pregnancy rates < 50% resulting from fixed-time AI.

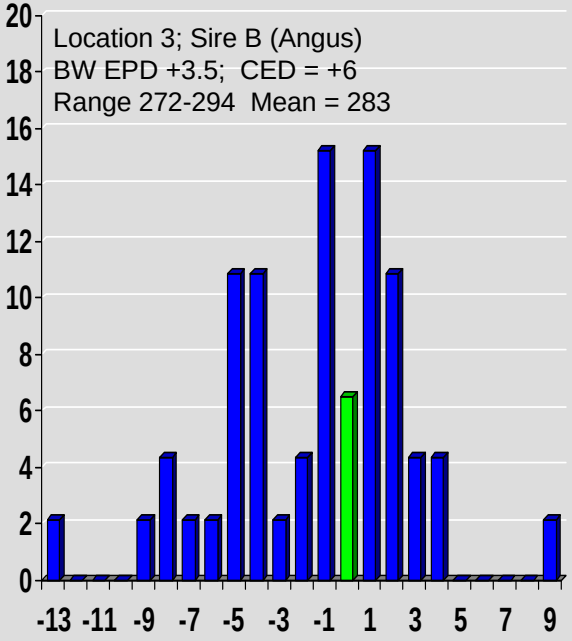
Do we know what to expect at calving from cows that conceive on the same day to the same sire?

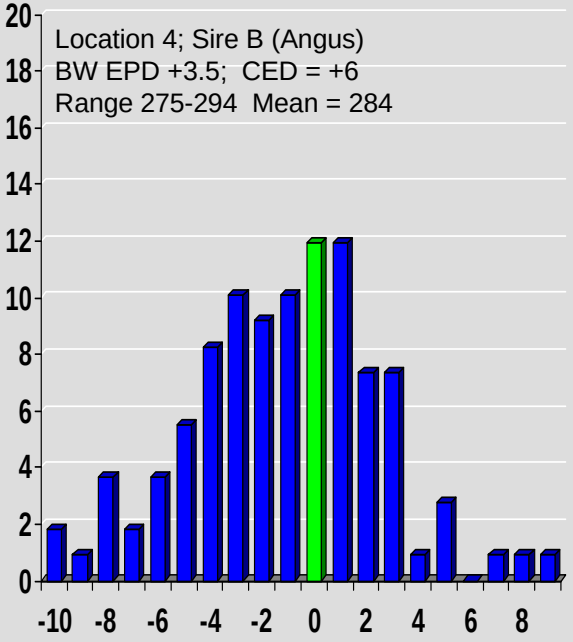

Location 1; Sire A (Angus)
BW EPD -0.3; CED = +11
Range 271-290 Mean = 281
20
18
16
14
12
10
8
6
4
2
0
-14 -12 -10 -8 -6 -4 -2 0 2 4


Location 1; Sire B (Angus)
BW EPD +3.5; CED = +6
Range 275-292 Mean = 281
20
18
16
14
12
10
8
6
4
2
0
-10 -8 -6 -4 -2 0 2 4 6 8


Location 1; Sire C (Angus)
BW EPD -1.1; CED = +11
Range 274-287 Mean = 281
20
18
16
14
12
10
8
6
4
2
0
-11 -9 -7 -5 -3 -1 1 3 5 7


Location 2; Sire D (Red Angus)
BW EPD +2.3; CED = -2
Range 273-300 Mean = 283
20
18
16
14
12
10
8
6
4
2
0
-12 -8 -6 -3 0 3 6 9 12 15

