The Future of Reproductive Management

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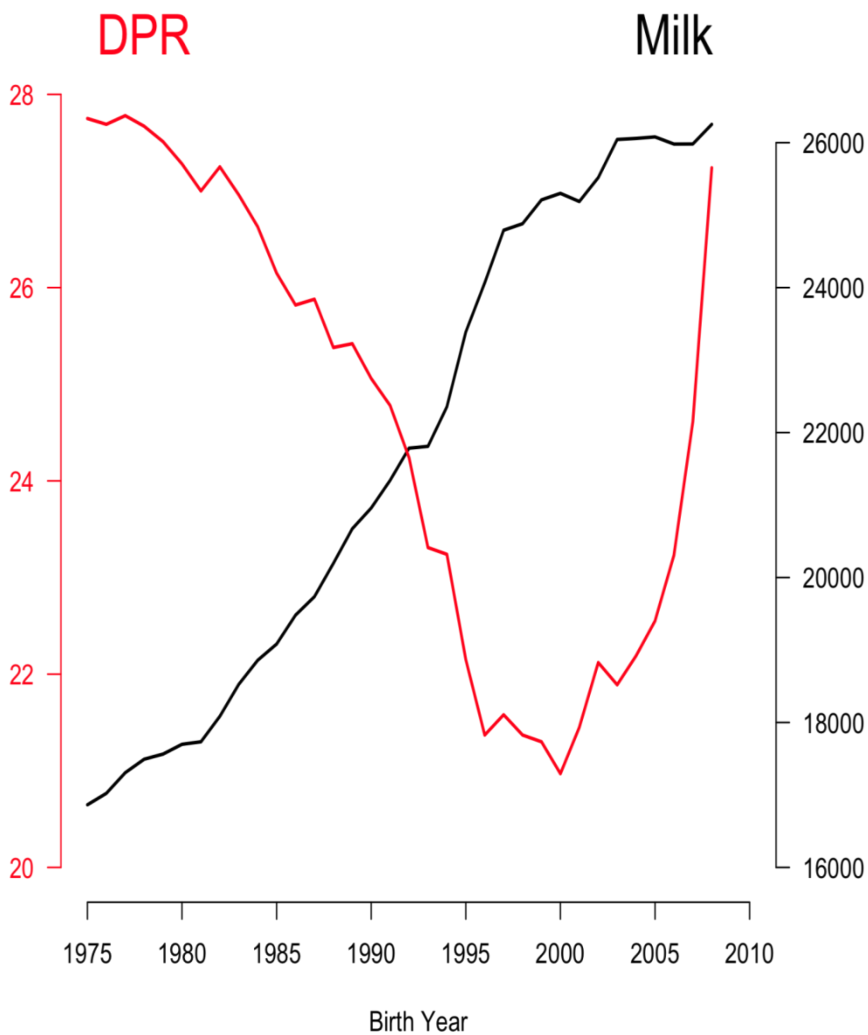
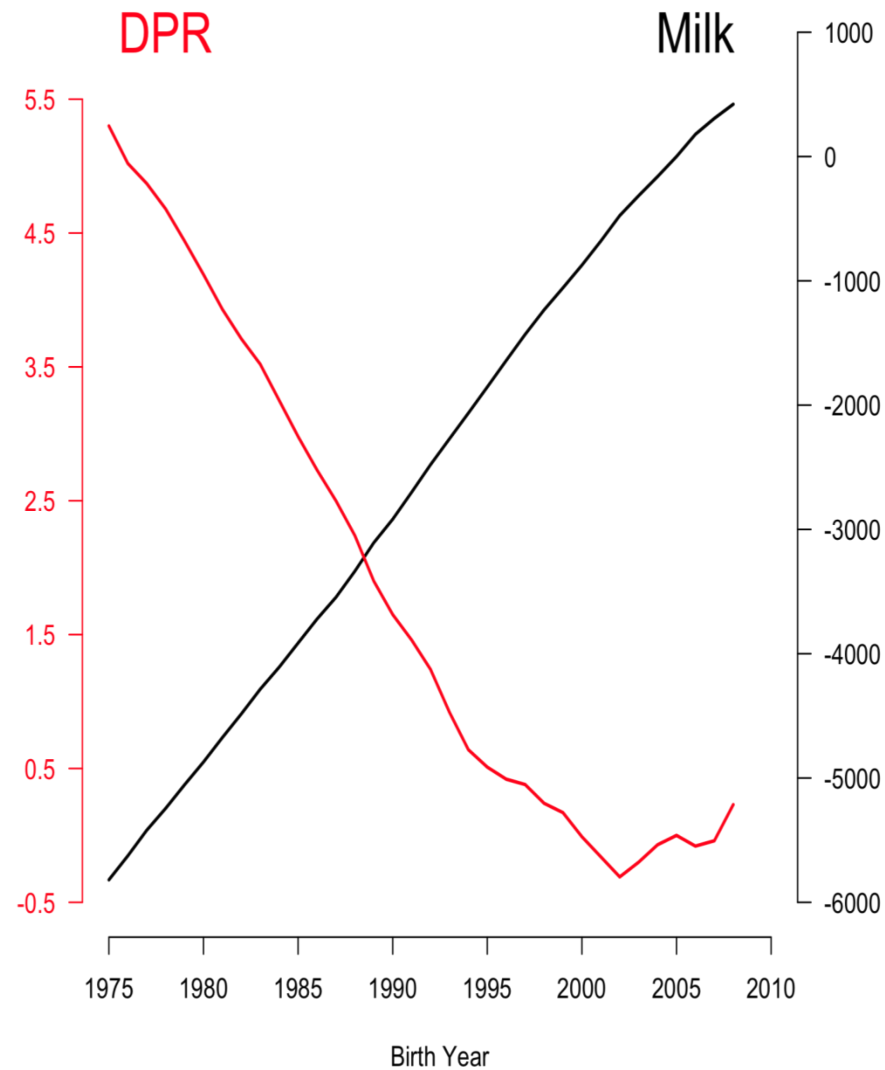
Phenotypic trend



Genetic trend



Animal Improvement Programs Laboratory ; ARS USDA

What Has Increased Efficiencies:

- Top 6 Tools:
  - 3 Times per day milk
  - Artificial insemination
  - Cow comfort (i.e. heat abatement)
  - Heifer age at first calving
  - Nutrition
  - Recombinant bovine somatotropin

- Other tools include:
  - Reproductive tools, vaccines, antibiotics, software, equipment, etc.

Elanco Science Symposium 2012

Advances in Reproductive Technologies and Genomics Offer Wider Use of Germplasm

- Heat Detection Systems
- Timed Artificial Insemination
- Ova Pick Up (OPU)
- Sex Sorted Sperm
- In Vitro Production of Embryos
- Embryo Transfer
- Genomic Evaluation of Young Sires, Dams, Calves

Technology Adapters:

- Dairies adopting reproductive technology in general are managed by relatively younger and more educated producers who do not work off-farm and plan to continue dairying for at least 10 yr (Khanal and Gillespie, 2010).

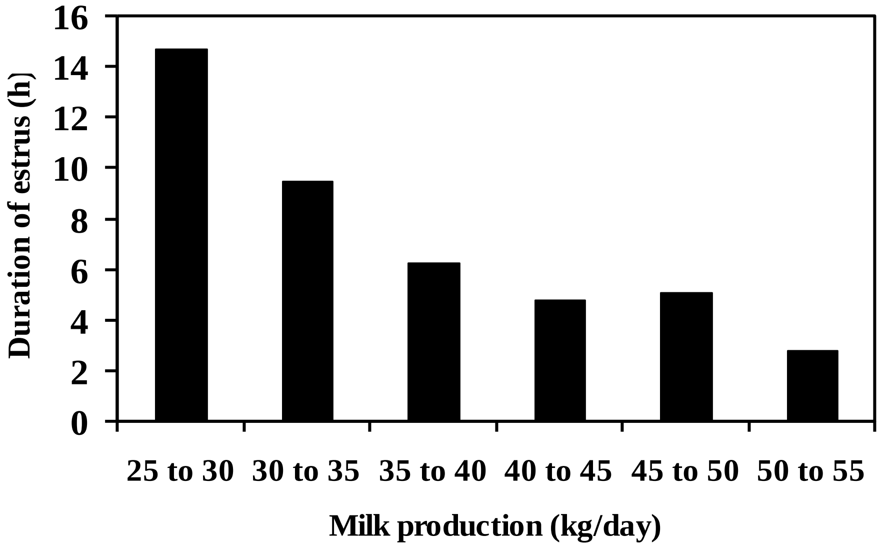
Progressive older adopters are mentors to all aspects of the dairy industry.

The Future is Now!

- The future is now from the perspective that current technology needs to be transferred more widely on to the dairies.
- Latest research is considered seriously if cost efficient to the producer, is viewed objectively, and not subject to miss-representation by third party interests that unfairly impacts the producer, support of research and technology development, and the consumer.

Estrous Detection is a Major Issue in High Producing Dairy Cows in Confinement Housing

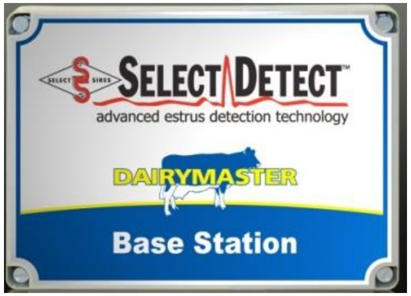
Wiltbank et al. (2006) Theriogenology 65:17-29



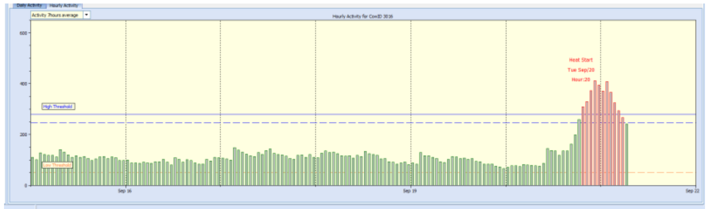
Three Basic Components

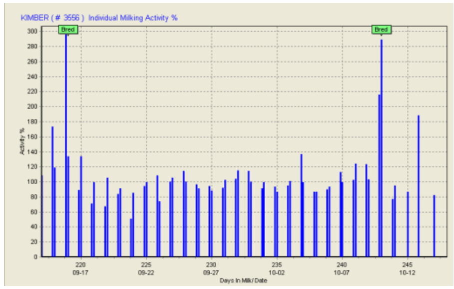
- **Sensor**

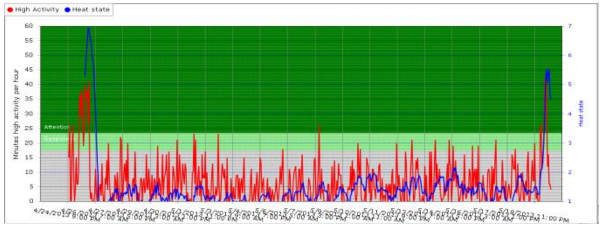
- **Hardware**



- **Software**







Ray Nebel, 2013

Systems that Interface with Milking Parlor

DeLaval

AfiKim

Dairymaster

Timed AI Optimized Fertility Programs

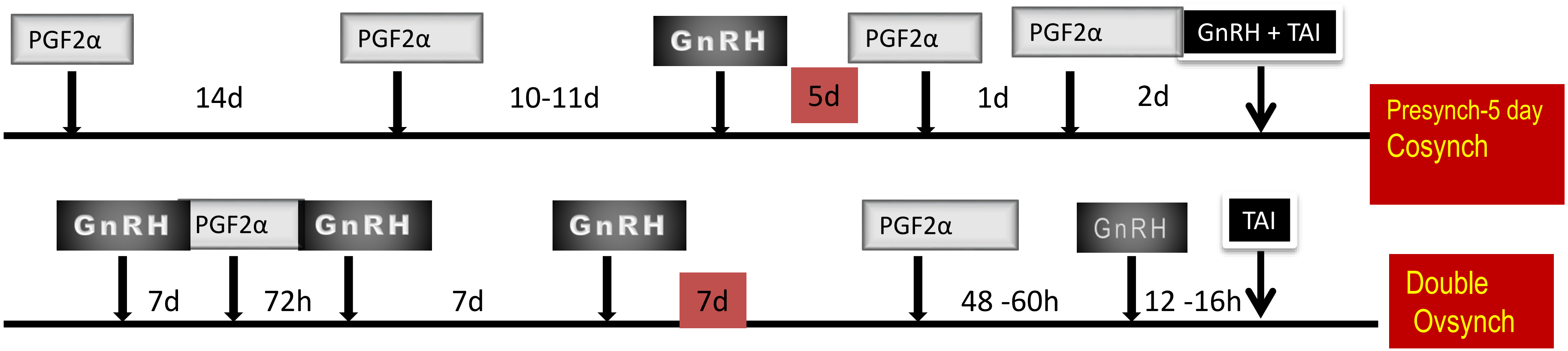
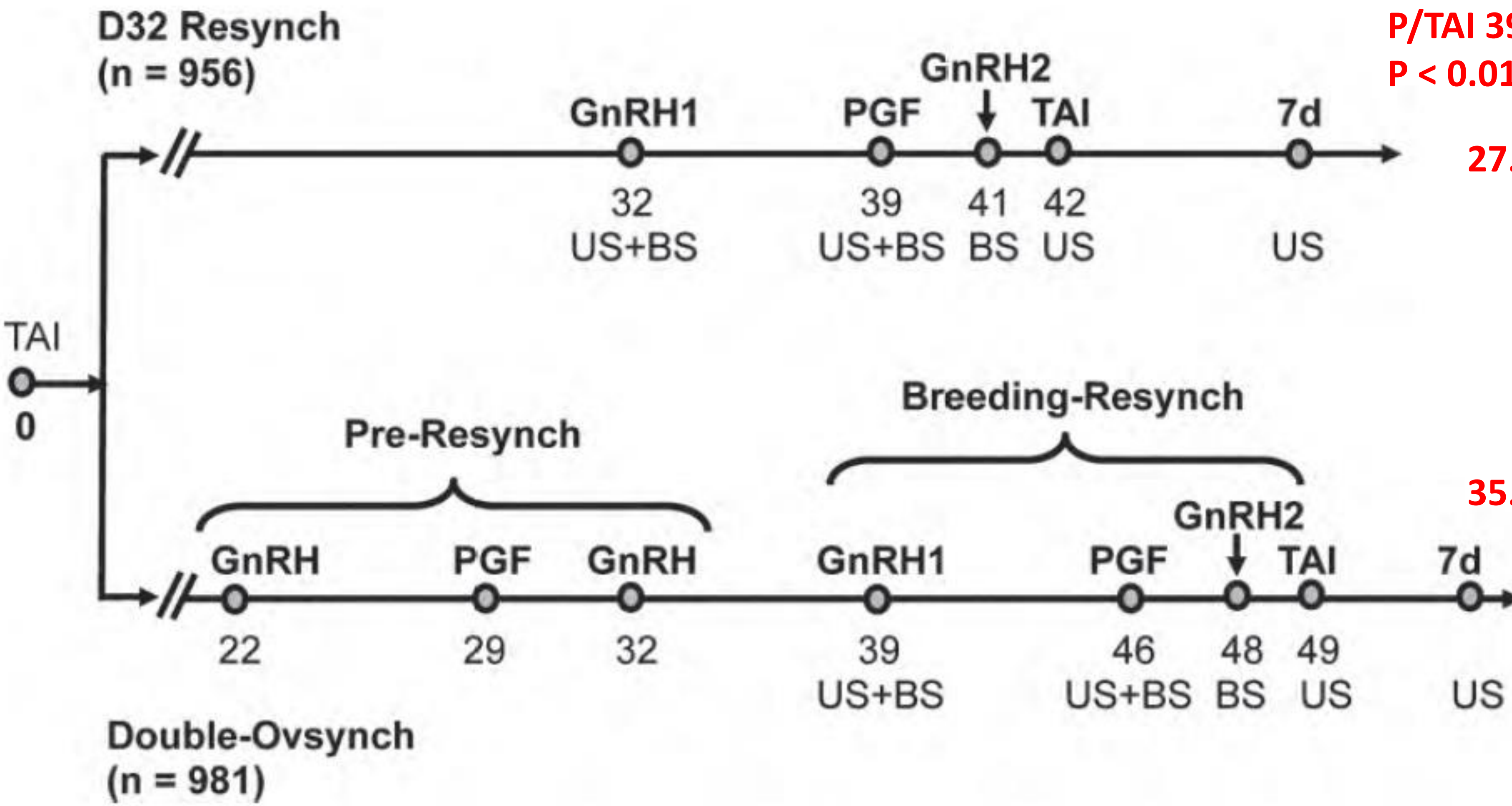


Figure 1. Diagram of the Presynch-5d Cosynch and Double-Ovsynch programs used for optimizing timed artificial insemination (TAI) in lactating dairy cows with the timely injections of GnRH and $PGF_{2\alpha}$.

