MU Beef Cow/Calf Series

Beef Cattle Reproduction

Whittier

M149, New 9/93/5M, $3.00

Beef Cattle Reproduction

Written by:
Jack Whittier, associate professor, animal science extension

Published by University Extension, University of Missouri-Columbia

Produced by the Office of Extension and Agricultural Information

For information on how to order additional publications in the Beef Cow/Calf series, see MU publication M147, *University Extension and Your Cow/Calf Operation*, or check with your local extension center.

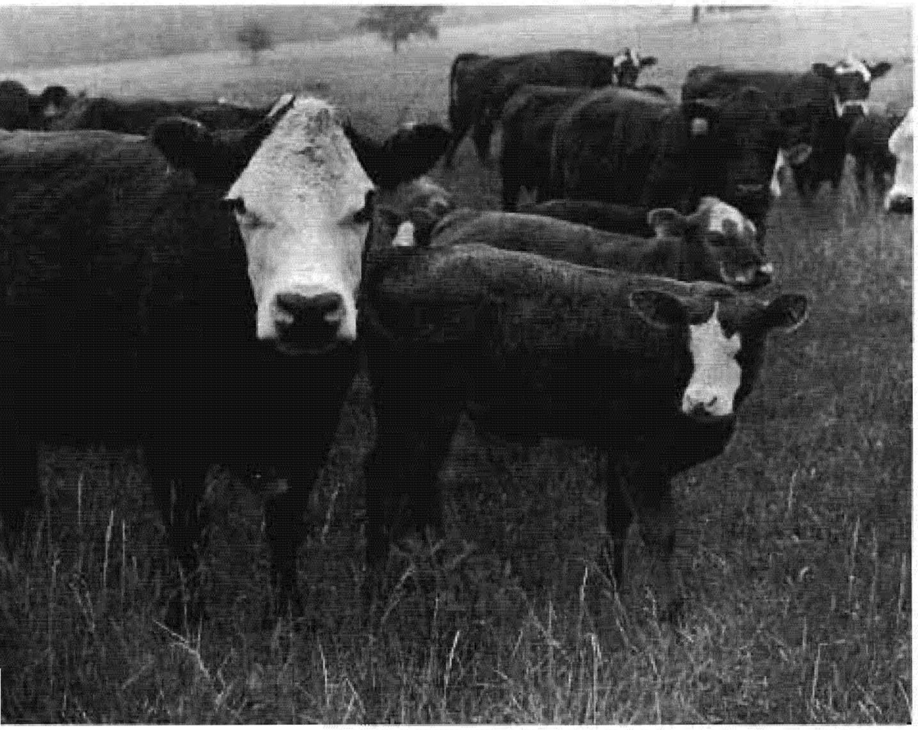
On the cover: *A growthy crossbred calf, almost as large as the mother cow, at weaning time. Getting the cow bred on time and producing a live calf are important steps in the herd reproduction cycle.*

MU Beef Cow/Calf Series

Beef Cattle Reproduction

Table of Contents

Beef Cattle Reproduction



Understanding cattle reproduction is the key to enhancing the genetics and productivity of any herd.

The cow's ability to mate, conceive, give birth and raise a healthy calf each year is paramount to profitable beef production. To successfully manage this reproduction, it is important to have a good understanding of the anatomy and physiology of both the male and female animals. This knowledge will help identify and ovetcome causes for failutes in reproduction.

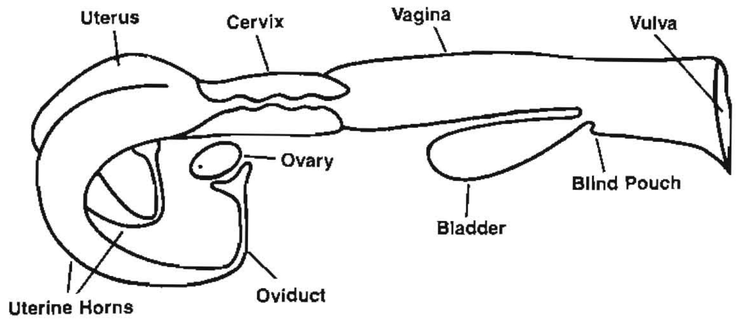
The quest to more fully understand science and biology has led to the development of numerous techniques for manipulating animal reproductive processes. These techniques give the modern beef producer many management options to pursue.

Reproductive anatomy of the cow

Two essential otgans of reproduction are located within the head of the animal.

