PHYSIOLOGICAL PRINCIPLES UNDERLYING SYNCHRONIZATION OF ESTRUS

M.F. Smith, G.A. Perry, J.A. Atkins, M.E. Risley, D.C. Busch, and D.J. Patterson

Division of Animal Sciences, University of Missouri, Columbia
Department of Animal and Range Sciences, South Dakota State University
Overview

• Physiology of the bovine estrous cycle

• Hormones utilized for estrus synchronization

• Estrus synchronization products

• Hormonal management of the luteal phase

• Hormonal management of follicular waves

• Management considerations
Characteristics of the Estrous Cycle

• Length of the estrous cycle
  Average 21 days (range 17 to 24 days)
  Two follicular waves – 17 to 20 days
  Three follicular waves – 21 to 24 days

- Estrus (standing heat)
  12 to 18 hours (range 8 to 30 hours)

- Ovulation
  Approximately 30 hours after the beginning of standing estrus
Duration of Estrus

Percentage of cows

Duration of Estrus, h

0-5 6-10 11-15 16-20 21-25 >25
Influence of confinement area on the number of mounts per estrus (P > 0.5)
Influence of the number of cows in estrus on number of times cows are mounted in drylot or pasture

- 11.0<sup>a</sup>
- 27.7<sup>a,b</sup>
- 30.9<sup>b</sup>
- 50.4<sup>c</sup>

**Number of Cows in Estrus**

- 1
- 2-3
- 4-6
- 7+

**Number of mounts**

- Pasture
- Drylot

- Pasture: 11.0<sup>a</sup>
- Drylot: 27.7<sup>a,b</sup>
- Pasture: 30.9<sup>b</sup>
- Drylot: 50.4<sup>c</sup>

**Superscripts**

- <sup>a,b</sup> superscripts differ $P < 0.07$
- <sup>b,c</sup> superscripts differ $P < 0.002$
Variation in Ovulation Time

Percentage of Cows

Time of Ovulation (h)
Ovarian Structures

- Graffian follicle

- Corpus luteum
The Estrous Cycle

- Estrus
- Ovulation
- Dominance
- Selection
- Recruitment
- Atresia
- CL → Progesterone

Hormone concentration
Stages of the Estrous Cycle

- Follicular Phase
- Estrus
- Luteal Phase
Follicular and Estrus Phases

- Maturation of the preovulatory follicle
- Estrous behavior
- Ovulation (induced by the LH surge)
• P₄ = Progesterone – CIDR and MGA

• PGF = Prostaglandin F – Lutalyse, ProstaMate, In Synch, Estrumate, estroPLAN
Corpus Luteum and Pregnancy

• Maternal recognition of pregnancy – day 15 to 16
• Caution – PGF can induce abortion in pregnant cows
Physiology of Follicular Waves

Day of the Estrous Cycle

- Estrus
- Dominance
- Selection
- Recruitment
- FSH
- Ovulation

0 2 4 6 8 10 12 14 16 18 20 0

Day of the Estrous Cycle
Problem of Anestrus!

![Graph showing progesterone levels over days]

- **Y-axis**: Progesterone (ng/ml)
- **X-axis**: Day

The graph illustrates the fluctuation of progesterone levels over time, highlighting the problem of anestrus.
Problem of Anestrus!

- GnRH
- CIDR
Hormones utilized in Estrus Synchronization Protocols

- Progesterone/Progestins
- Prostaglandin F$_{2\alpha}$
- GnRH
Progesterone

Biological Functions

- Inhibit estrus/ovulation
- Preparation for pregnancy
- Maintenance of pregnancy
Progestins/Progesterone

Role in Synchronization

- Inhibit estrus/ovulation
- Induce cyclicity
- Dominant follicle turnover
Prostaglandin $F_{2\alpha}$

**Biological Function**
- Luteal regression in nonpregnant animals

**Role in Synchronization**
- Induce premature luteal regression
Gonadotropin Releasing Hormone (GnRH)

**Biological Function**
- Control secretion of LH
- Induces gonadotropin surge

**Role in Synchronization**
- Induce ovulation
- Synchronize follicular waves
Estrus Synchronization Products

Progestins
- Melengestrol Acetate
- EAZI-BREED CIDR

Prostaglandin $F_{2\alpha}$
- Lutalyse
- ProstaMate
- In Synch
- Estrumate
- estroPLAN
Estrus Synchronization Products

GnRH

- Cystorelin
- Fertagyl
- Factryl
- OvaCyst
Hormonal management of the luteal phase

- Progestins
- Prostaglandin F$_{2\alpha}$
Role of Progestins in Estrus Synchronization

- Synchronization of estrus in
  - beef heifers & cows
  - dairy heifers & cows

- Advances onset of puberty in heifers

- Advances return to estrus after calving in cows
Progestins

- Melengestrol Acetate - MGA
- Controlled Internal Drug Release - CIDR
Progesterone
Pregn-4-ene-3, 20-dione

MGA
(melengestrol acetate)
6-methyl-17-alpha-acetoxy-16-methylene-pregn-4, 6-diene-3, 20-dione
Inhibition of Ovulation Following Long-term Progestin Treatment

Progestin Treatment
MGA for 14 days

2 4 6 8 10 12 14 16 18

Estrus (less fertile)

CL Regressed

14 16 18
Persistent Follicles

Persistent Follicle (PF) vs. Growing Follicle (GF)

Days Relative to Estrus (day 0)

Follicle Diameter (mm)

PF

GF
Prostaglandin F$_{2\alpha}$ (PGF)
(Lutalyse, ProstaMate, Estrumate, In Synch, estroPLAN)

- Causes CL regression
- No effect on noncycling cattle
- No induction of cyclicity
  … No Jump-start
- Effective days 6 to 16 of the estrous cycle (day 0 = estrus)
PGF$_{2a}$ – Effect of stage of the cycle

Day of the Estrous Cycle
Hormonal management of follicular waves

- GnRH – Induces dominant follicle to ovulate
- Estradiol – dominant follicle turnover ($\downarrow$FSH)
- Progesterone – dominant follicle turnover ($\downarrow$LH)
GnRH
(Cystorelin, Factrel, Fertagyl, Ovacyst)

- Induces ovulation
- Synchronizes follicular waves
- Induces formation of a CL
GnRH – Induced Surge of LH

- GnRH Injection
- LH Surge: 2 to 4 hours after GnRH injection
- Ovulation: 24 to 30 hours after GnRH injection
GnRH-Induced Ovulation During a Follicular Wave
Management considerations for selecting heifers and cows for synchronization of estrus
Before you start an estrous synch and AI program – Heifers

What has the pregnancy rate of your heifers been over the past few years?

Have your heifers received growth promoting implants?

Have you selected an appropriate target weight?
Have your heifers attained 65% of their mature body weight?

What proportion of your heifers have a reproductive tract score of $\geq 4$?
Before you start an estrous synch and AI program – Postpartum Cows

What has the pregnancy rate in your cows been over the past few years?

What is the current length of your breeding season?
What proportion of your cows are cycling by the start of the breeding season?

What was the body condition score of your cows at calving?
Postpartum Cows – contd.

What is the current body condition score of your cows?

How many days postpartum will your cows be when estrus synchronization is initiated?
Postpartum Cows and Heifers

How much time can you devote to estrus detection?

Considering your handling facilities, how many cows can you breed in an hour?