Resynchronized Fertility Program



P/TAI 39d
P < 0.01

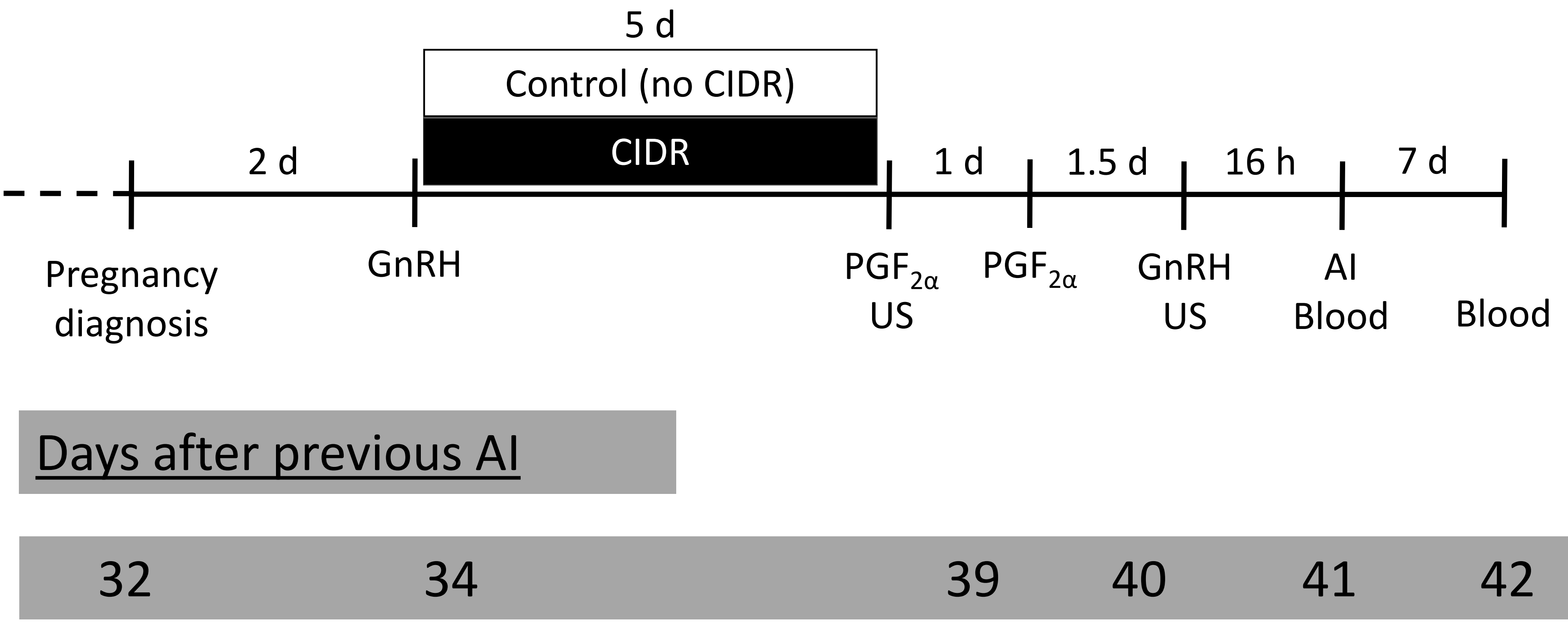
27.0%

35.3%

Giordano et al., (2012) J. Dairy Sci. 95:639-653.

Effect of Progesterone Supplementation During Resynchronization on Fertility of Dairy Cows

- 675 lactating cows (285 primiparous and 390 multiparous)
- Milked 3x/day (42.8 ± 0.4 kg/cow/day)



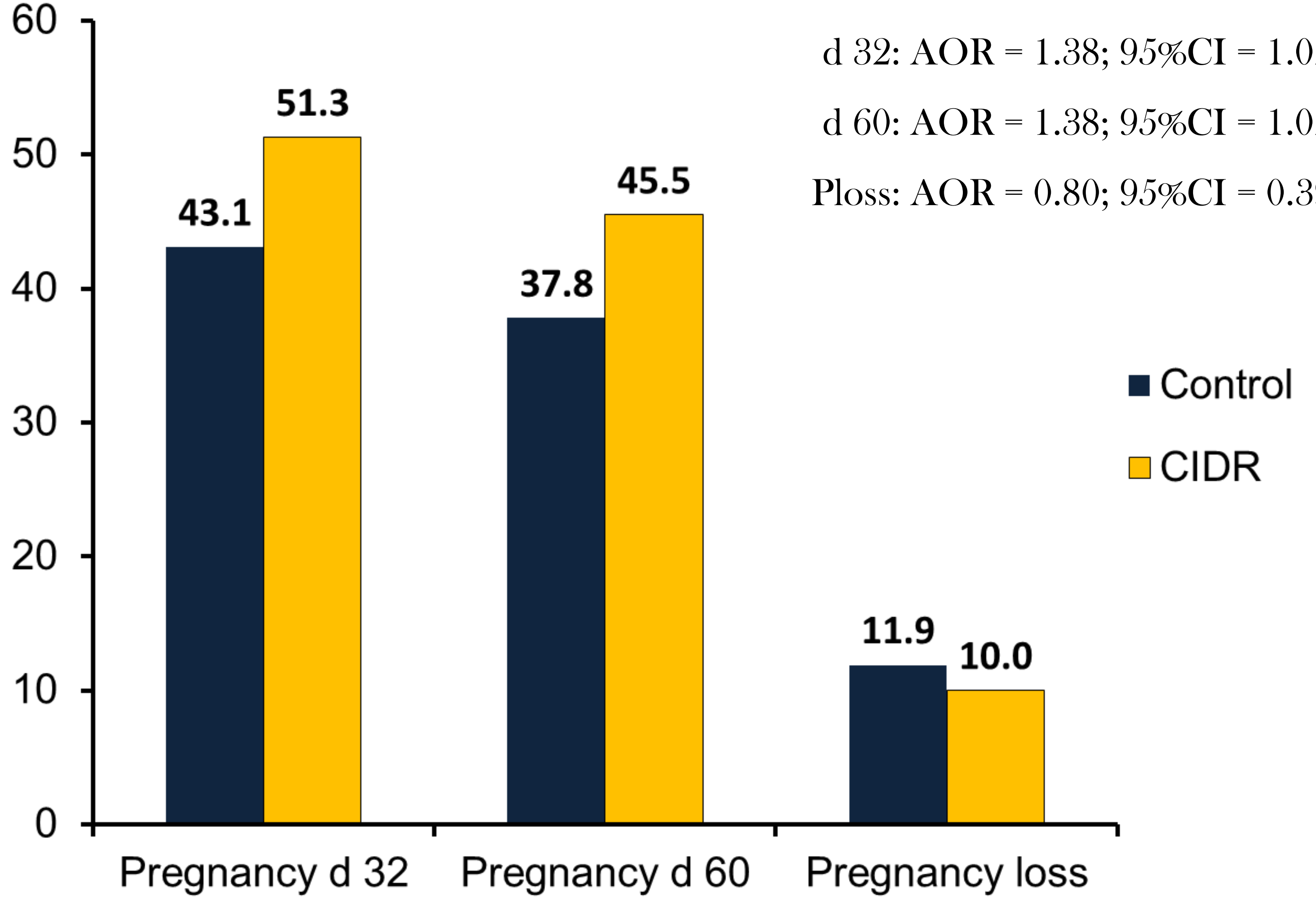
Bisinotto et al. (2010). *J. Dairy Sci.* 93:5798-5808.

Effect of Progesterone Supplementation During Resynchronization on Fertility of Dairy Cows

d 32: AOR = 1.38; 95%CI = 1.02-1.87; P = 0.04

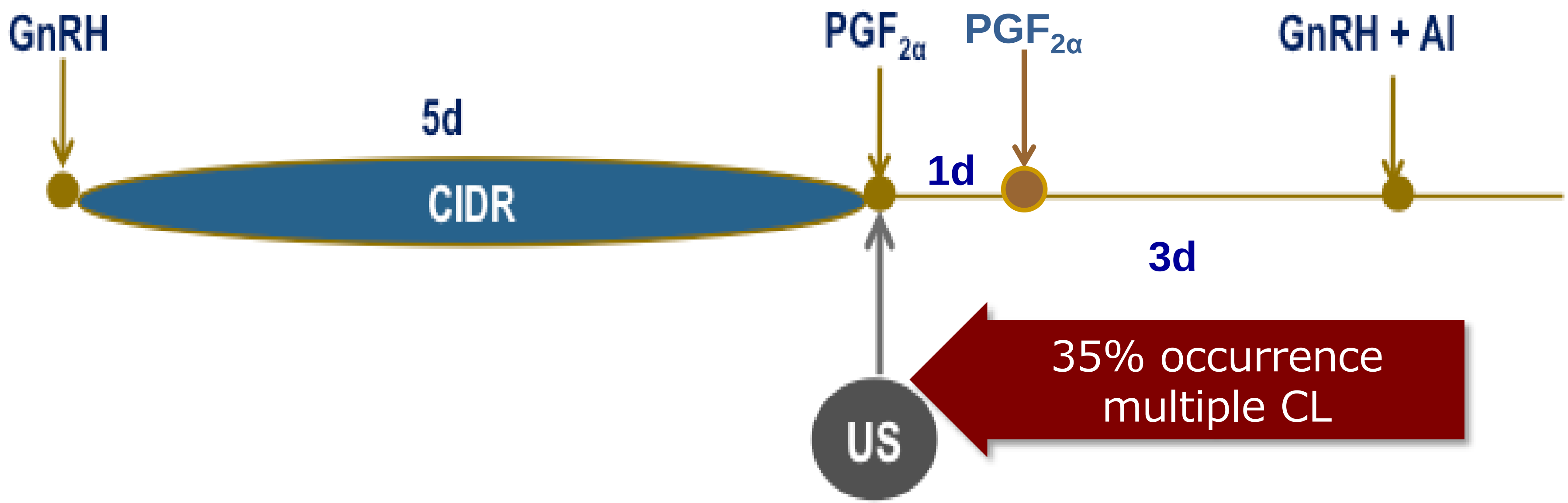
d 60: AOR = 1.38; 95%CI = 1.02-1.89; P = 0.04

Ploss: AOR = 0.80; 95%CI = 0.39-1.65; P = 0.55



Bisinotto et al. (2010). *J. Dairy Sci.* 93:5798-5808.

5-D TIMED AI PROGRAM FOR DAIRY HEIFERS



- Conventional semen:
  - 1 $PGF_{2α}$: 55.7% (845/1,518)
  - 2 $PGF_{2α}$: 61.7 (439/711)
- Sex-sorted semen:
  - 41.1% (663/1,614)

Rabaglino et al. (2010) J. Dairy Sci. 93:1050-1058
Lima et al., (2013) J. Dairy Sci. 96: 1-12

Cost per pregnancy (US $) according to reproductive program used for 1st breeding postpartum

Program	Semen	Pregnancy per AI or per embryo transfer. %										
		65.0	60.0	55.0	50.0	45.0	40.0	35.0	30.0	25.0	20.0	15.0
ET	Conv.	216.2	240.9	270.0	305.0	347.8	**401.3**	470.1	561.7	690.1	882.6	1.203.5
	Sexed	373.3	411.0	455.7	509.2	574.7	**656.5**	761.8	902.1	1.098.5	1.393.1	1.884.1
IVP-OPU	Conv.	235.6	261.9	293.0	330.3	375.9	**432.9**	506.2	603.9	740.7	945.8	1.287.8
	Sexed	267.4	296.3	330.5	371.6	421.8	**484.5**	565.1	672.6	823.2	1.048.9	1.425.3
IVP-Slaughter	Conv.	192.2	214.9	241.7	273.8	313.2	**362.3**	425.5	509.7	627.7	804.6	1.099.5
	Sexed	199.9	223.2	250.8	283.8	324.3	**374.8**	439.8	526.4	647.7	829.6	1.132.8
Timed AI	Conv.	72.0	84.7	99.6	117.6	139.6	167.0	202.3	249.3	315.2	414.0	578.7
	Sexed	90.5	104.7	121.5	141.6	166.2	197.0	236.6	289.3	363.2	474.0	658.7
Timed AI + ED	Conv.	68.1	80.4	95.0	112.5	133.9	**160.6**	195.0	240.8	305.0	**401.3**	561.7
	Sexed	86.5	100.4	116.8	136.5	160.6	**190.6**	229.3	280.8	353.0	**461.3**	641.7

Ribeiro *et al.* (2012) Anim. Reprod. 3:370-387

Technological Strategies Dealing with the Transition Period and Postpartum Health

- High fertility reproductive management platforms identified the need to optimize the unique health, metabolic and endocrine challenges encountered in the transition/postpartum periods to further improve fertility.
- Low fertility is associated with interrelated factors such as:
  - negative energy balance (NEB),
  - body condition score,
  - dystocia,
  - retained fetal membranes
  - twinning,
  - stillbirths,
  - metritis, and endometritis,
  - inadequate attention to:
    - nutrition, animal comfort, and housing.

The dairy producer in the future needs to undertake a holistic approach to optimize herd fertility.

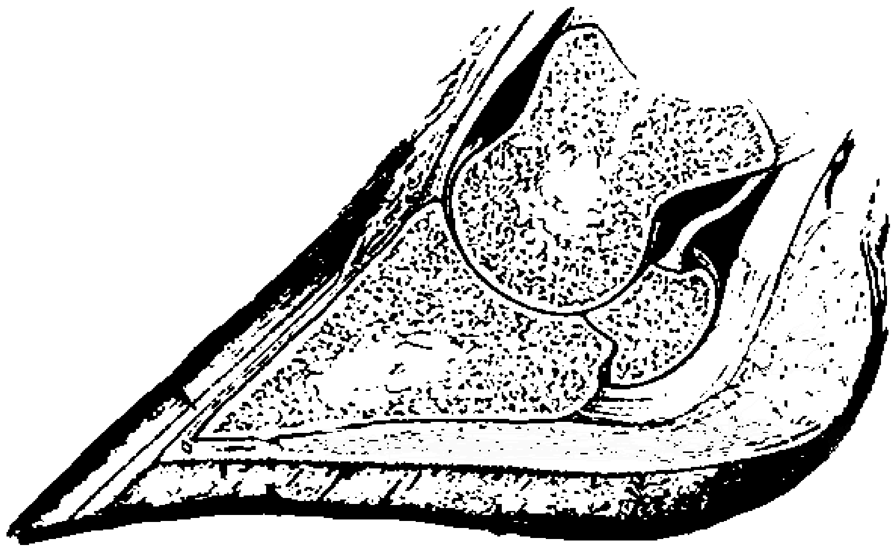
Body Condition Score Dynamics with Reproduction in 6396 Lactating Dairy Cows from four Dairies

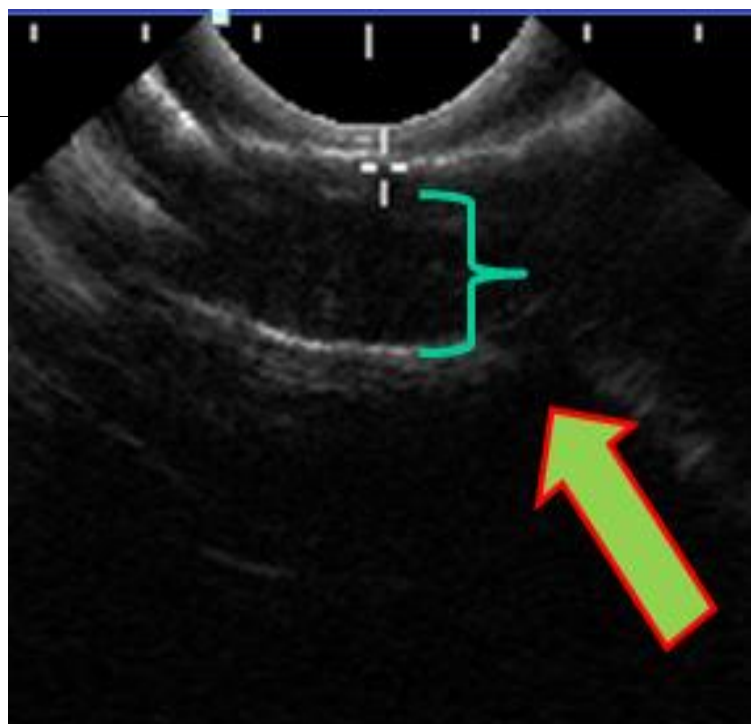
	Pregnancy Response				
	30 Day	**% Pregnant**	**58 Day**	**% Pregnant**	**Pregnancy Loss (30-58) Days**
BCS Change					
Lost ≥1 unit	28.0	(132/472) **	22.3	(105/472) **	20.5 (27/132) **
Lost <1 unit	37.3	(1204/3230)	31.7	(1020/3220)	14.5 (174/1197
No Change	41.6	(1008/2422)	37.2	(900/2422)	10.7 (108/1008)

* P<0.05; ** P<0.01

Santos JEP etal., (2009) Anim Reprod Sci 110:207–21.

