Introduction

Research in the area of equine breeding management has made major progress towards understanding the idiosyncrasies of equine reproduction since data was first reported at the Equine Nutrition and Physiology Society meeting in 1983. The purpose of this paper is to provide the horse industry with an overview of the types of technology equine scientists have developed as they relate to equine reproduction. The major focus of this manuscript is directed towards reproductive management of mares. However, several advances in stallion management also will be addressed.

Horses have the lowest reproductive efficiency of any species of livestock for several reasons: 1) horses usually are selected as breeding stock based on pedigree and athletic performance versus reproductive performance; 2) the “breeding” season is limited to a time of year which partially coincides with seasonal anestrus; and 3) failure to detect estrus or failure to breed the mare within 48 hours prior to ovulation.

From a horse breeder’s viewpoint, loss of time in producing a live foal translates into dollars and economic failure.

Questions critical to success are:

- Is she in estrus?
- Is she in foal?
- Is the pregnancy normal?

Prior to considering broodmare management practices in depth, horse breeders need a basic understanding of factors that contribute to reproductive inefficiency and failure in mares. Horse owners also should have knowledge of the mare’s reproductive anatomy, physiology, and endocrinology before attempting to breed the mare.

Seasonality

Mares are polyestrous (displaying more than one estrous cycle) during a restricted time of the year that coincides with long days, optimum food supply, and environmental conditions for survival of the young (May to October in the Northern Hemisphere, and November to April in the Southern Hemisphere). Two periods of reproductive status are seen, an ovulatory and an anovulatory season. During the ovulatory season the mare displays a definite estrous cycle which is accompanied by true estrous behavior and ovulation. The anovulatory season is characterized by a cessation of estrus and normal ovarian function. Transition periods between anestrus and estrous cyclicity are characterized by variability of ovarian activity and estrous behavior. During this period follicular development may occur without ovulation and there is a high frequency of erratic estrous behavior.

The anovulatory season is a period of sexual quiescence extending from the last ovulation of the breeding season to the first ovulation of the subsequent breeding season. Follicular activity is minimal during January and February (Northern Hemisphere) with an increase in activity from March to May. During anestrus the ovaries are usually small and hard. Estrous cycle length and duration of the heat period is longest during the autumn months and shortest between April and October. The number of estrous periods is lowest in winter months. The number of small follicles (<20 mm) increases slowly during January to March. In the latter part of March, the number of small follicles decreases; with a concomitant rise in the number of large follicles (>30 mm).

The Estrous Cycle

The process of reproduction is under neuroendocrine control. The pituitary hormones known to be involved in the estrous cycle are the gonadotropins: follicle-stimulating hormone (FSH) and luteinizing hormone (LH). Follicle-

Fact sheet

Recent Advances in Reproduction in Horses

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stimulating hormone potentiates follicular growth and subsequent amounts of estrogen to be secreted as they grow. Estrogen stimulates estrous behavior or the "heat" period in mares (5-7 days). Luteinizing hormone causes the ovarian follicle to mature and ovulate. After ovulation the follicle is replaced by a yellow-red mass of luteal tissue called the corpus luteum (CL), which secretes progesterone needed to maintain pregnancy up to day 100. Both FSH and LH are under control of the gonadotropin-releasing hormone (GnRH), which is secreted by the hypothalamus of the brain. Seasonal anestrus is caused by a change in the feedback mechanism between the ovary and the hypothalamus.

The estrous cycle is divided into two periods. The follicular phase is the period during which there is rapid growth of follicles. The mare displays behavioral estrus (5-7 days); then ovulation. The luteal phase begins with ovulation. During diestrus (14-15 days), the corpus luteum is formed and progesterone is produced. If the mare conceives the integrity of the corpus luteum is maintained and progesterone is secreted to maintain pregnancy for 40-50 days. Afterwards, a second rise of progesterone begins due to the formation of secondary CL. The production of PMSG from the endometrial cups is thought to provide the stimulus for secondary CL formation. Maternal progesterone secretion is necessary for approximately 100 days of gestation. Afterwards, pregnancy can be maintained by prostogestins produced by the fetal-placental unit. If the mare is not pregnant, prostaglandin F₂α will be secreted by the uterus to lyse the corpus luteum and the mare will return to estrus.

A variety of breeding management procedures have been developed based on equine reproductive research. These tools have practical application to the breeding farm owner and were designed to maximize the likelihood that mares become pregnant early in the breeding season. There are two major categories of breeding management procedures utilized: mechanical and hormonal.

