PHYSIOLOGICAL PRINCIPLES UNDERLYING SYNCHRONIZATION OF ESTRUS


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Overview

• Physiology of the bovine estrous cycle
• Estrus synchronization products
• Hormonal management of the luteal phase
• Hormonal management of follicular waves
• Physiological factors affecting pregnancy rate to FTAI

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

White et. al., 2002

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

**superscripts differ P < 0.07
***superscripts differ P < 0.002

ARSBC2014 1
Ovarian Structures
- Graffian follicle
- Corpus luteum

The Estrous Cycle
- Ovulation
- Dominance
- Selection
- Recrutiment
- CL = Progesterone

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)

Luteal Phase
- 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

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

Estrus

Selection

Recruitment

Dominance

Ovulation

Problem of Anestrus!

Progesterone (ng/ml)

0 1 2 3 4 5 6

Day

0 15 31 42

GnRH

CIDR

Problem of Anestrus!

FTAI Pregnancy rate in Anestrous Cows

• 2341 Cows
  – 4 Studies
    • Bader et al., 2005
    • Schafer et al., 2007
    • Busch et al., 2008
    • Wilson et al., 2010
  – Estrous Cycling: 1329/2341 = 57%
  – Anestrus: 1012/2341 = 43%

Hormones utilized in Estrus Synchronization Protocols

• Progesterone/Progestins
• Prostaglandin F2α
• GnRH

Progesterone

Biological Functions

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

Role in Synchronization

• Inhibit estrus/ovulation
• Induce cyclicity

Prostaglandin $F_{2a}$

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

Hormonal management of the luteal phase

• Progestins
• Prostaglandin $F_{2a}$

Progestins

• Melengestrol Acetate - MGA

• Controlled Internal Drug Release - CIDR
Progesterone

MGA

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

Inhibition of Ovulation Following Long-term Progestin Treatment

MGA for 14 days

CL Regressed

Estrus

(less fertile)

Persistent Follicles

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

Follicle Diameter (mm)

-12 -10 -8 -6 -4 -2 0

Days Relative to Estrus (day 0)

Prostaglandin F$_{2\alpha}$ (PGF)

(Lutalyse, Prostafate, Estrumate, In Synch, estraPLAN)

- 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$_{2\alpha}$ – Effect of stage of the cycle

Hormonal management of follicular waves:
GnRH (Cystoclin, Factrel, Fertagyl, Ovacyst)

- Induces ovulation
- Synchronizes follicular waves
- Induces formation of a CL
**GnRH-Induced Ovulation During a Follicular Wave**

- **Day of the Estrous Cycle**
  -estrus
  - NO
  - YES
  - NO
  - YES

**Endocrinology of Fertility in Cattle**

- **Day of Cycle**
  - Follicular Phase
  - Luteal Phase

**Factors Affecting Pregnancy Rate**

- Ovulation to GnRH-1
- Follicle Size at AI
- Estradiol at AI
- Progesterone after AI
- Progesterone at PGF
- Pregnancy Rate

Atkins et al 2013

**How do you determine what went wrong?**

- Calculate the conception rate and/or pregnancy rate – Is it actually low?
- Ask for help – Veterinarian, AI rep, extension specialist, etc.
- Don’t make any assumptions.
- When trouble shooting try to systematically work through the possibilities.
What are the primary problems?

- Cattle are not good candidates for an estrus synch/AI program
- Protocol compliance
- Sire selection
- Facilities
- Shipping (trucking) stress
- Cattle lose weight during the breeding season.
- Failure to pay attention to detail.
- Unlikely the biological activity of the ES products is compromised

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?

Heifers-contd.

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?

Postpartum Cows – contd.

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?

Estrus Synchronization Products

Progestins
- Melengestrol Acetate
- EAZI-BREED CIDR

Prostaglandin F₂α
- Lutalyse
- Prostaire
- In Synch
- Estrumate
- estroPLAN

Estrus Synchronization Products

GnRH
- Cystorelin
- Fertagyl
- Factryl
- OvaCyst

Hormonal management of follicular waves

- GnRH – Induces dominant follicle to ovulate

- Estradiol – dominant follicle turnover (↓FSH)

- Progesterone – dominant follicle turnover (↓LH)

GnRH
(Cystorelin, Factrel, Fertagyl, Ovacyst)

- Induces ovulation

- Synchronizes follicular waves

- Induces formation of a CL
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

Variation in Ovulation Time

GnRH – Induced Surge of LH

White et. al., 2002