Lameness





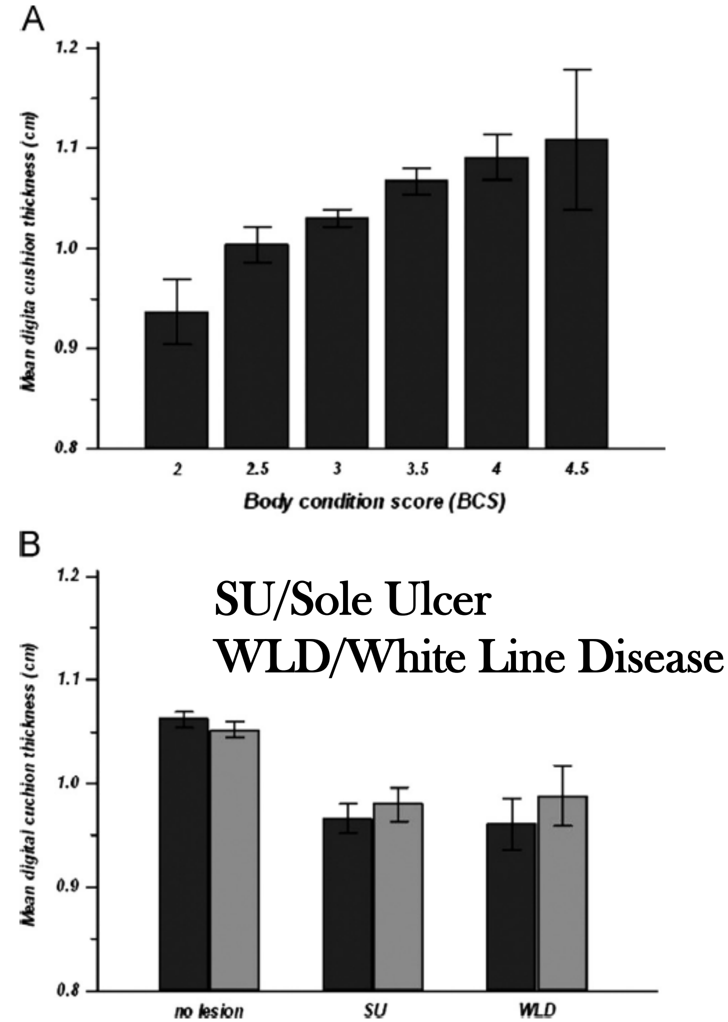
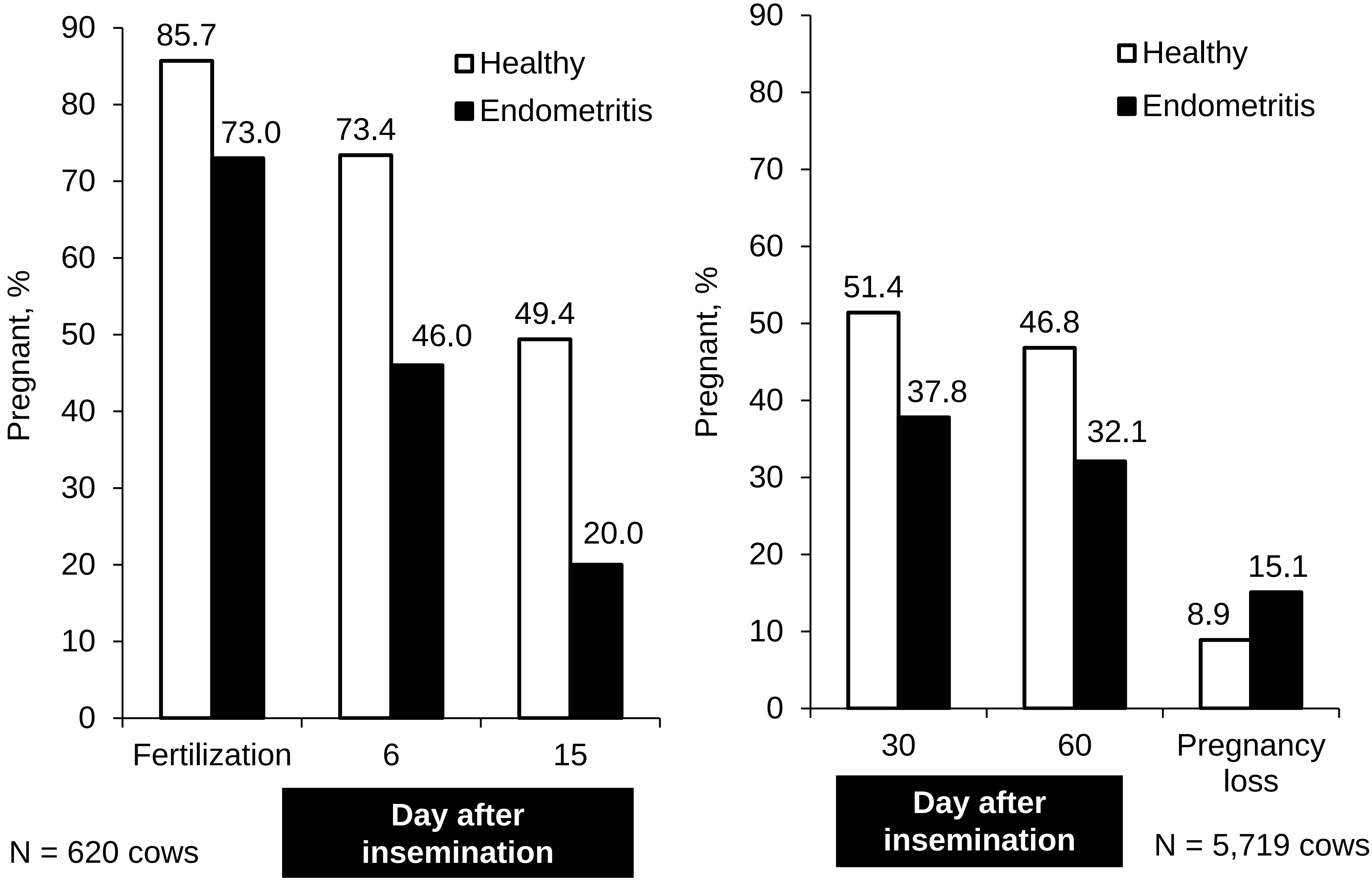


Fig. 4. (A) Mean digital cushion thickness by body condition score (BCS). (B) Mean digital cushion thickness at dry-off for cows that were not diagnosed with claw horn disruption lesions (CHDL) at dry-off examination (first dark gray bar), cows without CHDL in the subsequent lactation (first light gray bar), cows with sole ulcers (SU) at dry-off (second dark gray bar), cows with SU in the subsequent lactation (second light gray bar), cows with white line disease (WLD) at dry-off (third dark gray bar), and cows with WLD in the subsequent lactation (third light gray bar).

Bicalho et al., (2009) J. Dairy Sci. 32:3175-3184

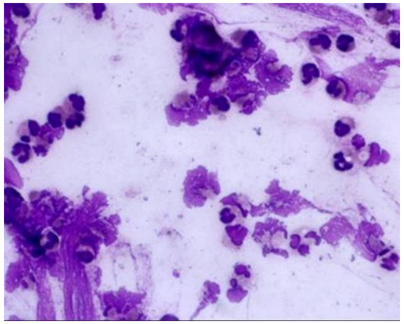


Bisinotto *et al.* (2012) *Anim. Reprod*. 9:260-272

Santos *et al.* (2012) *Soc. Reprod. Fertil.* Suppl. 67:387-403.

Figure 3. Impact of endometritis on establishment and maintenance of pregnancy in dairy cows

Based on the literature and previous studies



Several risk factors: NEB, DMI, DOA, parity, RP, Ease, twins, …

Metritis is diagnosed.
Sick cows will have heavy anaerobic contamination

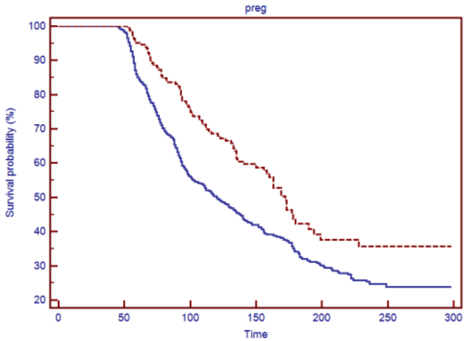
Subclinical endometritis; A. pyogenes?, inflamation and no bacteria?

parturition | 0-3 DIM | 7-14 DIM | 20-35 DIM | 35-45 DIM | > VWP

Fimbriated E. coli contamination is the # 1 cause uterine diseases

T. Pyogenes and F. necrophorum cause clin. endometritis

Metritis, CE, and SCE will impact repro performance



Vaccine Formulation

Bicalho R., Cornell University, personal communication, 2013

- Inactivated Cells:
  - *Escherichia coli,*
  - *Truperella pyogenes*
  - *Fusobacterium necrophorum* are the primary bacterial causes of uterine
  - diseases
- Immunogenic Proteins:
  - FimH, an *E. coli* type 1 pilus adhesive protein
  - LKT, *F. necrophorum* leukotoxin; virulence factor
  - PLO, *T. pyogenes* pyolysin; cholesterol-dependent cytolysins
- Vaccines Immunized 230 and 260 d of Pregnancy
  - Vac. 1 Cells + Proteins: **Subcutaneous**
  - Vac. 2 Proteins: **Subcutaneous**
  - Vac. 3 Cells: **Subcutaneous**
  - Vac. 4 Cells + Proteins: Intravaginal
  - Vac. 5 Proteins: Intravaginal

Effects of different vaccine formulations on incidence of researcher diagnosed puerperal metritis. Vaccines were evaluated separately in Model 1, and grouped in Model 2.

Model and variables	Puerperal metritis incidence (%)	Percent (%) Reduction	Odds ratio (95% CI)	P-value
Model 1				
Control, n=105	12.12	Referent	baseline	0.21
Vaccine 1, n=54	6.25	-48.4	0.48 (0.13 – 1.80)	
Vaccine 2, n=53	4.08	-66.3	0.31 (0.07 – 1.44)	
Vaccine 3, n=53	2.04	-83.1	0.15 (0.02 – 1.20)	
Vaccine 4, n=53	13.46	+11.2	1.13 (0.41 – 3.01)	
Vaccine 5, n=53	14.00	+15.5	1.18 (0.43 – 3.21)	
Model 2				
Control	12.12	Referent	baseline	0.03
Subcutaneous	4.11	-66.1	0.31 (0.11 – 0.86)	
Intravaginal	13.73	+13.3	1.15 (0.50 – 2.63)	

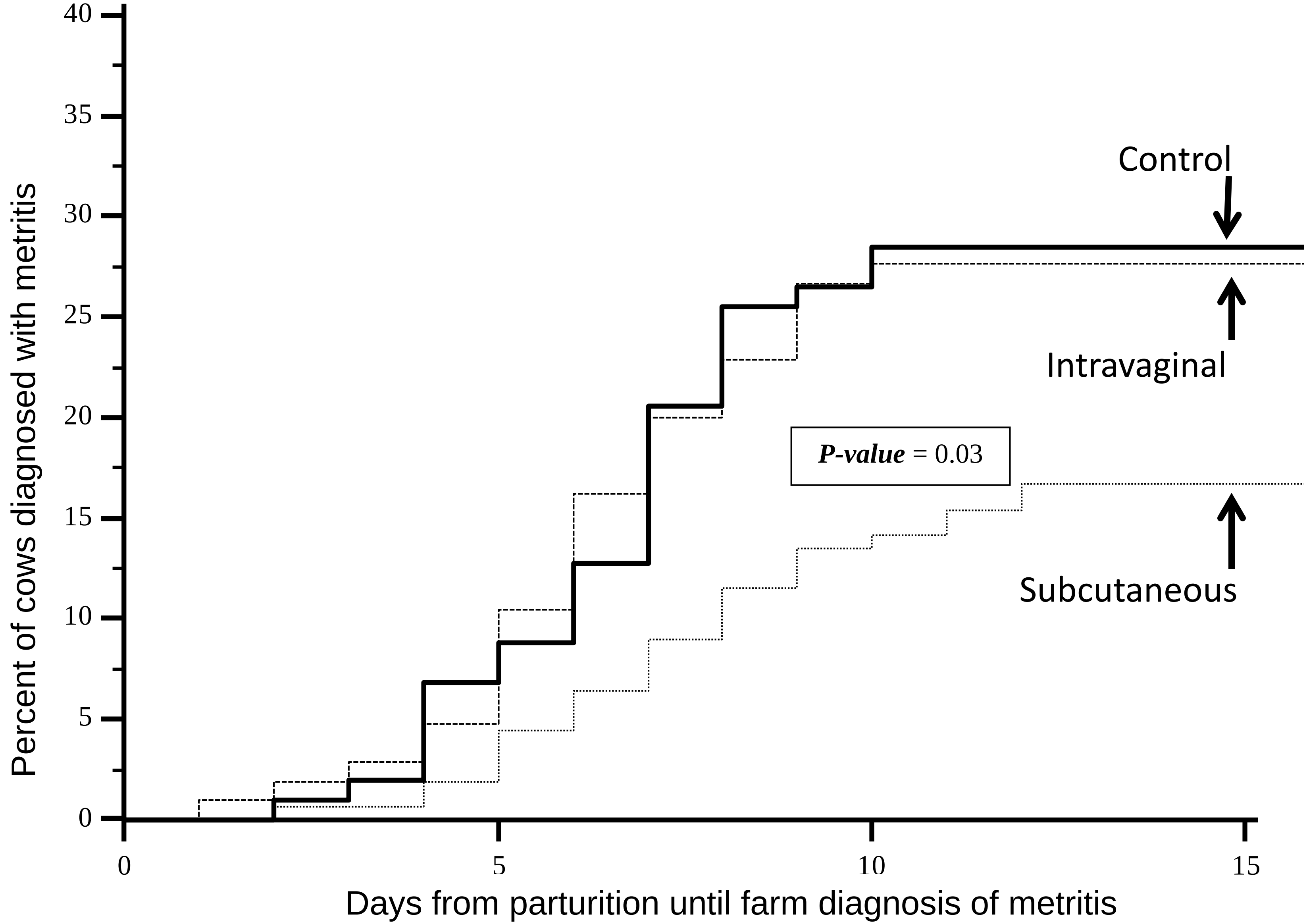


Figure 3: Kaplan-Meier survival analysis illustrating the effect of vaccination group (Control = solid line, intravaginal = long dashed line, and subcutaneous= short dashed line). Bicalho R., Cornell University, personal communication, 2013)

Prepartum nutritional strategy affects reproductive performance in dairy cows

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†Department of Population Medicine, Ontario Veterinary College, University of Guelph, Guelph, ON, Canada N1G 2W1

Cardoso et al., (2013) J. Dairy Sci.96:5859

Table 4. Least squares means of blood metabolites and liver composition from Holstein cows fed diets with different energy densities prepartum[1]

			FO[3]			CU[4]			
Variable	Week[2]	n	HE[5]	CE[6]	*P*-value	HE	CE	SEM	*P*-value
Blood									
NEFA (µEq/L)	−2	351	251.74	224.30	0.15	181.09	311.81	1.12	<0.01
	−1	349	456.05	408.10	0.14	362.60	513.27	1.12	<0.01
	1	346	816.56	667.14	<0.01	739.96	736.20	1.17	0.93
	2	309	617.95	508.11	0.01	597.05	525.89	1.21	0.09
	3	331	345.64	271.84	<0.01	330.56	284.21	1.20	0.05

Cows that received CE diets during the last 3 wk before calving had fewer days to a subsequent pregnancy compared with cows that consumed HE diets (157 < 167 d; HR = 0.696; 95% CI = 0.5 to 0.9; *P = 0.04).*

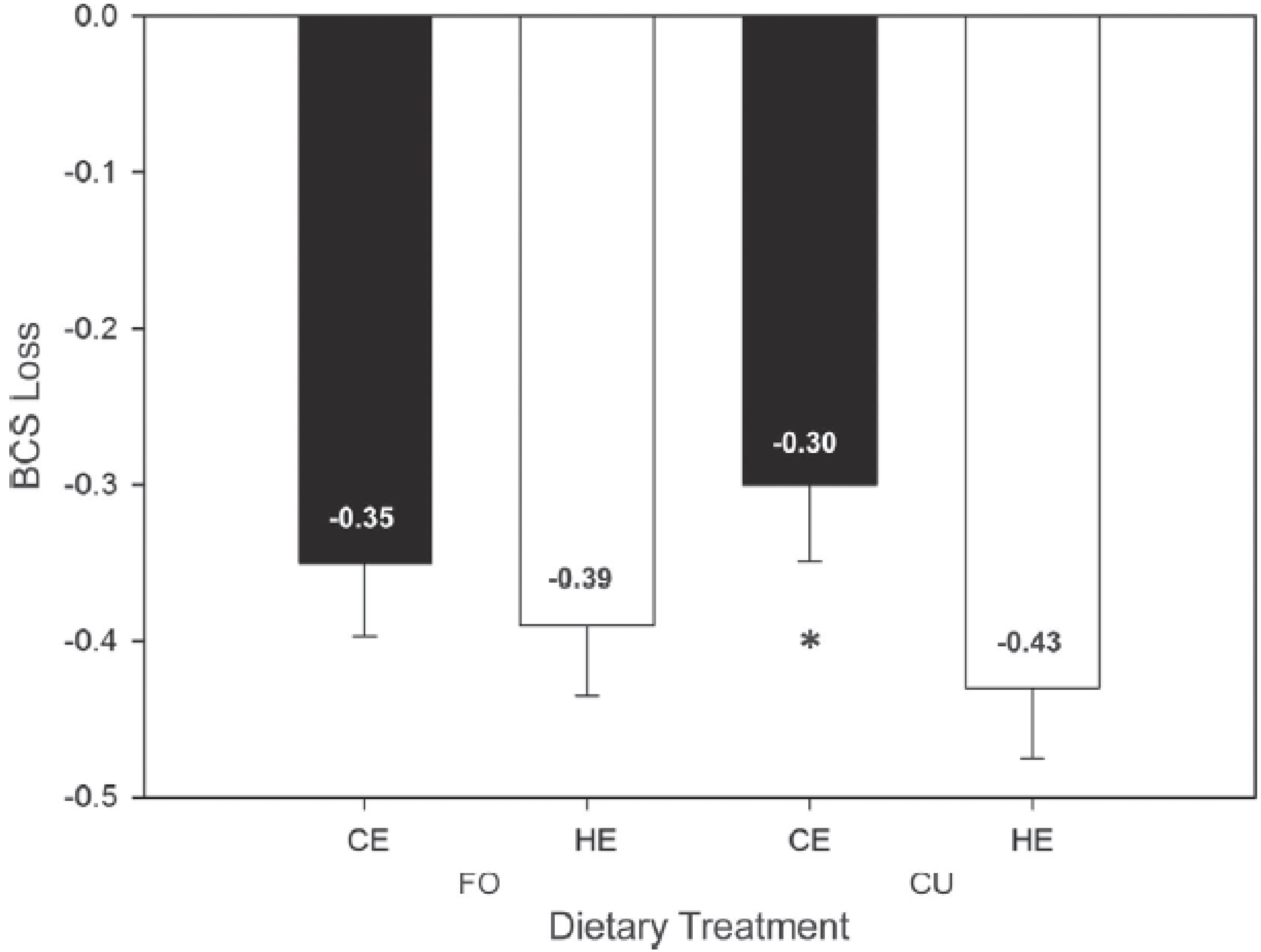


Figure 1. Least squares means and SE for BCS (1 to 5 scale) loss from wk 1 to wk 6 postpartum for cows receiving different dietary treatments prepartum. CU = close-up period; FO = far-off period; HE = high-energy diet; CE = controlled-energy diet (see Table 2). $^{*}P = 0.04$.