**Mechanical Breeding Management Procedures**

Mechanical breeding management procedures include: 1) teasing; 2) rectal palpation; 3) ultrasound; 4) artificial insemination; and 5) artificial lighting.

Teasing and estrous behavior record keeping are the most important parts of a successful breeding program. Teasing is the presenting of a mare to a stallion to determine the sexual receptivity of the mare. Signs of estrous behavior differ in type and intensity among mares. Certain mares may tease positively to a particular stallion while displaying nonreceptivity to another. It is important with maiden mares and for mares with unknown teasing history to spend the extra time with one or two stallions to determine any idiosyncrasies. Positive signs of estrus include: posturing, tail raising, urination, and eversion of the vulvar labia (winking). Mares that are not in estrus may kick, bite, squeal, and pin their ears in response to exposure to the stallion.

Rectal palpation, and more recently ultrasound, are common procedures to improve reproductive efficiency. Both offer evaluations of a range of normal and abnormal physiological, cyclic, and seasonal changes, and pathology of the ovary and entire reproductive tract. Conception and foaling rates can be enhanced by using ultrasound, which enables breeders to visualize structures of the reproductive tract such as follicular development, embryo characteristics, and uterine status. Both rectal palpation and ultrasonography are used to predict time of ovulation, confirm pregnancy, and determine any reproductive tract abnormalities.

Artificial insemination, permitted for use in all registered breeds except the racing Thoroughbred, has many advantages both for stallions and mares. These include: 1) use of smaller inseminate volumes; 2) decreased danger to mares and handlers; 3) reduced uterine infection; 4) more effective utilization of older stallions; and 5) reduction of stallion use.

Infusion of large volumes of extender into the mare’s uterus before or after breeding with the intent of diluting harmful bacteria or prolonging sperm life is actually detrimental to conception rates. Semen may be lost through the cervix or spermatozoa number may be diluted to the extent that number of sperm reaching the oviduct is decreased. It is recommended that insemination volumes above 30 ml be avoided whenever possible.

Studies comparing plastic versus latex artificial vaginas and mare versus phantom mounts on stallion seminal and behavioral characteristics demonstrated that 1) either treatment had no effect on number of sperm per ejaculate; 2) use of an estrus mare as a mount did not have a beneficial effect on measured parameters; and 3) use of a phantom increased time to ejaculation, as did use of plastic liners.

Because mares are seasonal reproducers that respond to long photoperiod, artificial lighting programs often are used to advance the onset of the breeding season. By subjecting mares to lighting regimes of a continuous 16L:8D or interrupted 10L:8D:2L:4D in early December, one can
induce ovarian activity and ovulation in 60 days. Interrupted lighting regimes, researched at Rutgers University, have an advantage to horse breeders by reducing the total number of hours that lights must be on to advance the onset of ovulation and thereby saving money. Since most breeding farms begin breeding on February 15, mares should be placed under lights on the previous December 1.

**Hormonal Breeding Management Procedures**

Various hormones, such as progesterone, progesterin, human chorionic gonadotropin, gonadotropin-releasing hormone, and altrenogest (synthetic progestin) have been evaluated for their efficacy in the control of the mare’s estrous cycle. Hormone therapy can be used to correct deviations in normal estrous cycles, ease the frustration of the transition period, and synchronize estrus for breedings to stallions with limited bookings or for use in embryo transfer industry.

**Gonadotropin-Releasing Hormone**

While artificial lighting is currently the most widely utilized method for hastening the onset of follicular growth in anestrous mares, numerous studies have been conducted in recent years investigating the effects of single or multiple injections of GnRH, GnRH analogues and pituitary extracts on the stimulation of follicular growth and ovulation. Initial studies failed to enhance ovulation even though gonadotropin secretion was elevated and follicular growth was stimulated. These suggested that the pattern and frequency of administration may have been critical. Elegant research, conducted at Rutgers University using pulsatile administration of GnRH with the intent of simulating natural release, was successful in the induction of follicular development and ovulation in deep anestrous mares in 11 days in the absence of long photoperiod. Research in this area is still being conducted to make GnRH treatment practical for use on breeding farms.

**Human Chorionic Gonadotropin**

Because the luteinizing hormone has been implicated as the gonadotropin responsible for ovulation, hormone preparations with LH-like activity can be used to induce ovulation. Human chorionic gonadotropin (HCG) is commonly incorporated without detrimental effects into breeding programs to shorten estrus and hasten ovulation for application in synchronization. A dose of 2000 IU of HCG given on the second day of estrus will cause ovulation of a mature follicle within 48 hours.