The hypothalamus controls several body processes and behaviors along with reptoductive processes. Body temperature, concentration, components of body fluids and the drive to eat and drink are just a few of the hypothalamus' functions. It is classified as a neuroendocrine gland — it sends and receives neural signals through the nervous system and

Figure 1. Reproductive anatomy of the cow



sends and receives hormonal messages through the endocrine system.

The second organ, the pituitary gland, sits at the base of the brain. This gland is about one-half inch in diameter and weighs about one gram. Physiologically, the pituitary is divided into two distinct regions: the anterior and the posterior pituitaries. Each region secretes various hormones that direct body processes. Some of these hormones are responsible for reproductive events, while others control growth, metabolism and water balance.

The female reproductive organs consist of the ovary, uterus, cervix, vagina and vulva. A diagrammatic sketch of the reproductive tract of the cow is shown in Figure 1. Female reproductive tracts of various farm animals are similar to the cow. The primary difference between these animals is the shape of the uterus.

Ovary

The ovary, or female gonad, is responsible for two basic functions:

1. Production of the female gamete, the egg or ovum.
2. Production of several primary reproductive hormones, including estrogen and progesterone.

A cow has two bean-shaped ovaries located within the abdominal cavity. The size of the ovaries varies with the stage of the reproductive cycle and age of the female, but they generally are 1 to 1.5 inches long.

Oviduct

The oviduct begins as a funnel-shaped tube rhat engulfs the ovary. This funnel portion of the oviduct is called the infundibulum. When ovulation occurs, the ovum is gathered by the infundibulum and channeled into the oviduct (also known as the fallopian tube) where fertilization takes place if viable sperm are present. Here the ovum remains capable of fertilization for only a short time. It is essential that sperm be present in the oviduct near ovulation. The ovum moves through the oviduct into the uterine horn within the next three to four days. If the ovum is fertilized, it then begins embryological development; if not, it degenerates and disappears, and the next estrous cycle ensues.

Uterus

The body of the uterus of the cow is short, while the uterine horns are relatively long and well developed. The fertilized embryo moves from the oviduct into the uterine horn, where it attaches to the uterine wall. The newly developing fetus grows within a layer of membranes called the placenta. Nourishment from the dam passes through this membrane to the embryo. There is no direct blood connection between the fetus and the dam. Instead, a complex system selectively allows certain molecules to pass from the maternal side of the placenta to the fetal side and vice versa.

Cervix

The cervix is, in effect, the neck of the uterus. It has thick walls and a small opening that softens and relaxes to allow a passageway for sperm at mating and expulsion of the fetus at the time of birth. During pregnancy, the cervix is filled with a thick mucus secretion known as the cervical plug, which protects the uterus from infections that might enter by way of the vagina. The cervical plug softens and is expelled and the cervical opening begins to dilate in the days prior to calving.

Vagina

The vagina is the receptacle for the male's penis during service. During natural mating, the bull's semen is deposited in the vagina near the cervix. When artificial insemination is used, an insemination instrument is threaded through the vagina and cervix, and semen is deposited at the uterine side of the cervix. Urine is discharged from the urinary bladder through the urethra, which opens into the base of the vagina. The region behind the urethral opening is called the vestibule and is a common passageway for both the urinary and reproductive systems. The external opening of the vagina is called the vulva.