Monitoring Milk Composition to Access Metabolic and Health Status as Related to Reproductive Performance

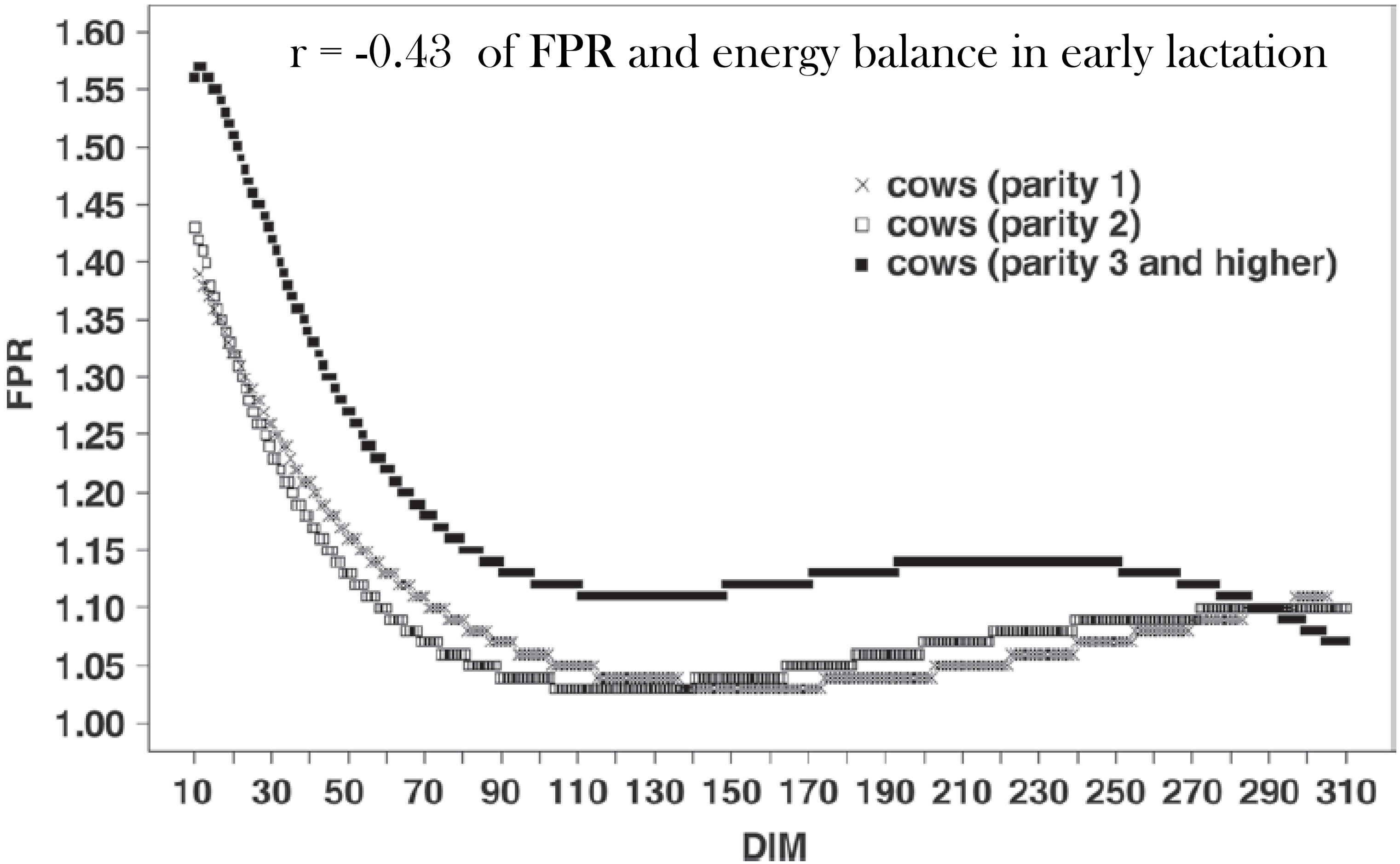


Figure 3. Lactation curves for fat:protein ratio (FPR) of cows in first, second and ≥ third parities. Buttchereit etal. (2010) J. Dairy Sci. 93:1702-1712

Acta argiculturae Slovenica, Supplement 3, 155–159, Ljubljana 2012

Liga PAURA [1], Daina JONKUS, Diana RUSKA

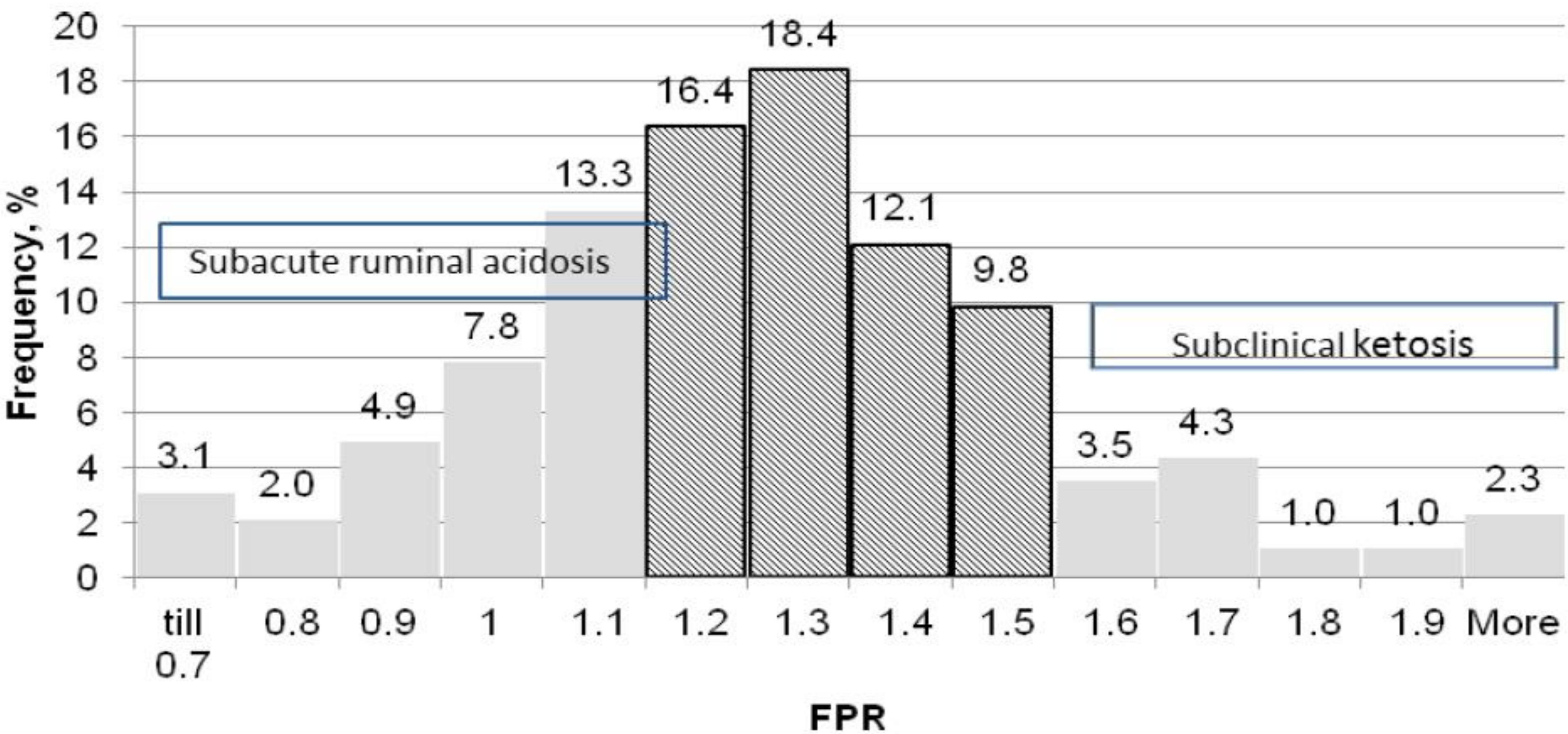


Figure 5: Distribution of FPR in milk of LB and HF cows in the first and second lactation phase

Genetic associations of test-day fat:protein ratio with milk yield, fertility, and udder health traits in Nordic Red cattle

E. Negussie ,1 I. Strandén , and E. A. Mäntysaari. J. Dairy Sci. (2013) 96 :1237–1250

Table 2. Heritability (diagonal)1 and genetic correlation (below diagonal) and phenotypic correlation (above diagonal) between test-day milk fat:protein ratio (FPR) and fertility traits calving to first insemination (DFI), days open (DO), number of inseminations (NI), nonreturn rate to 56 d (NRR), and clinical mastitis (CM) for selected DIM

	FPR at DIM						
Trait	30	60	110	160	210	260	310
FPR at DIM							
30	**0.16***	0.49*	0.35*	0.22	0.16	0.13	0.12
60	0.96*	**0.19***	0.38*	0.29*	0.22	0.18	0.16
110	0.87*	0.97*	**0.23***	0.35*	0.30*	0.26*	0.22
160	0.79*	0.92*	0.99*	**0.25***	0.35*	0.31*	0.26
210	0.71*	0.86*	0.95*	0.99*	**0.25***	0.34*	0.28*
260	0.66*	0.81*	0.91*	0.96*	0.99*	**0.25***	0.30*
310	0.61*	0.74*	0.82*	0.88*	0.93*	0.98*	**0.24***
DFI	0.28*	0.14*	0.05	−0.01	−0.04	−0.04	−0.01
DO	0.24*	0.19*	0.13	0.09	0.05	0.03	0.03
NI	0.03	0.02	−0.01	−0.01	−0.09	−0.15	−0.21
NRR	0.01	0.01	0.02	0.04	0.06	0.09	0.12
CM	0.19*	0.21*	0.21*	0.20	0.18	0.16	0.12

Online Technology to Precisely Integrate Cow Biological Windows to Achieve Reproductive Potential

Plus…

Subclinical mastitis

Ketosis

Progesterone serial testing

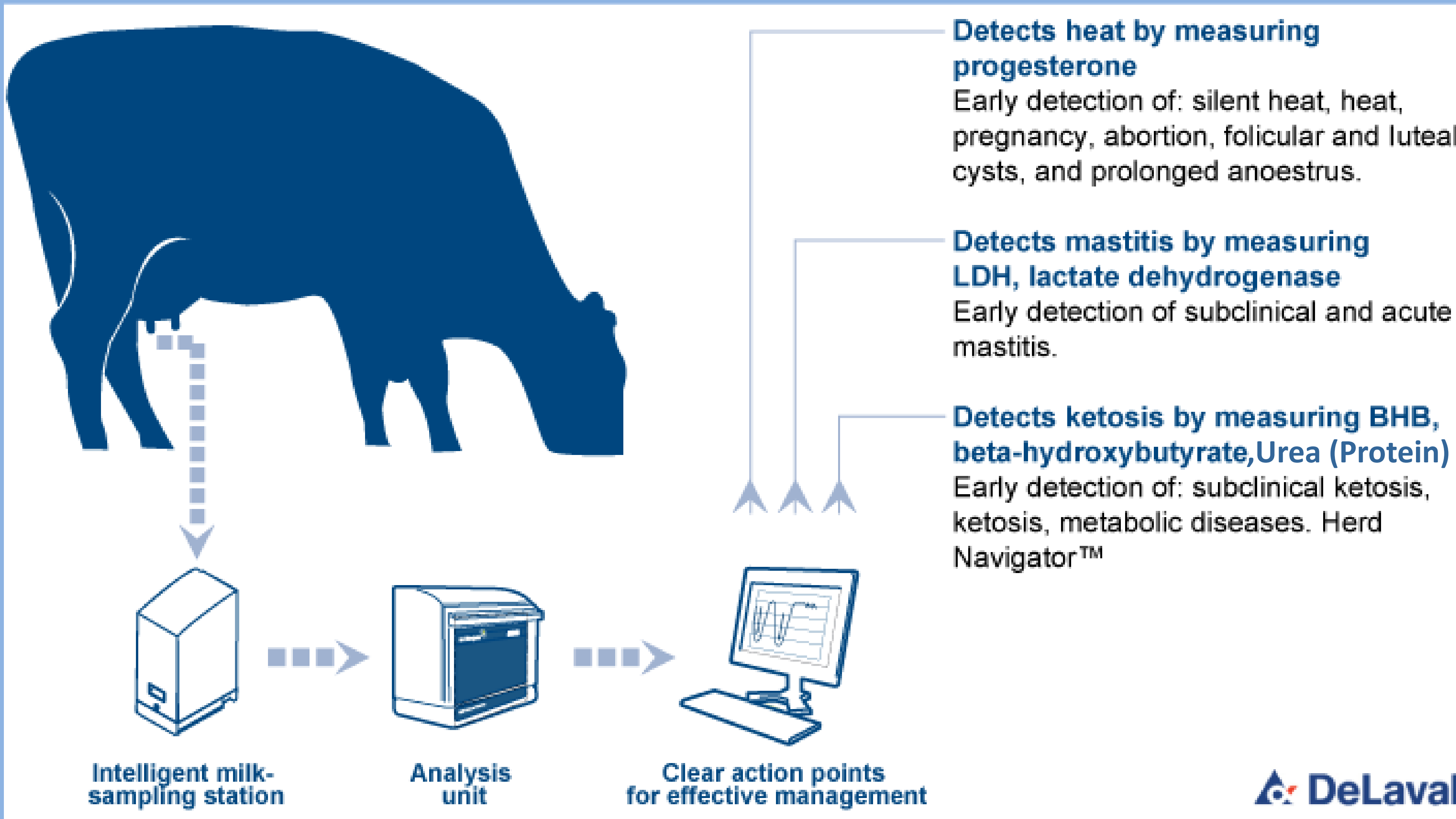
Milk components

Milk yield

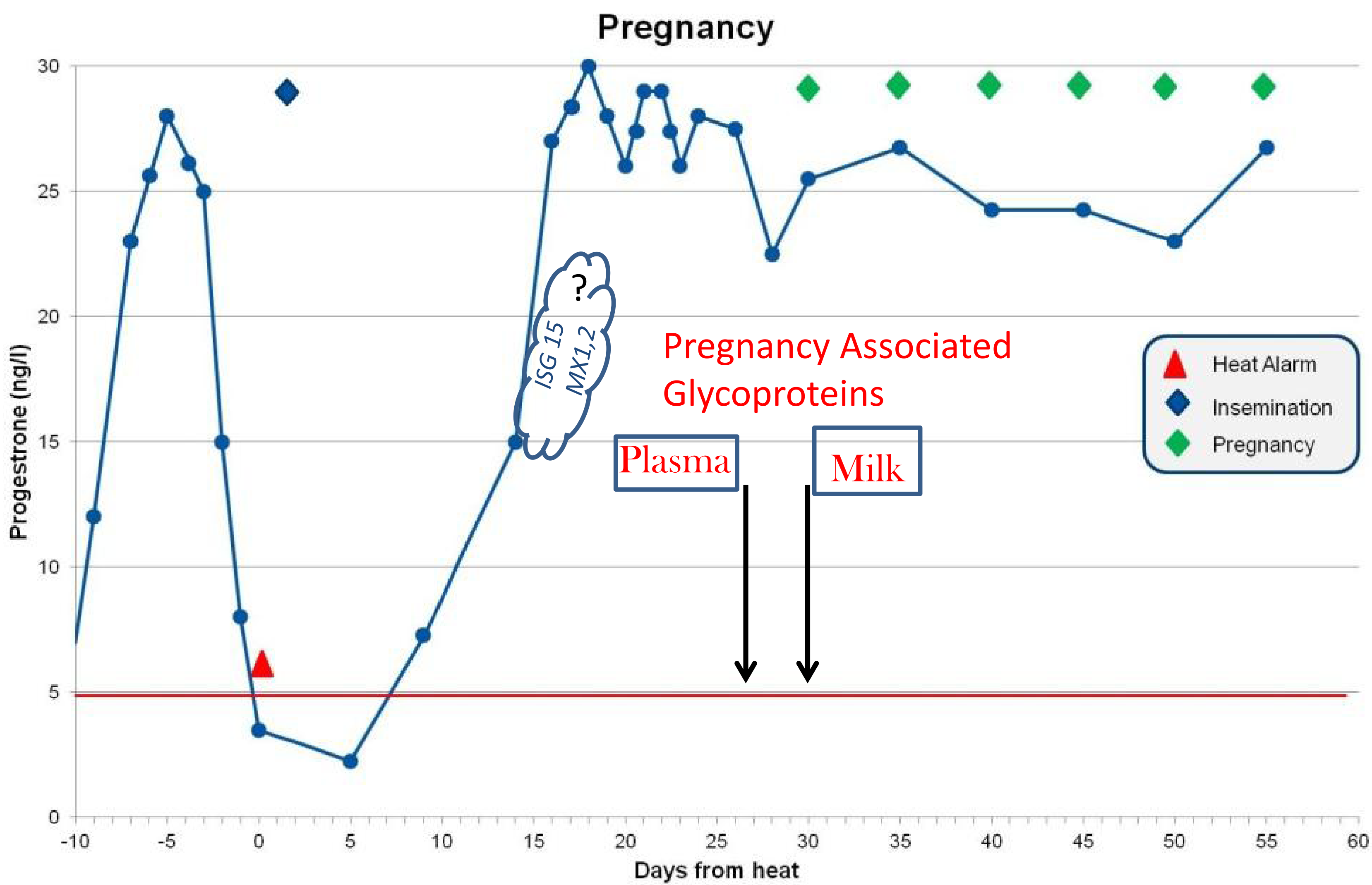
Rumen temperature

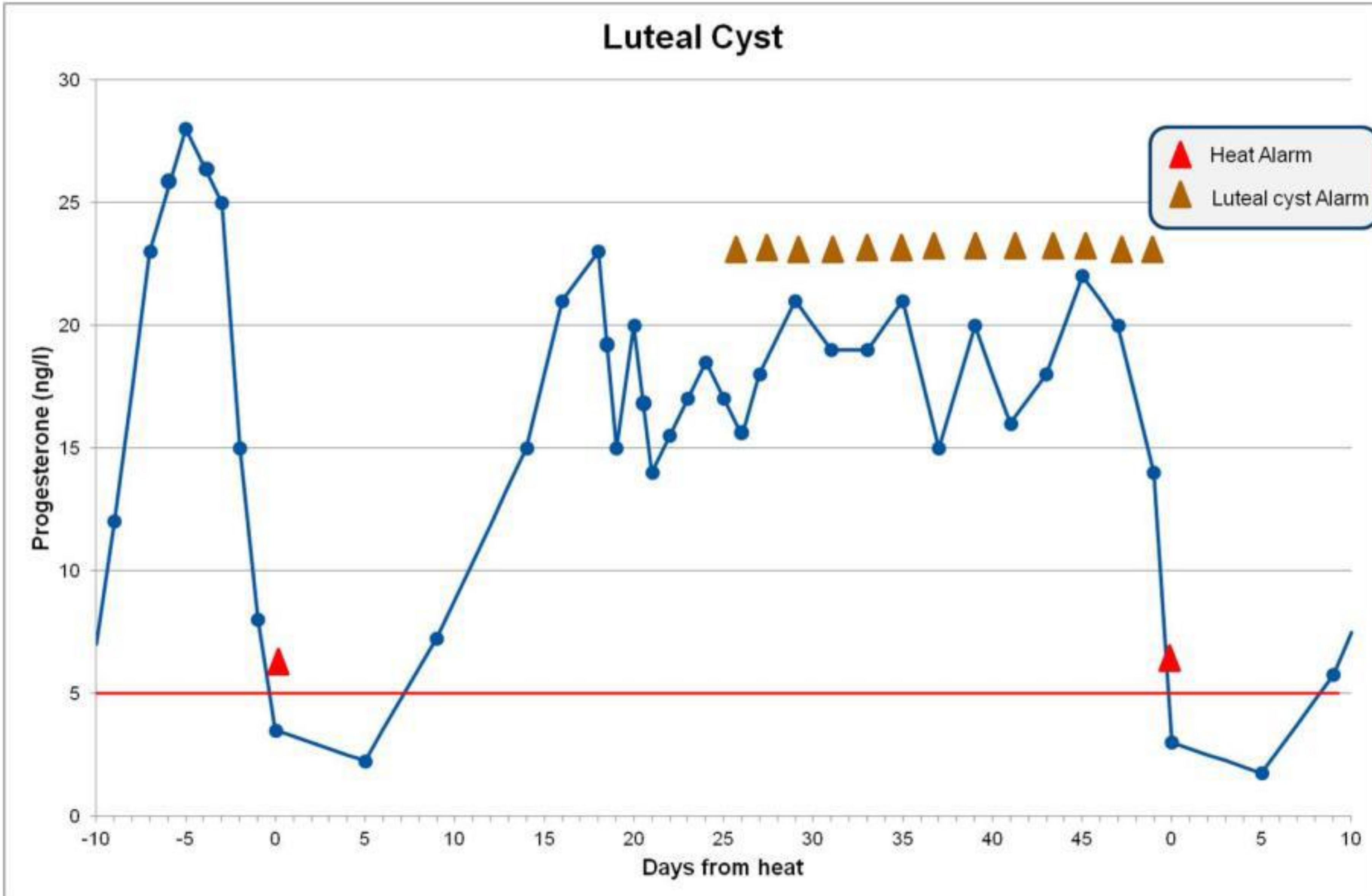
Activity

Tympanic temperature


Detects heat by measuring progesterone
Early detection of: silent heat, heat, pregnancy, abortion, folicular and luteal cysts, and prolonged anoestrus.
Detects mastitis by measuring LDH, lactate dehydrogenase
Early detection of subclinical and acute mastitis.
Detects ketosis by measuring BHB, beta-hydroxybutyrate,Urea (Protein)
Early detection of: subclinical ketosis, ketosis, metabolic diseases. Herd Navigator™
Intelligent milk-sampling station
Analysis unit
Clear action points for effective management
DeLaval

BioSensor Technology


Pregnancy
Progestrone (ng/l)
Days from heat
30
25
20
15
10
5
0
-10
-5
0
5
10
15
20
25
30
35
40
45
50
55
60
?
ISG 15
MX1,2
Pregnancy Associated Glycoproteins
Plasma
Milk
Heat Alarm
Insemination
Pregnancy


Luteal Cyst
Heat Alarm
Luteal cyst Alarm
Progesterone (ng/l)
30
25
20
15
10
5
0
-10
-5
0
5
10
15
20
25
30
35
40
45
0
5
10
Days from heat

Courtesy of Dr. Kevin McSweeney

Coordination of Nutritional and Reproductive Management Systems

Effects of Increasing Days of Exposure to Prepartum Transition Diets on Reproduction and Health in Dairy Cows.