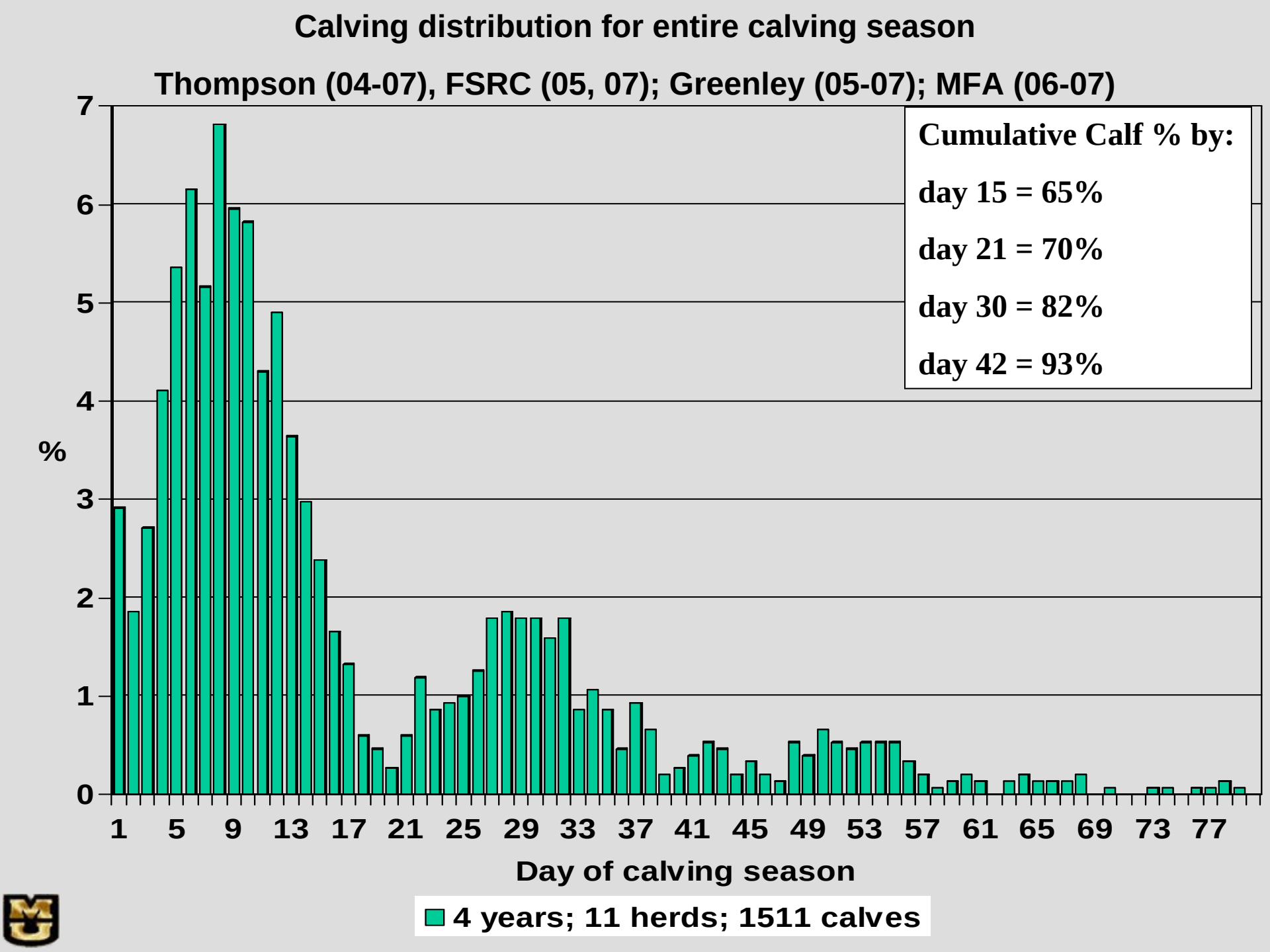

Location 3; Sire B (Angus)
BW EPD +3.5; CED = +6
Range 272-294 Mean = 283
20
18
16
14
12
10
8
6
4
2
0
-13 -11 -9 -7 -5 -3 -1 1 3 5 7 9