**Prostaglandins**

Prostaglandin F<sub>α</sub>(PGF<sub>α</sub>) is released naturally by the endometrium of the uterus to cause luteolysis of the corpus luteum and a subsequent reduction in progesterone. Therefore, PGF<sub>α</sub>and its analogs, when administered exogenously, are valuable tools for inducing regression of the CL and subsequent return to estrus. Prostaglandins are probably the most widely used hormone therapy in the horse industry. Industry personnel should be aware that PGF<sub>α</sub> and its analogs are absorbed through the skin and can cause abortion in women. Therefore women of child-bearing age should exercise extreme caution when handling these products, for they may be unaware of pregnancies in early stages. As with all drugs, they should be utilized with veterinary supervision.

Various clinical uses of prostaglandins are:

- induction of estrus in “silent heat” mares
- termination of persistent corpus luteum
- short-cycling of mares
- shortening the interval to second foal heat
- induction of abortion

Prostaglandin treatment of mares with mature CL results in a return to estrus in 2-4 days and ovulation in 7-12 days. In combination with HCG treatment, PGF<sub>α</sub> can be used effectively for synchronization of ovulation.

PGF<sub>α</sub> is only effective when administered while the mare has a functioning CL (days 4-15 diestrus). Therefore it is of little use early in the breeding season when normal estrous cycles have yet to be established.

**Progesterone and Progestins**

Progesterone and synthetic progestin treatments have been widely used in mares to shorten prolonged estrus during the transition period, to suppress estrous behavior, and to supplement endogenous progesterone for pregnancy maintenance. While both are equally effective, progesterone, which is given by injection, has a disadvantage in route of administration. Synthetic progestins such as altrenogest can be given orally and are therefore much easier for the horse breeder to use.

The transition period from anestrus to normal seasonal estrus is often difficult for horse breeders because the transitional heat periods are often long, erratic, and not always accompanied by ovulation. Administration of
progesterone or synthetic progestin blocks the expression of estrus and regulates erratic follicular activity. When treatment is stopped, the hypothalamus is cued to again produce GnRH which subsequently stimulates the release of FSH and LH. Progesterone should be given intramuscularly at a dose of 100-150 mg daily for 7 to 9 days. Dosage of altrenogest is 1 ml per 110 pounds of body weight orally for 15 days.

Progesterone and altrenogest can also be used to supplement progesterone levels for pregnancy maintenance. Mare blood progesterone concentrations of at least 2.5 ng/ml are necessary up to day 100 to ensure a viable pregnancy.

Many horse breeders wonder whether or not they should breed mares on foal heats. Progesterone and altrenogest can also be used to shorten the postpartum interval to the second foal heat.

**Estradiol**

A final hormone therapy that horse breeders may want to take advantage of is that of estradiol-17ß. Given intramuscularly in a dosage of 1-2 mg per day, estradiol will bring about estrus and accompanying behavior for utilization in “jump” mares used in stallion collection.

**Stallion Collection**

Research studies suggest that 100-250x10⁶ progressively motile sperm per insemination are optimal for conception. It also has been demonstrated that increasing daily frequency of ejaculation from one to two collections does not increase total sperm output. In other words, there are only a certain amount of spermatozoa available each day; therefore care must be taken to make intervals between breedings (in natural cover) long enough to insure maximum conception rates. Once ejaculation frequency exceeds every other day, sperm output per ejaculate decreases. This is not to suggest, however, that are insufficient spermatozoa to impregnate a mare. Stallion semen should be evaluated under a microscope regularly during the breeding season to document fertility.

Besides frequency of ejaculation; stallion age, testes size, libido, and seasonality must also be considered when evaluating fertility. Both anabolic steroids and winter daylengths render stallions less fertile by reducing gonadotropin secretion which in turn decreases testicular size, sperm output, and libido. Older stallions produce less spermatozoa than younger stallions. Libido can also be reduced by overuse, misuse, and lack of teasing by an estrous mare.

**Summary**

Although special management practices are often employed to prepare mares and stallions for reproductive functions just before the breeding season, the most important preconditioning management practices are utilized year round. Fall of the year is an ideal time to examine barren mares to identify and treat specific reproductive problems while evaluating breeding status and fertility. Have a good working relationship with your veterinarian who can assist in uterine biopsies and cultures which may be necessary for barren mares. Proper nutrition, parasite control, vaccination schedules, record keeping, and sanitation are all critical to making the breeding farm successful.

Equine scientists around the world are committed to providing horse breeders and owners with the most recent technology in all aspects of equine management, from nutrition to growth and reproduction. With continued industry support progress toward the production of a better equine athlete is possible.

**References**