- 9.9 MJ metabolizable energy (ME) /kg DM
- Metaboliszable protein balance 286 g/day
- Dietary cation anion difference (DCAD) of -150 meq/kg DM
- BioChlor
- Monensin

DeGaris et al., 2010

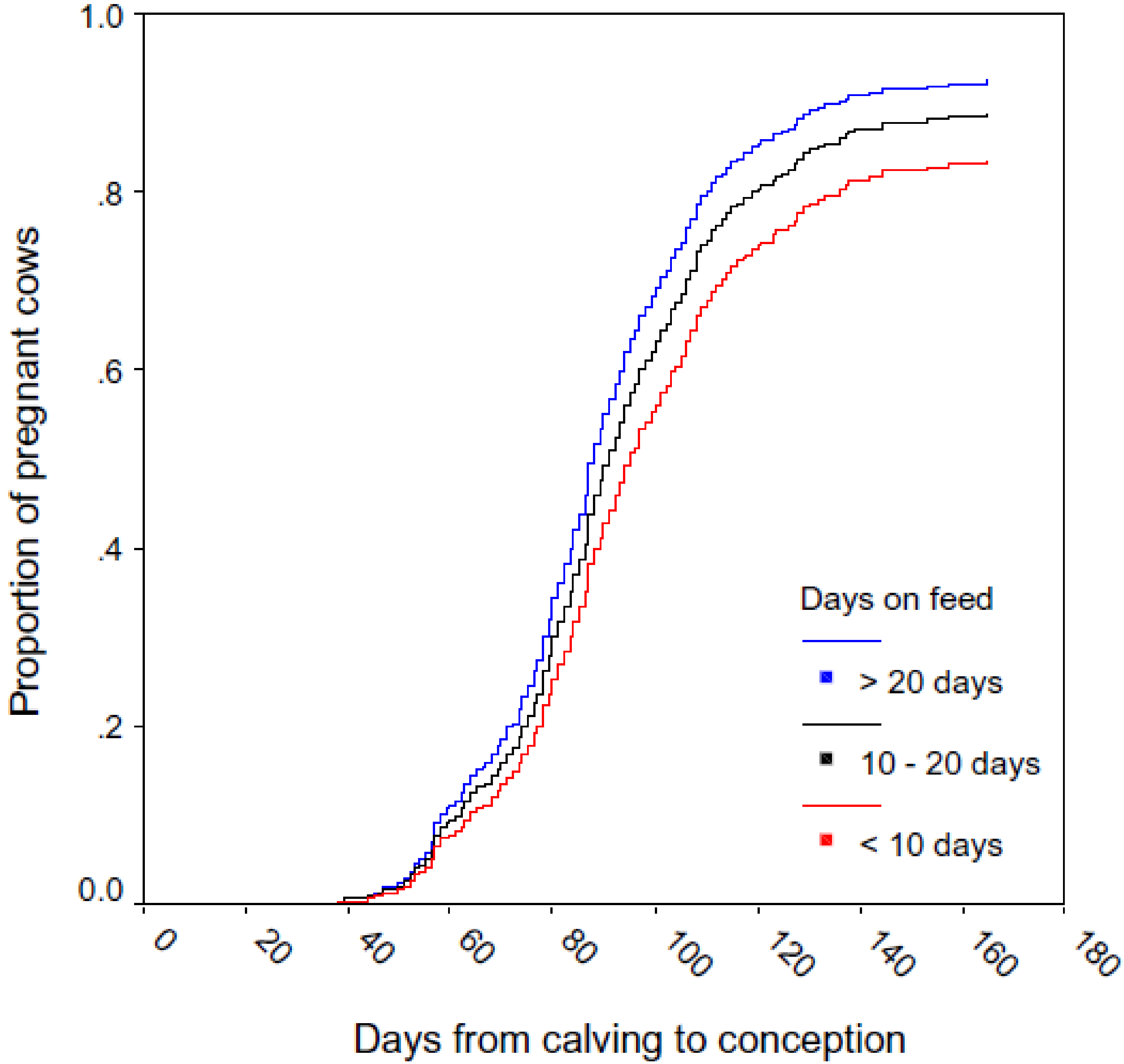
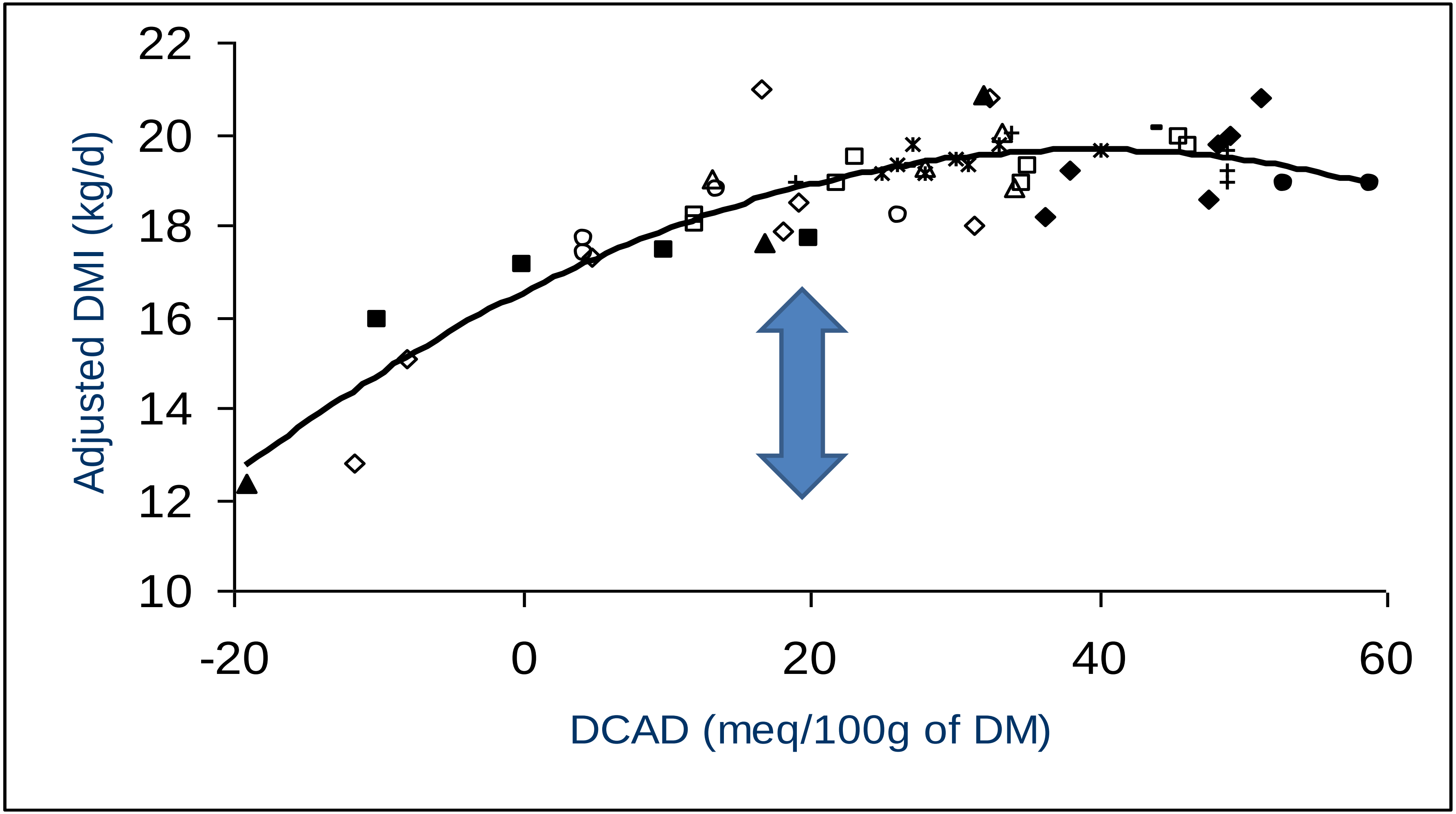


Figure. Survival graph for calving to conception and cumulative pregnancy for cows exposed to the pre-calving transition diet for <10, 10–20 and >20 days. Adapted from DeGaris P.J.and Lean I.J., 2009.

Improved DMI with increasing DCAD



Hu and Murphy (2004) *J. Dairy Sci*. 87:2222.

Effects of differential supplementation of fatty acids during the peripartum and breeding periods of Holstein cows: I. Uterine and metabolic responses, reproduction, and lactation

F. T. Silvestre,* T. S. M. Carvalho,* N. Francisco,* J. E. P. Santos,* C. R. Staples,* T. C. Jenkins,† and W. W. Thatcher*[1]

Table 4. Fatty acid (FA) profiles of diets[1]

	Prepartum[2] (g/100 g of FA)		Postpartum[3] (g/100 g of FA)		Breeding[4] (g/100 g of FA)	
Fatty acid	PO	SO	PO	SO	PO	FO
C14:0	0.69	0.65	0.66	0.51	0.67	1.50
C16:0	28.11	19.61	27.34	16.55	27.76	24.52
C18:0	3.54	3.30	3.51	3.24	3.47	3.61
C18:1 *cis*-9	23.59	18.32	23.50	17.76	23.52	21.62
C18:2 n-6	37.91	50.28	37.24	53.04	37.82	40.74
C18:3 n-3	6.16	7.84	7.76	8.90	6.75	5.86
C20:5 n-3	0.0	0.0	0.0	0.0	0.0	1.03
C22:5 n-3	0.0	0.0	0.0	0.0	0.0	0.22
C22:6 n-3	0.0	0.0	0.0	0.0	0.0	0.92
n-6/n-3	6.15	6.41	4.79	5.95	5.60	5.07

[1]Diets contained one of the following fat supplements: PO (palm oil; EnerGII), SO (safflower oil; Prequel 21), or FO (fish oil; StrataG). All fat supplements were manufactured as Ca salts by Virtus Nutrition, LLC, Corcoran, CA.

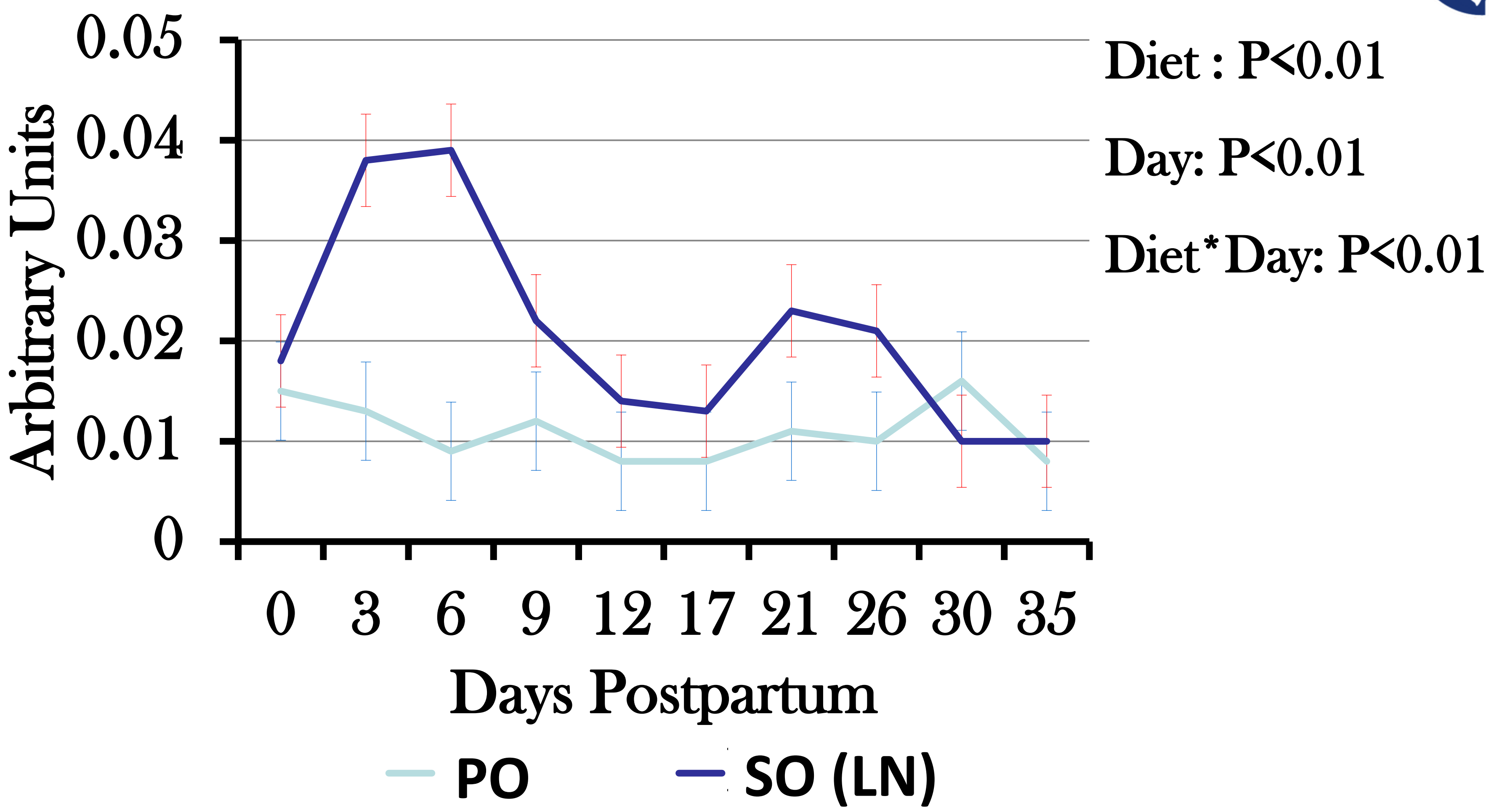
[2]Diet fed for at least 14 d before parturition.

[3]Diet fed from parturition to 30 d postpartum.

[4]Diet fed from 30 to 160 d postpartum.