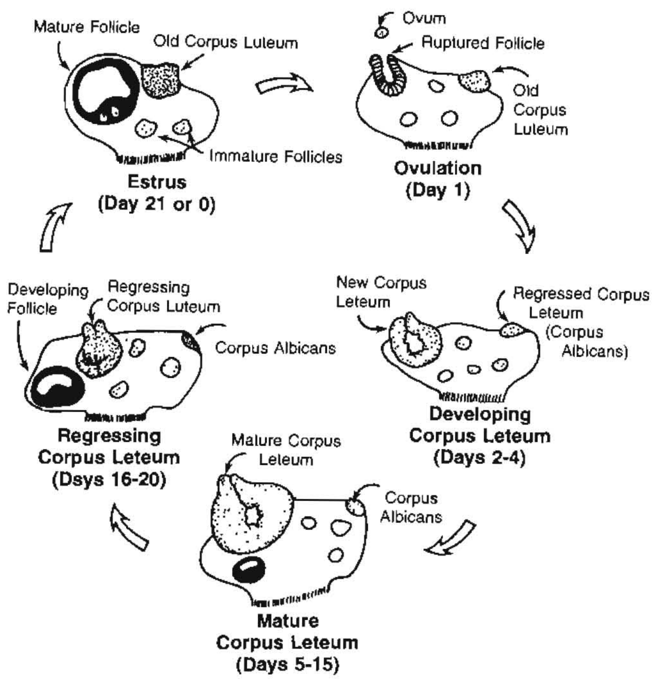
Reproductive physiology of the cow

The ovary produces an egg during oogenesis (see Figure 2). In contrast to spermatogenesis in the bull, which is continuous, oogenesis is completed in the developing fetus before birth: the female is born with all the eggs she will ever have. After puberty, the female begins to cycle every 20 to 24 days. In cattle, this cycle of egg development is called the estrous cycle. During each esttous cycle, two prominent structures are present within the ovary. They are the follicle and corpora lutea.

Each of these structures undergo a development phase and subsequent regression phase during the estrous cycle. Follicles begin within the ovary as one of several thousand primary follicles, which consist of a germ cell surrounded by a layer of flattened cells. This germ cell has the potential to mature into an egg if the follicle completes the development phase. However, only a small percentage of primary follicles continue through the secondary and tertiary follicular phases and ultimately undergo ovulation. Primary follicles that never complete development die and are replaced by newly formed primary follicles.

The relatively few primary follicles that complete development do so through a series of phases. Many layers of cells are added to the single layer of cells surrounding the egg in the secondary follicle, and a central cavity forms as it develops to the tertiary stage. The follicle and cavity within the follicle grow larger and the egg becomes attached to a stalk of cells on the side of the follicle opposite the future site of ovulation.

Figure 2.
Ovarian changes during a typical 21-day estrous cycle in which pregnancy does not occur. The development and regression of the corpus luteum and of the follicles are continuous processes in non-pregnant, cyclic females.



As the follicle continues to grow, the outer layer of the follicle becomes thinner. This follicle is mature and called a Graafian follicle. The outer layer of the follicle ruptures at the appropriate time and the egg and contents of the follicular cavity are released.

Follicular development occurs in two to three distinct follicular waves during the estrous cycle and in concert with other reproductive and behavioral functions. In the follicular wave that precedes ovulation, one follicle is established as the dominant follicle, which ovulates at the appropriate time. Near the time of ovulation, the uterus is prepared to receive both the egg and sperm from the bull.

Following ovulation, the remaining cells of the follicle undergo a differentiation process by action of pituitary hormones. This process, called luteinization, gives rise to the second ovarian structure, the corpus luteum. This structure is often simply called the CL and has the important function of secreting the hormone progesterone.

The CL goes through a maturation and regression cycle much the same as that for a follicle. A blood clot-type structure known as a corpus hemorrhagicum forms in the cavity left by the ruptured follicle and is transformed into a CL by day five of the cycle (day zero is estrus). The CL is fully functional from day five to day 15 of the cycle and then begins to regress if the female does not become pregnant. The CL regresses and no longer secretes progesterone as the dominant follicle of the next estrous cycle begins to develop. As the CL regresses further, it becomes known as the corpus albicans and remains visible on the ovary for several subsequent cycles.

Figure 2 illustrates the changing structures on the ovary during a typical 21-day estrous cycle. The dynamic development and regression of the corpus luteum and follicles is a continual process until the cow becomes pregnant. In the pregnant female, CL regression does not occur and the cyclic activity stops until after calving.

After calving, a cow generally remains anestrous (does not cycle) for roughly 60 days, then estrous cycles return. The length of this postpartum anestrous period can be affected by nutrition, lactation, environmental stress and numerous other factors. Keeping the length of this anestrous period to a minimum is a main consideration in successful cow-calf progtams. If the cow is to produce calves on a yearly interval, she must rebreed within 85 days after calving.

Problems with estrous cycles

Any condition that prolongs the period of time that blood levels of progesterone remain high will have the same effect as pregnancy in stopping the 21-day cycle. Occasionally the CL does not regress normally (known as a persistent CL) even though the animal is not pregnant. This condition requires diagnosis and treatment by a veterinarian.

Abnormally short estrous cycles (7 to 11 days) can occur. This condition appears to be caused by either no corpus luteum being formed, or if one is formed, it is nonfunctional and progesterone levels remain low. An estrous cycle can be shortened intentionally by injecting a hormone called prostaglandin, which causes the CL to regress. Prostaglandin injection is one method used to synchronize estrus of animals within a cow herd.

Estrus, commonly called "heat," is not always accompanied by ovulation, or ovulation by estrus. Heat without ovulation (anovulatory heat) will not result in pregnancy even though the female is bred. Ovulation without behavioral estrus (silent heat) is not uncommon in cows, especially during the first few weeks after calving. Such females will not accept service from a male.