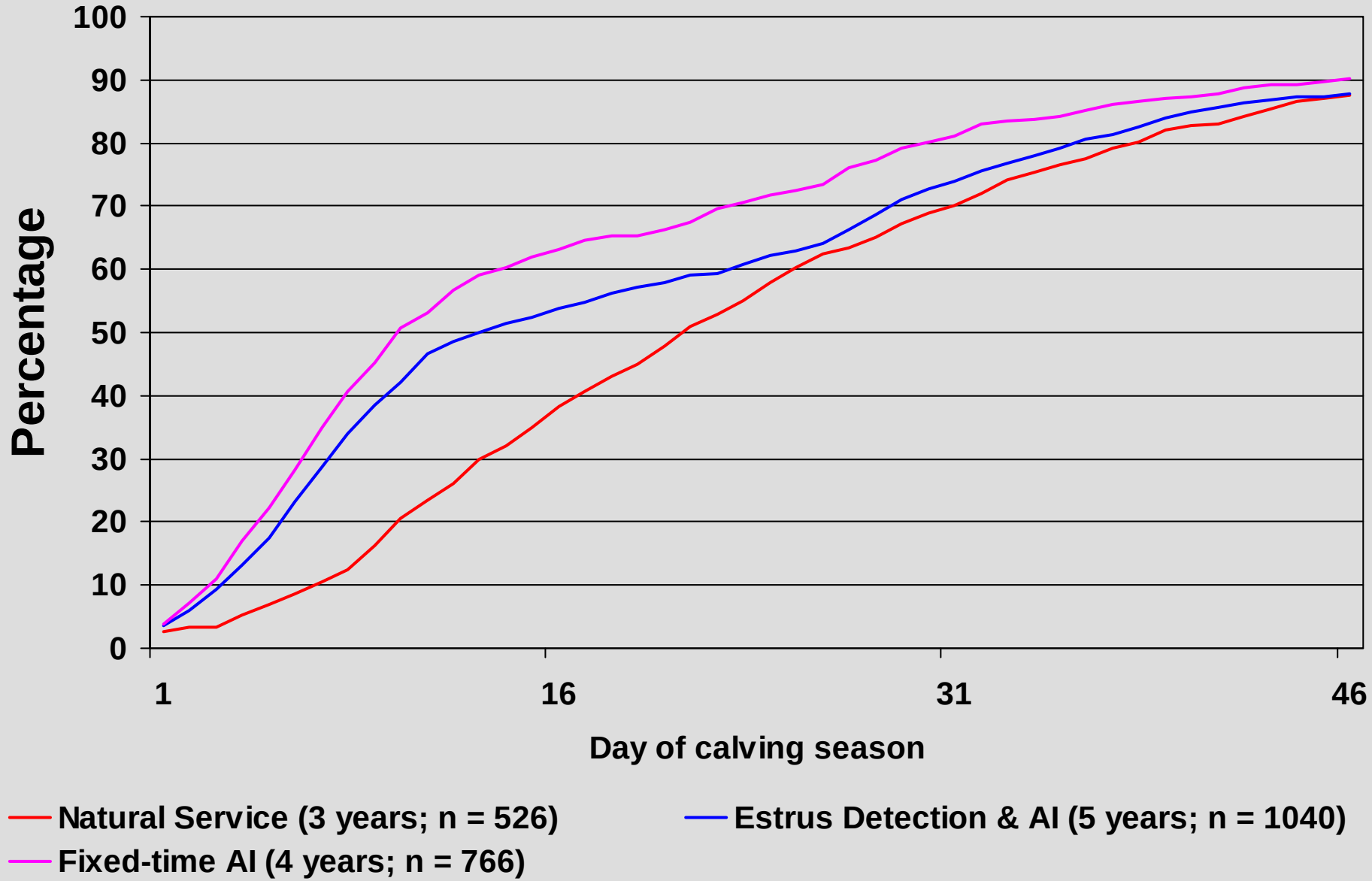

Location 4; Sire B (Angus)
BW EPD +3.5; CED = +6
Range 275-294 Mean = 284
20
18
16
14
12
10
8
6
4
2
0
-10 -8 -6 -4 -2 0 2 4 6 8

Consider the impact of estrus synchronization on calving distribution……

Hughes, 2005

- Opportunities for increasing profits lie in managing females from the later calving intervals forward toward the first and second calving intervals.
- High production herds see 61% of the calves born by day 21, 85% by day 42 and 94% by day 63.


Calving distribution for entire calving season
Thompson (04-07), FSRC (05, 07); Greenley (05-07); MFA (06-07)
Cumulative Calf % by:
day 15 = 65%
day 21 = 70%
day 30 = 82%
day 42 = 93%
%
0
1
2
3
4
5
6
7
1
5
9
13
17
21
25
29
33
37
41
45
49
53
57
61
65
69
73
77
Day of calving season
4 years; 11 herds; 1511 calves


Cumulative calf crops (MU Thompson Farm) for the first 46 days over 12 calving seasons
Percentage
100
90
80
70
60
50
40
30
20
10
0
1
16
31
46
Day of calving season
Natural Service (3 years; n = 526)
Estrus Detection & AI (5 years; n = 1040)
Fixed-time AI (4 years; n = 766)

- Improvements in methods to synchronize estrus create the opportunity to significantly expand the use of AI in the U.S. cowherd . . . . . .

Acknowledgements

Faculty, Students, & Staff

Faculty
Mike Smith
Matthew Lucy
Mark Ellersieck

Students
Jon Bader
Nicole Leitman
Daniel Mallory
Daniel Schafer
Jacob Stegner
George Perry
Dallas Wilson
Stacey Wood (Follis)

Research Specialists & Postdoctoral Fellows
Dan Busch
Naoto (Freddie) Kojima

Regional Extension Livestock Specialists
Roger Eakins
Al Kennett
Chris Zumbrunnen

MU Farms & Centers
David McAtee
Jon Schreffler
Randall Smoot
Dave Davis
Dennis Jacobs

Acknowledgements

Financial Support

Acknowledgements

Product support

Pfizer

Merial

IVX

Semen Support

ABS Global

Acclerated Genetics

Genex

Select Sires, Inc.

Acknowledgements

Cooperators

4-M Ranch

John Ranch

Jim Wallis Farms

Circle A Angus Ranch

Jim Clement, DVM

MFA, Inc.

SEMO University

MU Farms & Centers

Thompson Farm

Greenley Center

FSRC