J. Dairy Sci. (2011) 94 :189–204

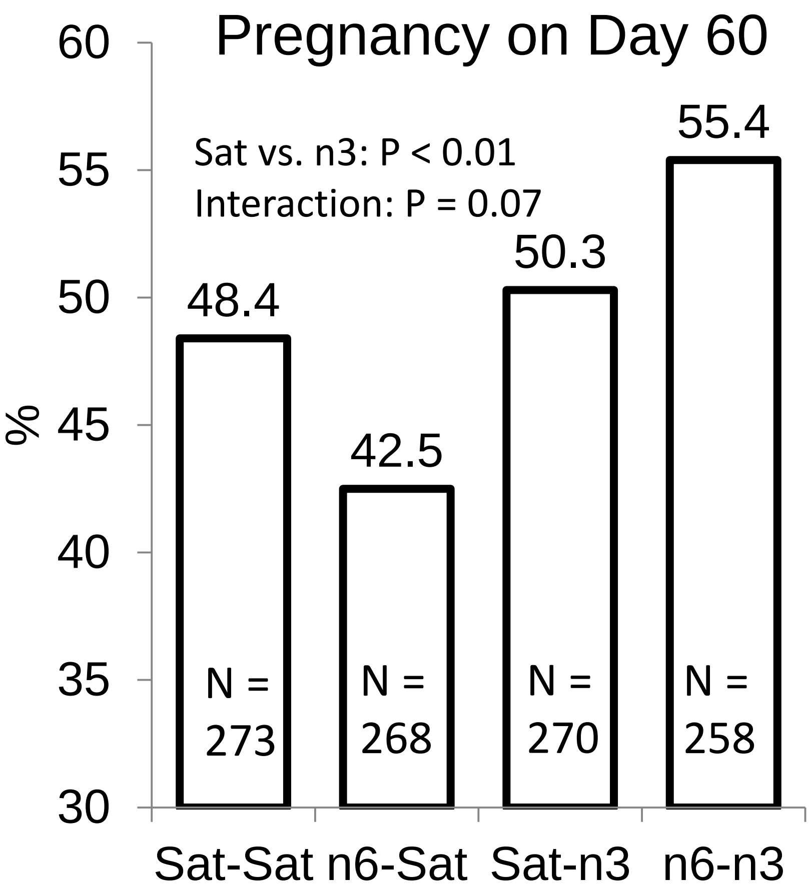
Plasma Haptoglobin

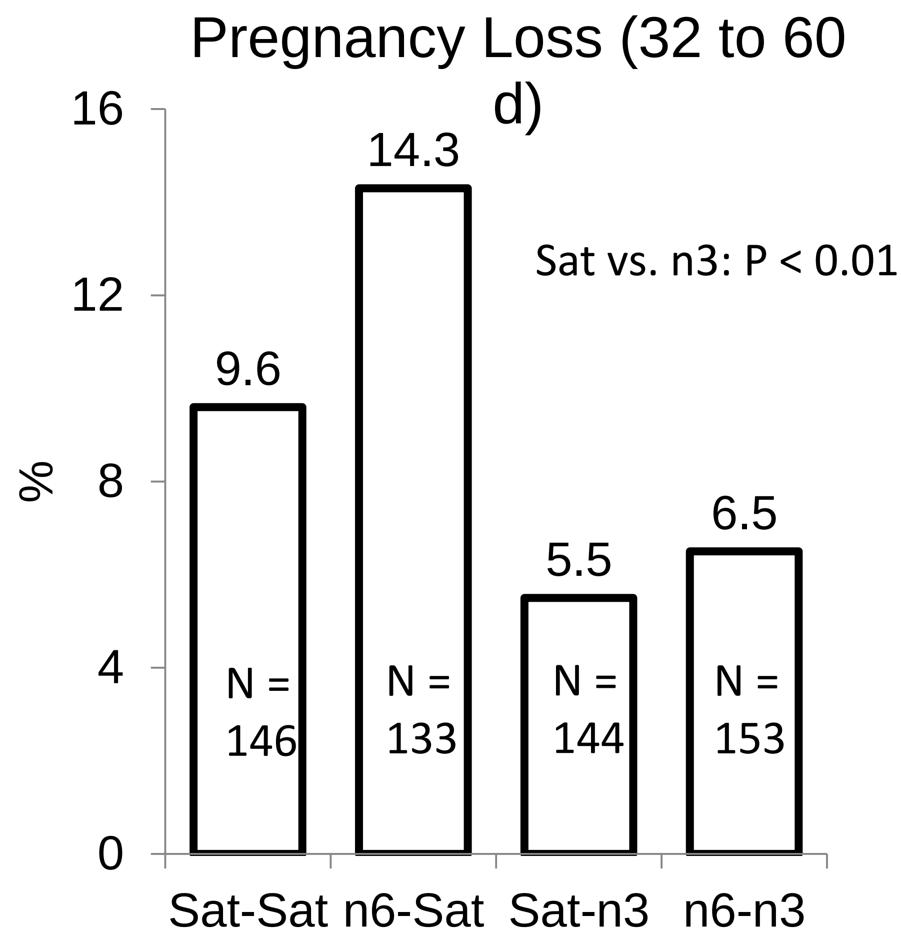


*Haptoglobin Values only for cows diagnosed with clear, lochia and flacks discharge at the vaginoscopy (8dpp)

Effects of Fatty Acid Supplementation During the Transition and Breeding Periods on Fertility of Dairy Cows

Transition diets = -30 to 30 DIM
Breeding diets = 30 to 160 DIM



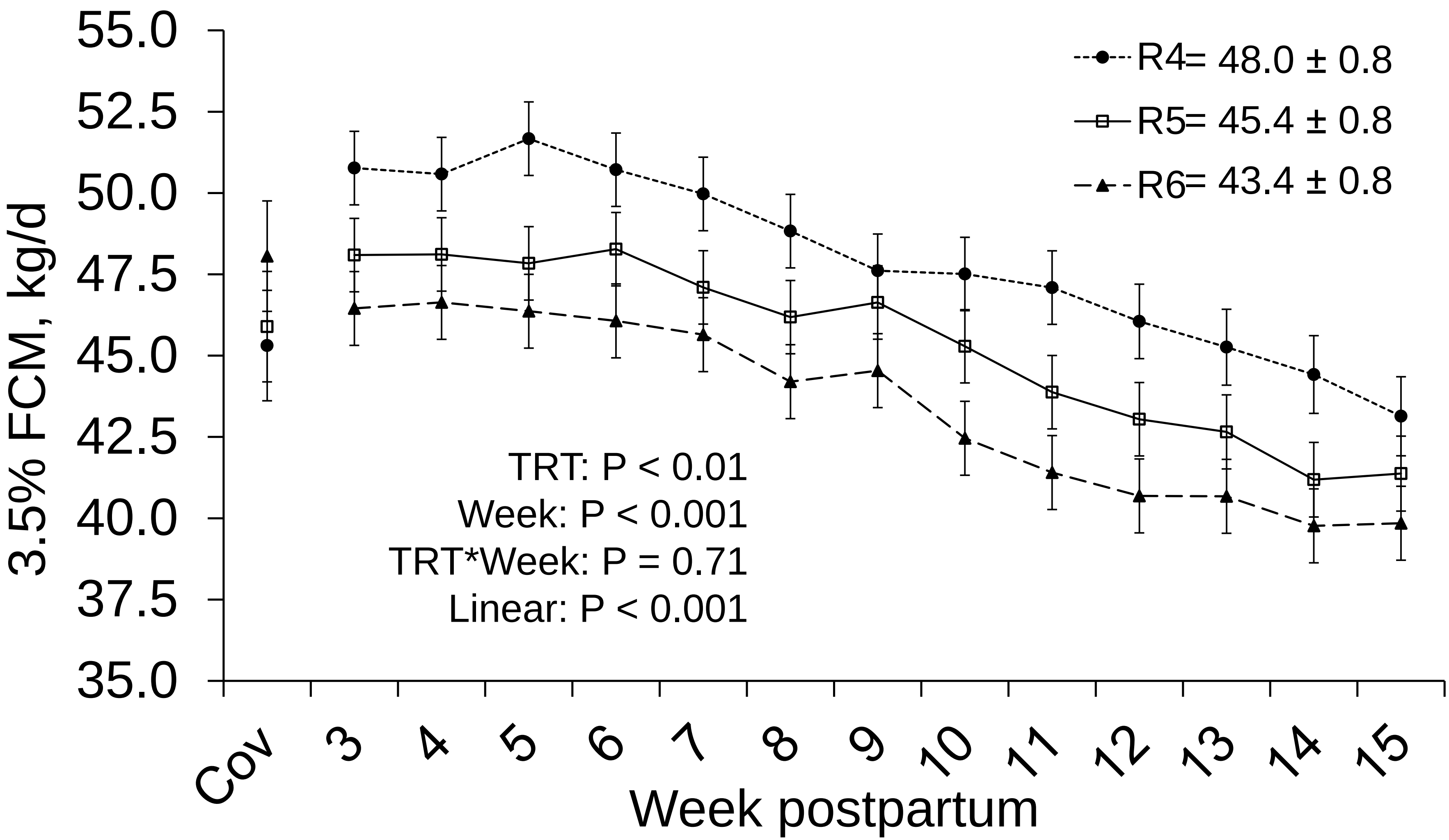


Silvestre *et al.* (2011) J. Dairy Sci. 94 :189–204 ratio of n6:n3

Materials and Methods

- 45 multiparous cows blocked by parity (2 vs. > 2) and milk yield between 6 and 10 DIM and, within each block, randomly assigned to 1 of 3 treatments
  - TMR with a ratio of n6:n3 FA of 4:1
  - TMR with a ratio of n6:n3 FA of 5:1
  - TMR with a ratio of n6:n3 FA of 6:1
- The FA profile of diets was altered by incorporating Ca salts of fish oil (StrataG), safflower oil (Prequel) and palm oil (EnerGII)
- Cows were fed a common diet for the first 14 DIM
- Lactation performance evaluated from day 15 to 106 postpartum (13 weeks)
- Cows were challenged with LPS intramammary
  - Acute phase response and neutrophil function were evaluated

3.5% FCM of Early Lactation Dairy Cows Fed Diets Containing Different Ratios of n6:n3 Fatty Acids



Greco et al., 2013 – J. Dairy Sci 96: E-Suppl. 658

ASSISTED REPRODUCTIVE TECHNOLOGY

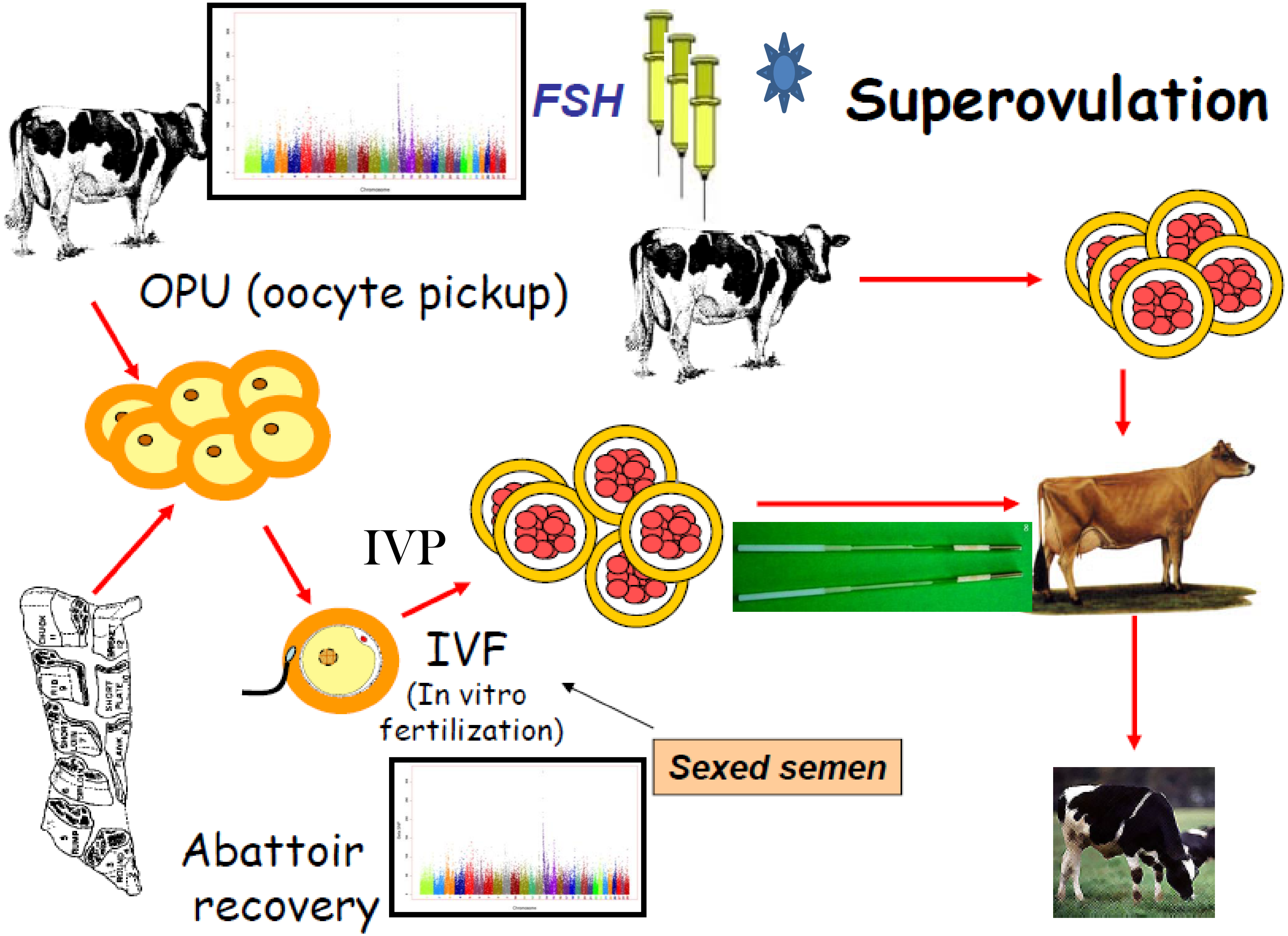


Figure. Assisted reproductive technologies for production of embryos in the cow. For superovulation, multiple follicles are recruited to grow by administration of FSH. Following ovulation and AI, embryos are recovered by flushing the uterus. For IVF, oocytes obtained either from excised ovaries (usually from the abattoir) or from living cows (by OPU) are matured in vitro, fertilized with conventional or sexed semen, and then cultured until transfer into recipients. The figure is from Hansen (2013).

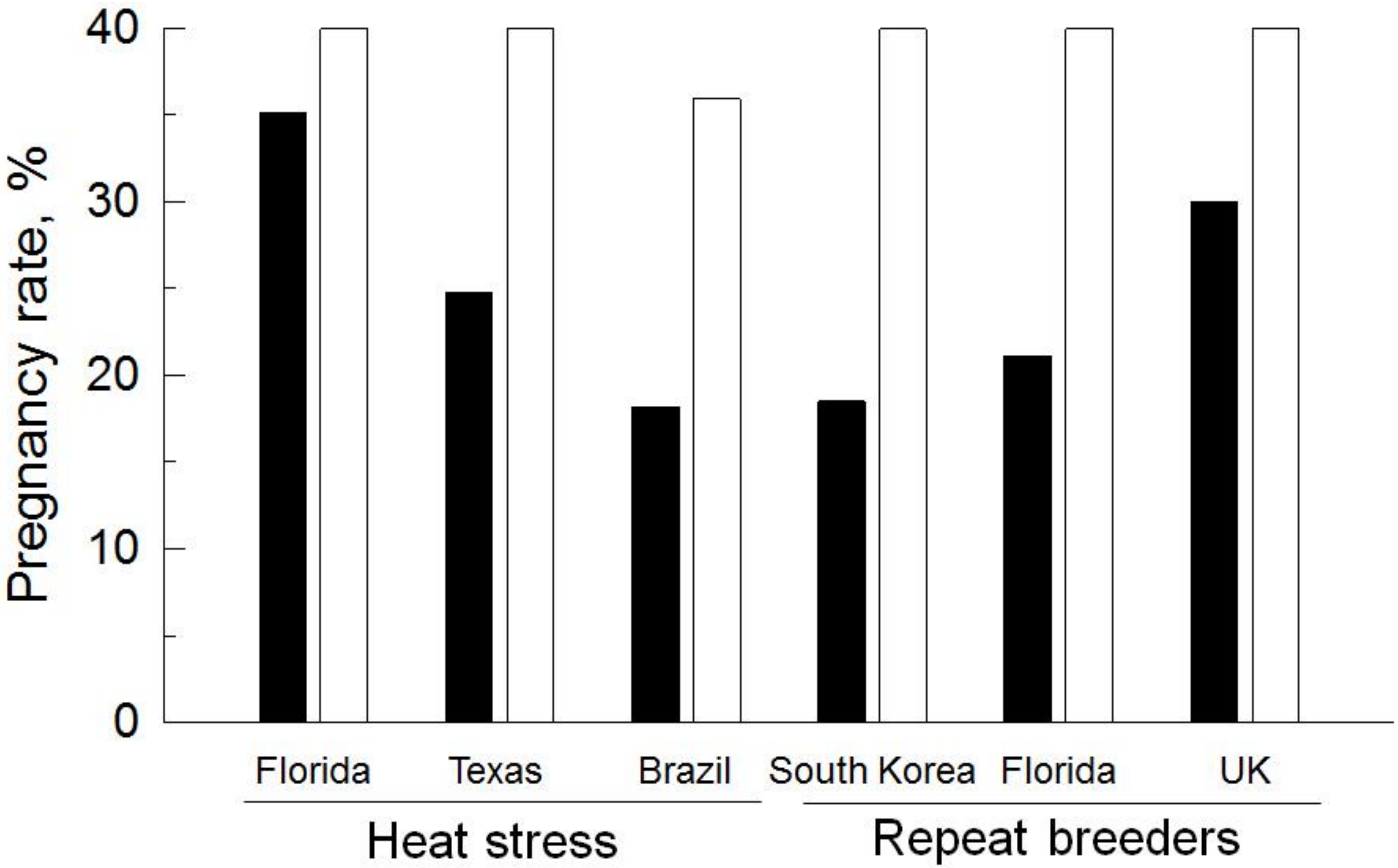


Figure. Studies in lactating dairy cows in which pregnancy rates were improved by embryo transfer (open bar) as compared to AI (filled bar). Data from heat stress experiments are from Block et al. (2010) (Florida), Stewart et al. (2011) (Texas) and Vasconcelos et al. (2011) (Brazil). Data from repeat breeder studies are from Son et al. (2007) (South Korea), Block et al. (2010) (Florida) and Canu et al. (2010) (UK).

Example of Futuristic Development

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A designer network coordinating bovine artificial insemination by ovulation-triggered release of implanted sperms

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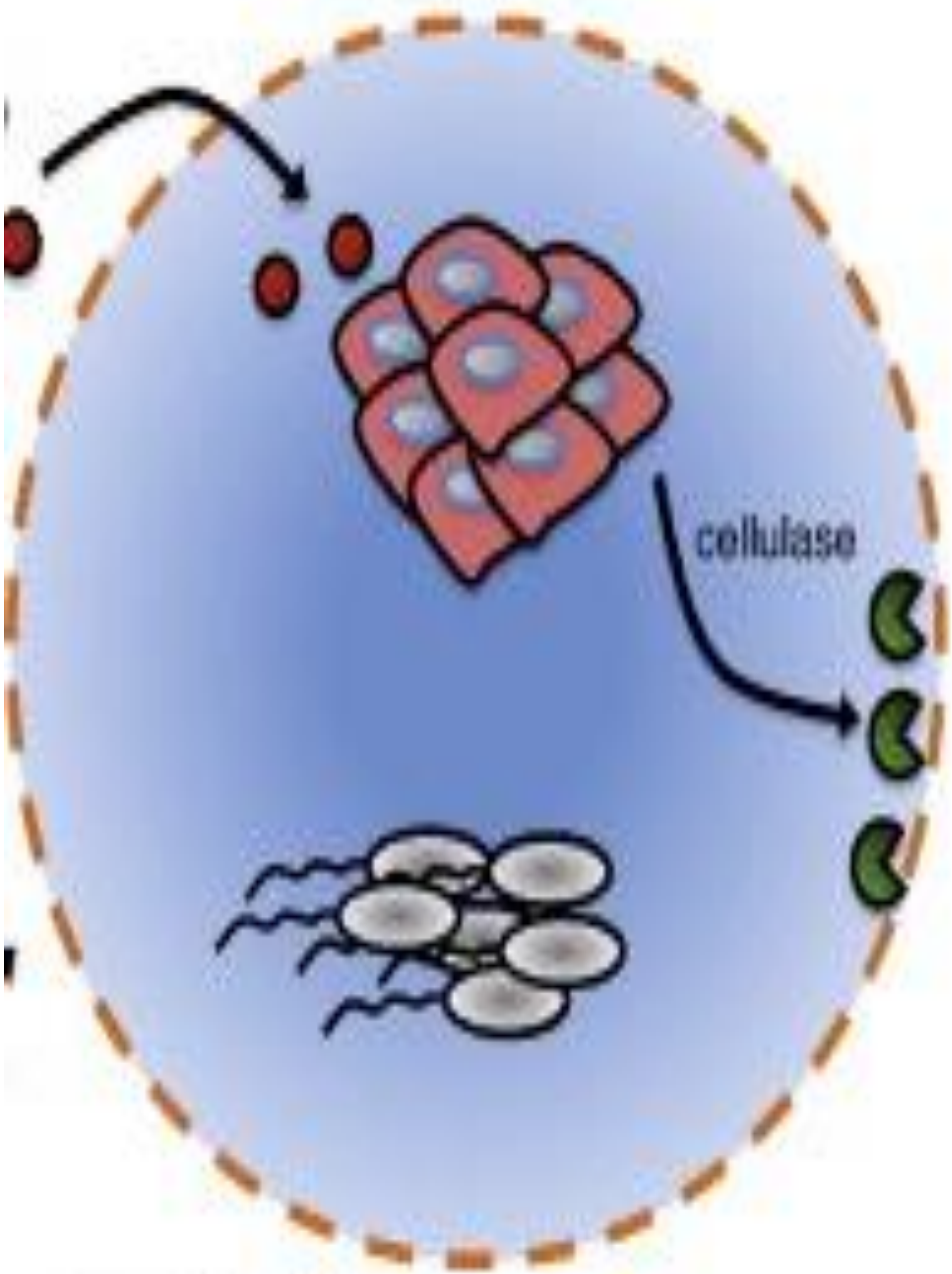


Kemmer et al. (2011) J Cont Rel 150:23-29

A designer network coordinating bovine artificial insemination by ovulation-triggered release of implanted sperms

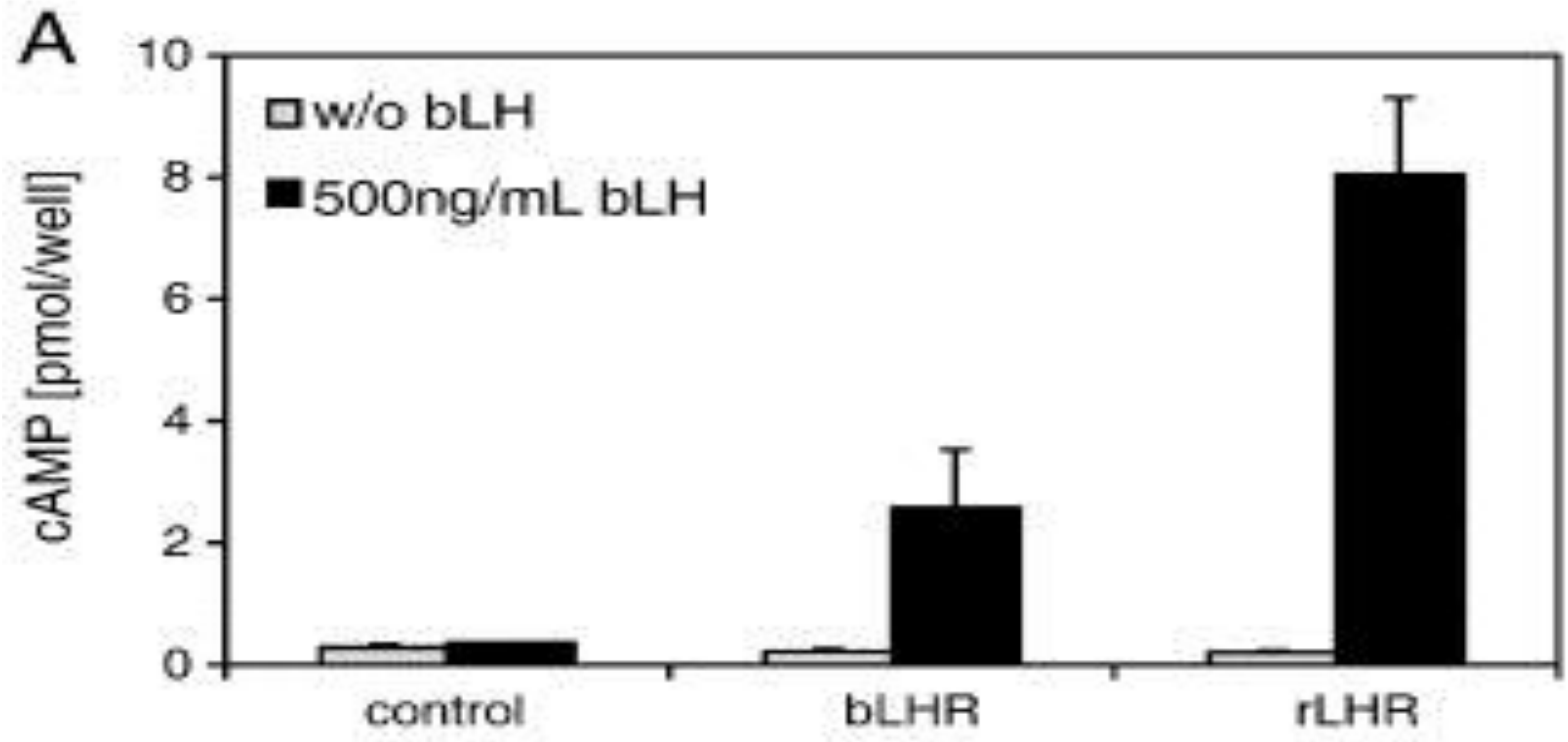


Fig. 1 Characterization of a composite synthetic signaling and transcription circuit enabling luteinizing hormone-triggered transgene expression in mammalian cells. (A) Intracellular cAMP levels resulting from bovine luteinizing hormone (bLH)-triggered luteinizing hormone receptor (LHR) signaling.

Kemmer et al. (2011) J Cont Rel 150:23-29

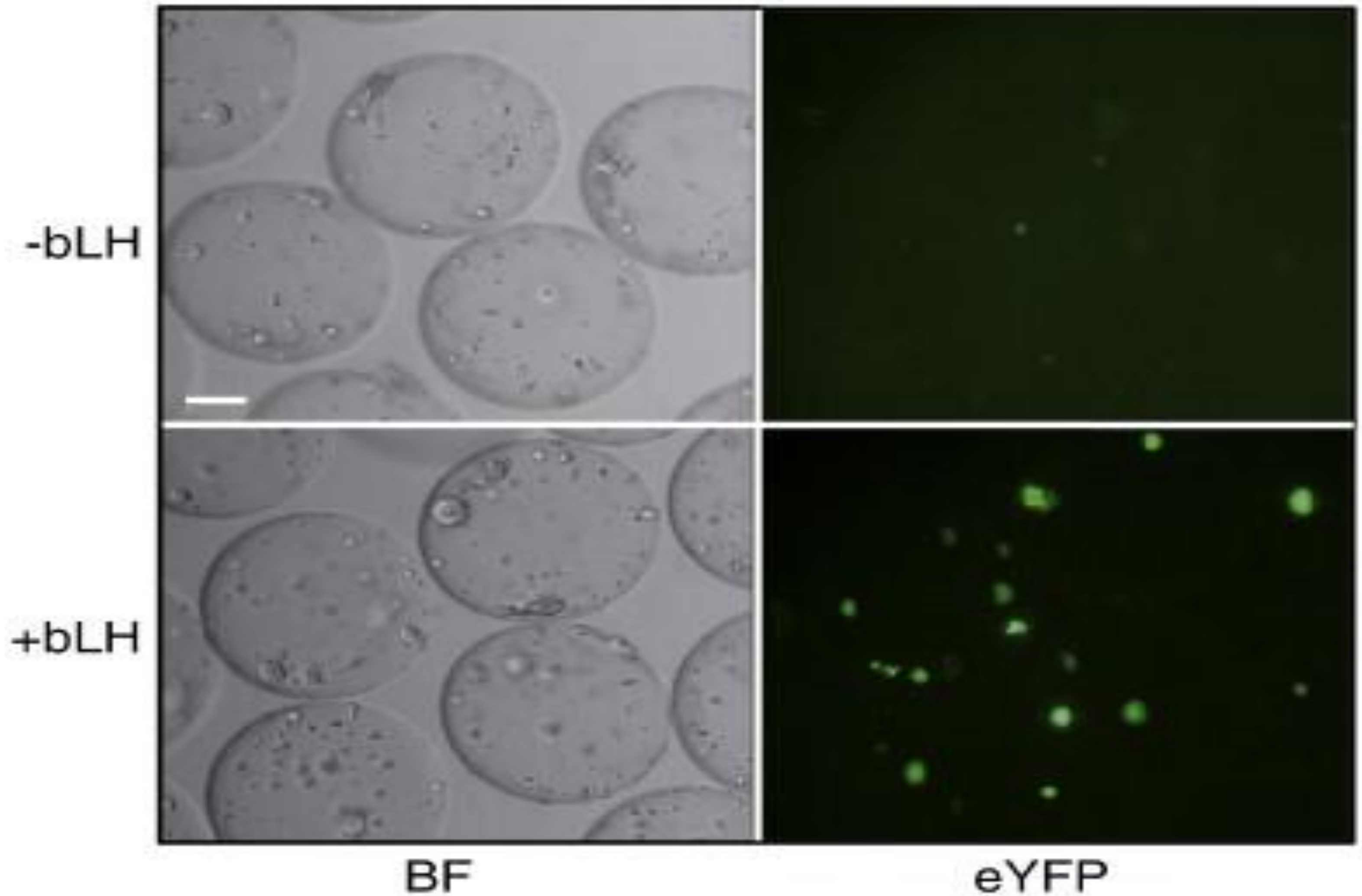


Fig. 3 Bovine LH-triggered activation of cells entrapped in cellulose implants. Bright field (BF) and fluorescence (EYFP) micrographs of 2% (w/v) cellulose implants containing HEK-293 rLHR6 engineered for P CRE -controlled EYFP expression (35 cells/capsule) and cultivated for 48 h in the presence or absence of 500 ng/mL bLH. Scale bar, 100 μm.

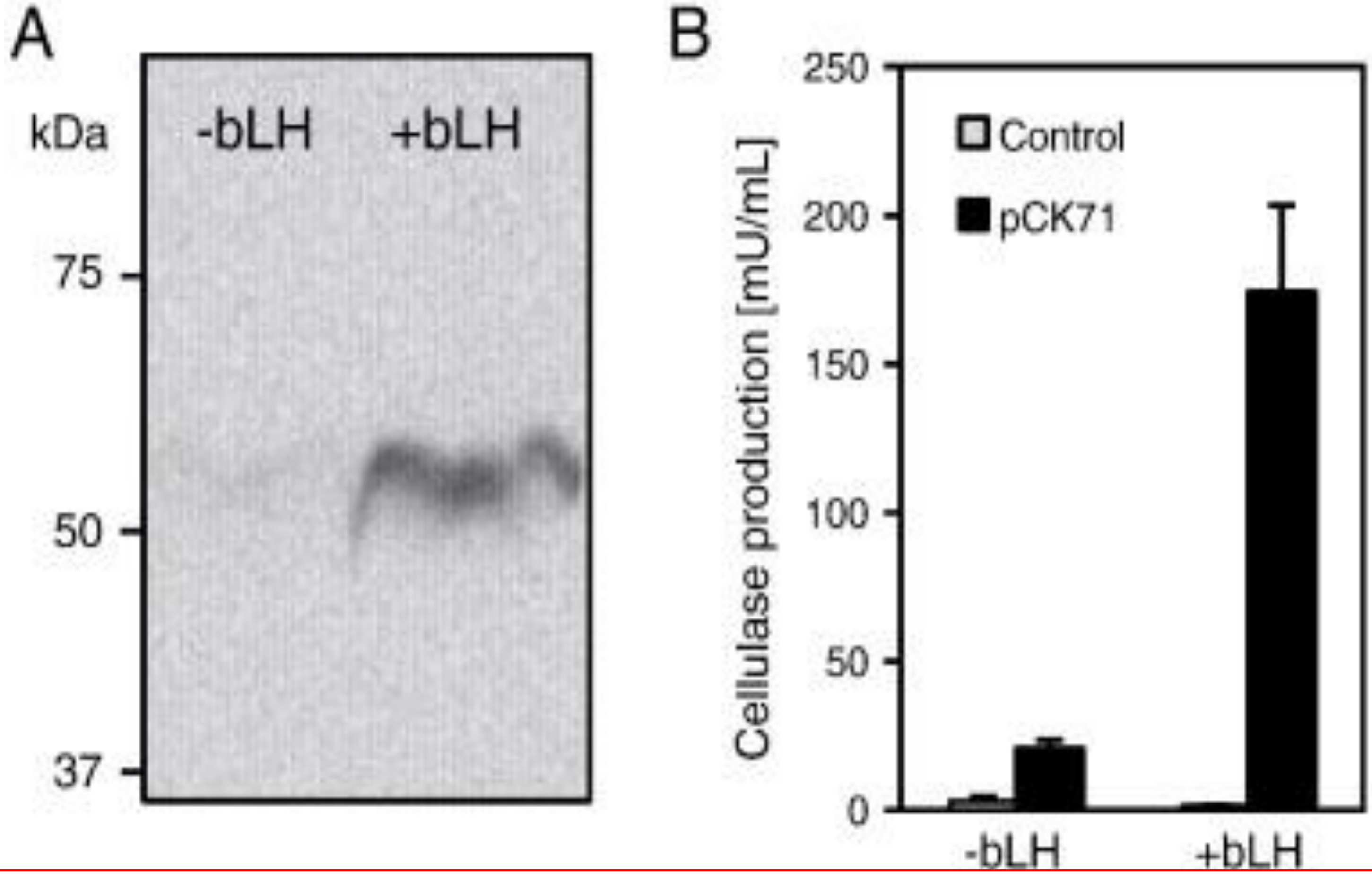
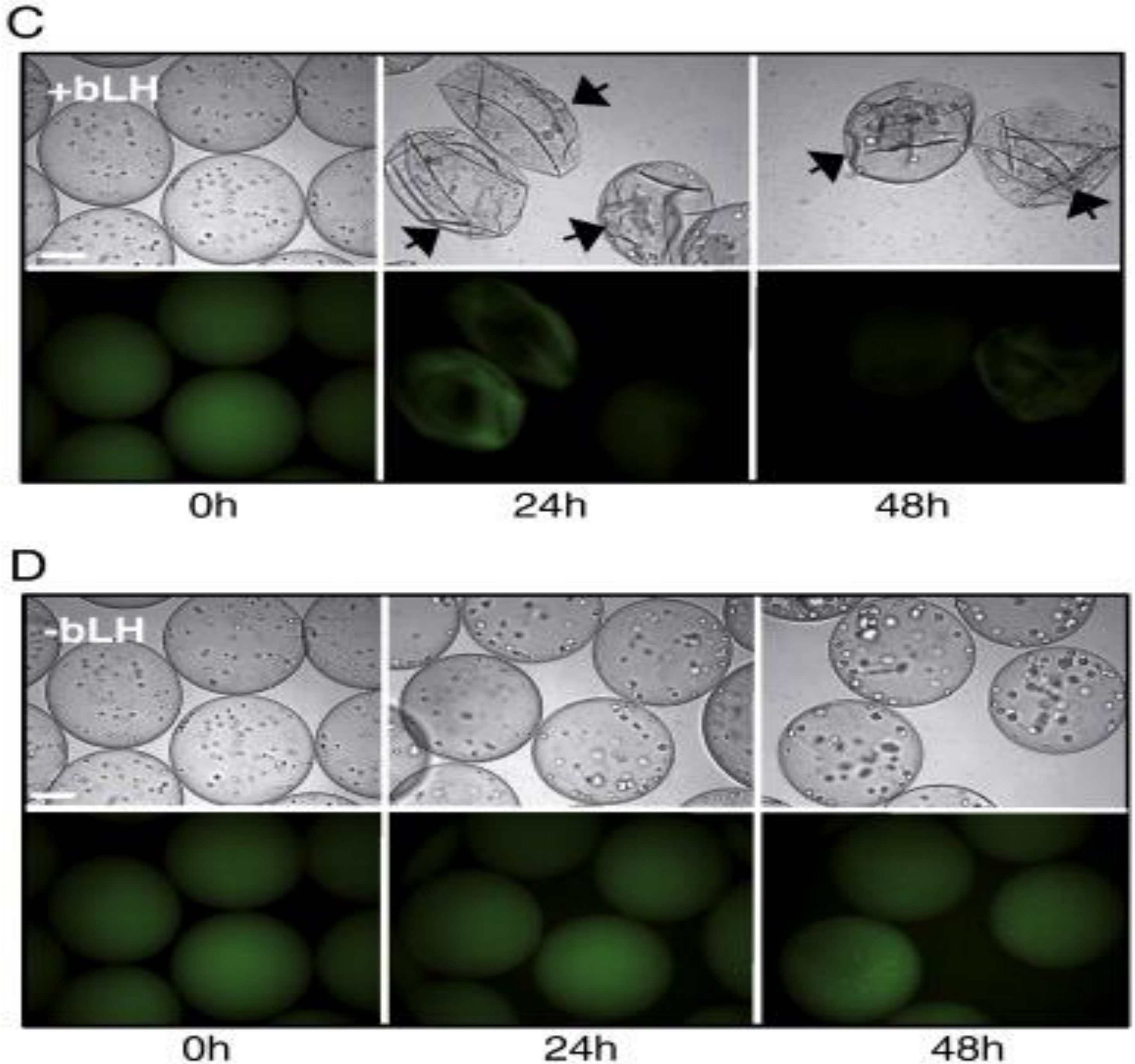


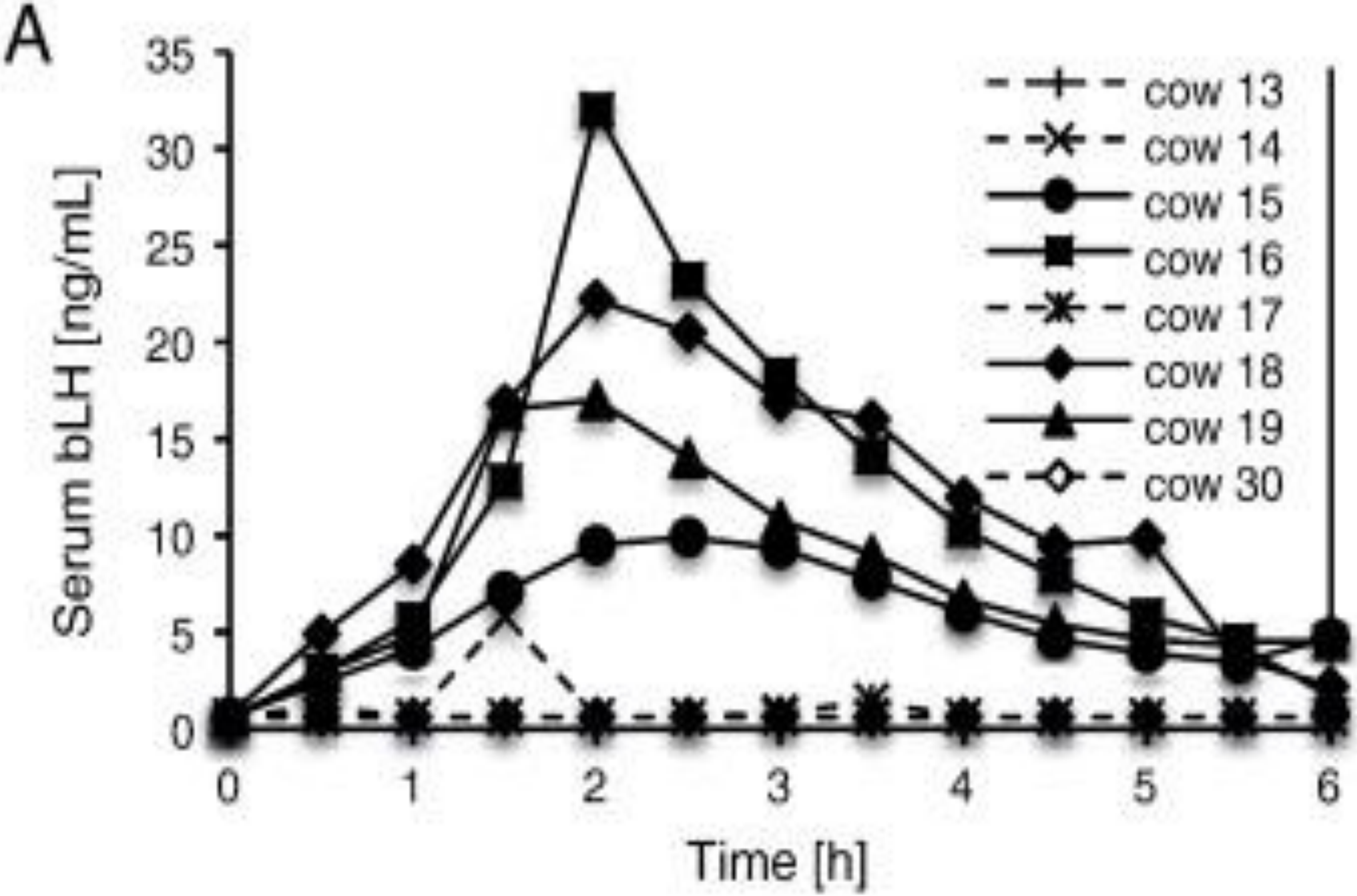
Figure: Bovine LH-triggered secreted cellulase expression enables autolysis of cellulose implants. (A,B) Western blot analysis (A) and enzymatic activity (B) of secreted cellulase in the culture supernatant of 5×10^4 HEK-293$_{rLHR6}$ engineered for P_{CRE}-controlled secreted cellulase (pCK71) or parental HEK-293$_{rLHR6}$ (control) cultivated for 48 h with or without 500 ng/ml bLH. Each bar represents the mean value ± s.d. of three replicates. (C,D) Controlled lysis of cellulose implants and release of FITC-dextran following bLH-triggered cellulase expression by microencapsulated cells. Bright field and fluorescence micrographs of implants containing HEK-293$_{rLHR6}$, engineered for bLH-inducible P_{CRE}-driven cellulase expression as well as FITC-dextran in 2% (w/v) cellulose implants (35 cells/capsule) and cultivated for 0 h, 24 h and 48 h in the presence (C) or absence (D) of 500 ng/mL bLH.


C
+bLH
0h
24h
48h
D
-bLH
0h
24h
48h

Movie 1 Sperm

Movie 2 Capsule Sperm

Movie3 Sperm Released



Ovulation-triggered capsule disruption in the uterus of Swiss dairy cows. (A) Profiles of serum bLH levels of estrus-synchronized cows injected i.m. with either 5 mL (20 µg) GnRHto trigger an endogenous LH surge (solid lines) or with 5 mL 0.9% (w/v) NaCl (dashed lines) as a control.

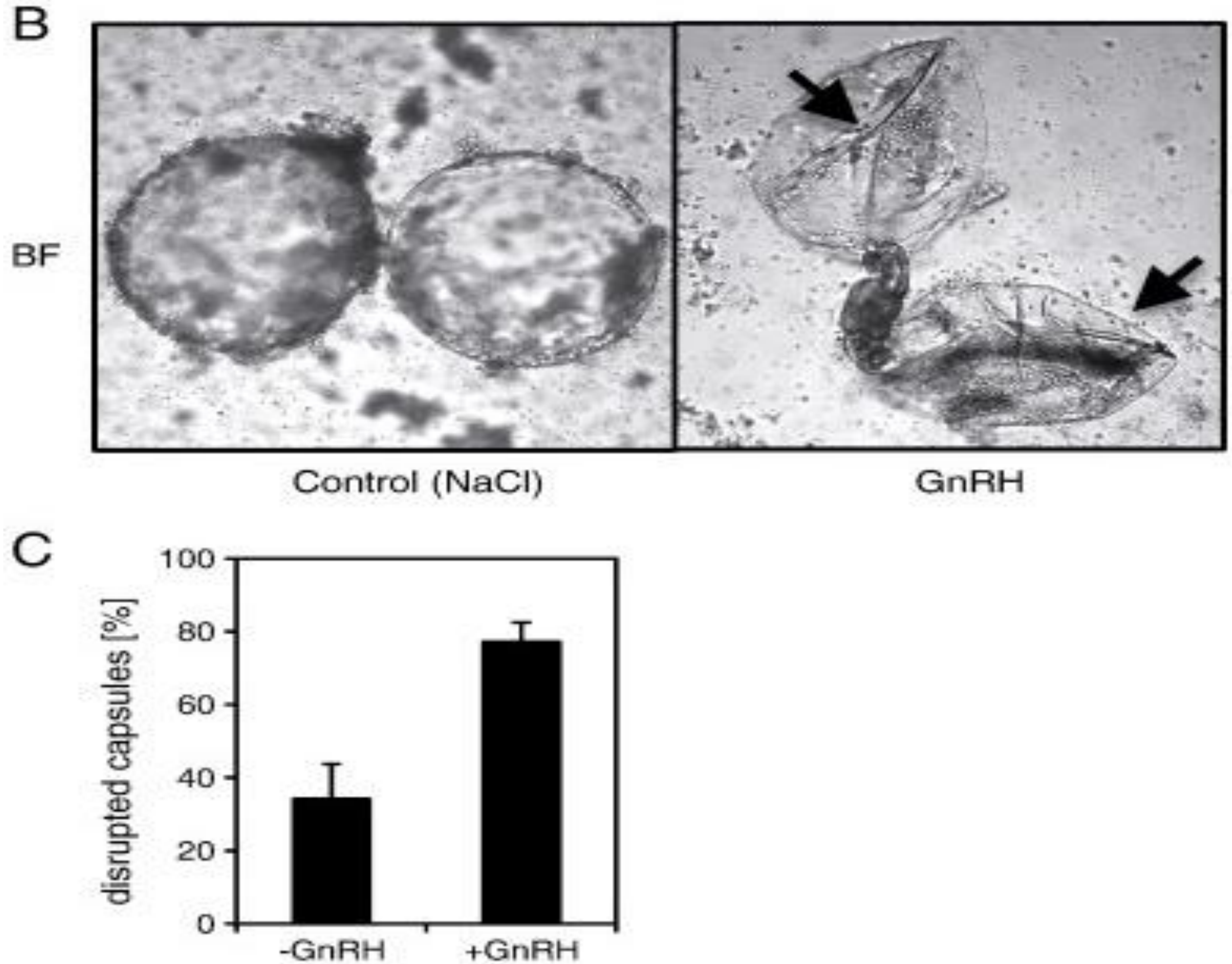
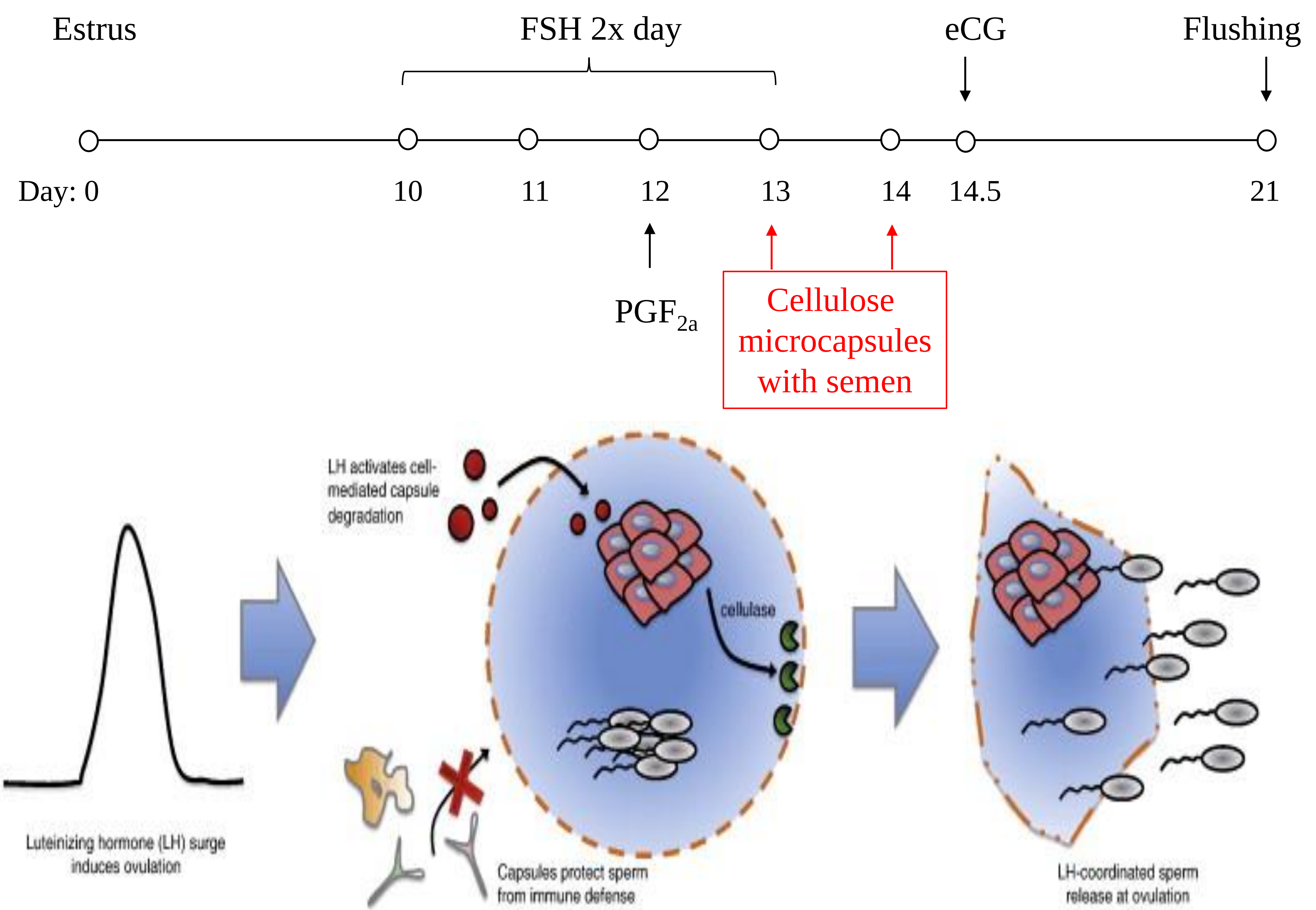


Fig. (B) Micrographs of microcapsules explanted from the uterus 40 h after treatment of the cows with either GnRH or NaCl. Arrows indicate disrupted capsules. Scale bar, 100 μm. (C) Quantification of capsule disruption. The number of intact and disrupted capsules explanted from the uterus of both treatment groups was scored by light microscopy. Each bar represents the mean value ± s.d. of disrupted capsules explanted from indicated treatment groups (n = 4).



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D

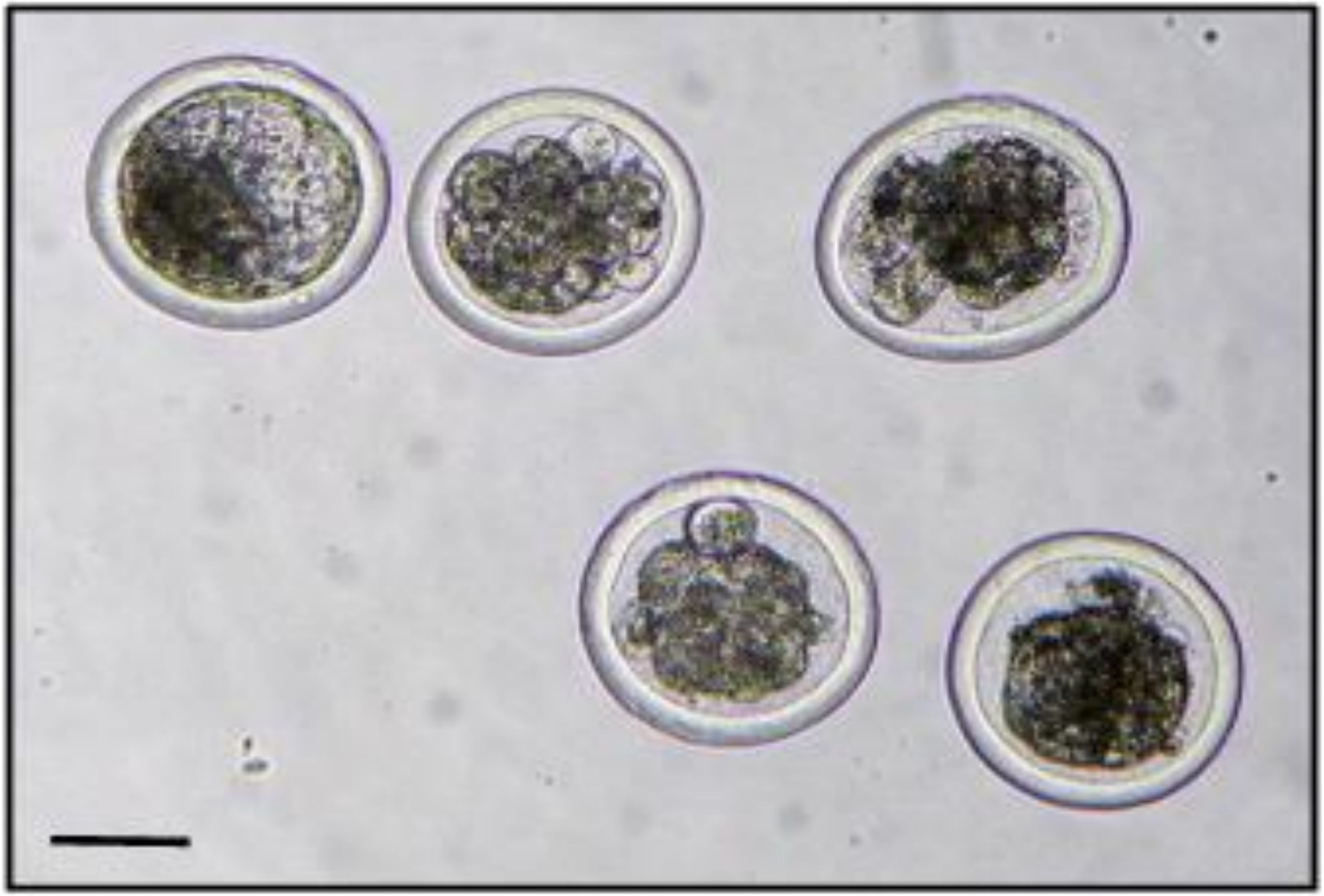

Fig. (D) Micrograph of cow embryos explanted from the uterus of superovulated cows 7 days after administration of cellulose implants containing bull spermatozoa and HEK-293$_{rLHR6}$, engineered for bLH-inducible P_{CRE}-driven expression of secreted cellulase. Scale bar, 50 μm.

Take Home Messages

•Highly effective TAI programs for first and repeated services are applicable to both fertile and sub-fertile cows improve herd reproductive performance and can be combined with electronic monitoring of heats.

•Holistic approaches to integrate reproductive management with nutrition, metabolic status, and health will constitute the breeding programs of the future.

•Controlling energy in the prepartum diet minimizes drastic changes in loss of body condition postpartum, enhances transition efficiency, and improves intervals to first breeding and pregnancy.

•Biosensor technology in the milking parlor allows for individual monitoring of the cow's metabolic and reproductive statuses via monitoring milk constituents and cow physiological responses. This technology with the appropriate algorithms to interpret the information will allow for earlier and more efficient decisions to manage nutritional and reproductive management needs of individual or groups of cows.

Take Home Messages

•Specific nutriceutical approaches through manipulation of the diet will enhance both milk production and fertility by optimizing energy intake, immune function, sensitivity of tissues (i.e., mammary gland, uterus, ovary, conceptus, and coordination of peripheral tissues [i.e., liver, adipose and muscle] during critical physiological periods).

•Advancements in assisted reproductive technology will improve: (1) efficiency of the superovulation process; (2) freezability and fertility of IVP embryos; and (3) utilization of sexed sperm in combination with genetically superior oocytes, from genomic superior donors, to further improve rate of genetic progress.

•On-farm utilization of new and exciting technologies for holistic approaches to reproductive management will increase with ease of application, effectiveness of the responses, net economic benefit, and both support and use of such technologies by producers and consumers.

Thank You

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