Hormonal regulation of the female reproductive tract

The endocrine glands secrete hormones that control the female reproductive system. These secretions are produced in the glandular cells and pass into the blood and lymph systems for transport to specific parts of the body where they produce their function.

The female hormone, estrogen, is produced by the ovarian follicle. Estrogen influences:

- Development and function of the secondary sex organs.
- Onset of behavioral estrus, i.e., the period of sexual receptivity.
- Rate and type of animal growth, especially deposition of fat.
- Prepares the prepubertal heifer and post-partum cow for onset of cyclic sexual activity.

Progesterone, secreted by the corpus luteum, suppresses the further development of follicles and the secretion of estrogen. High progesterone levels and low levels of estrogen prevent a cow from coming into heat. Also, progesterone is necessary for preparing the uterus to receive the fertilized egg, and it maintains the proper uterine environment for the continuation of pregnancy.

Estrogen and progesterone are not completely separate in their functions. Both must be present for certain processes to occur. For example: The estrogen/progesterone concentration ratio dictates the onset and duration of behavioral estrus.

Development of the uterus is initiated by estrogen and completed by progesterone. Estrogen causes contraction of the uterus near the time of estrus and ovulation, which aids in sperm transport, while progesterone has a quieting effect on the uterus so that there are no contractions that might disturb pregnancy.

The production of ovarian hormones is under direct influence of gonadotropic hormones produced by the anterior pituitary. The pituitary secretes the follicle stimulating hormone (FSH) and luteinizing hormone (LH), both of which travel through the blood to the ovary. Release of FSH and LH is regulated by gonadotropin releasing hormone (GnRH) coming from the hypothalamus. FSH stimulates the growth, development and function of the follicle, while LH causes the follicle to rupture during ovulation and causes the subsequent development of the corpus luteum.

The cyclic rise and decline of reproductive hormone concentrations are shown in Figure 3. This process is repeated every 20 to 21 days in a normal cycling cow but changes if conception occurs. Following pregnancy and the anestrous period, estrous cycles continue.

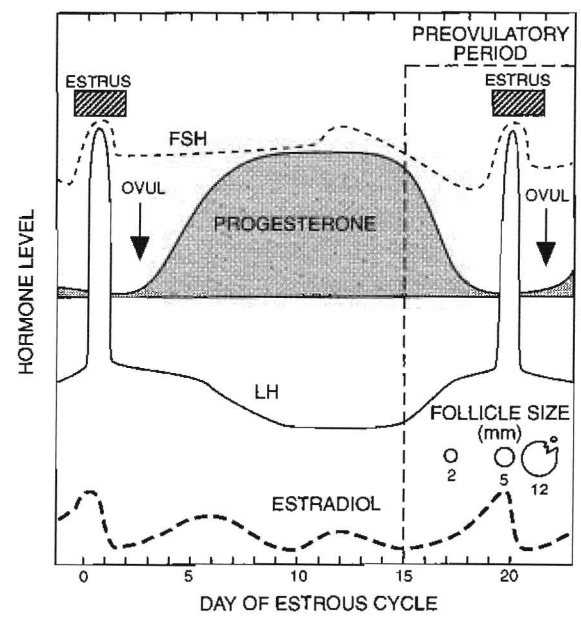


Figure 3.
Rise and decline of reproductive hormone concentration during a typical 21-day estrous cycle.

Reproductive anatomy of the bull

Good reproductive performance of a bull is necessary to obtain a high percent calf crop when natural service is used for breeding. For optimum production during a short breeding season, a bull must be fertile as well as capable and willing to mate a large number of cows. A basic understanding of the bull's reproductive tract will improve management. This knowledge will also help you better understand breeding soundness examinations, reproductive problems and breeding impairments.

The reproductive tract of the bull consists of the testicles, secondary sex organs and three accessory sex glands. These organs work in concert to form, mature and transport the spermatozoa that are eventually deposited in the female reproductive tract during mating. The secondary sex organs are the epididymis, vas deferens and penis. The three accessory sex glands include the seminal vesicles, prostrate and bulbourethral gland (Cowper's gland). This basic anatomy is illustrated in Figure 4.

Testicles

The testicles are located outside the body cavity in the scrotum and have two very vital functions: producing spermatozoa and producing the male hormone, testosterone. The testicles are located outside the body cavity for normal sperm formation, which occurs only at 4 to 5 degrees below body temperature.

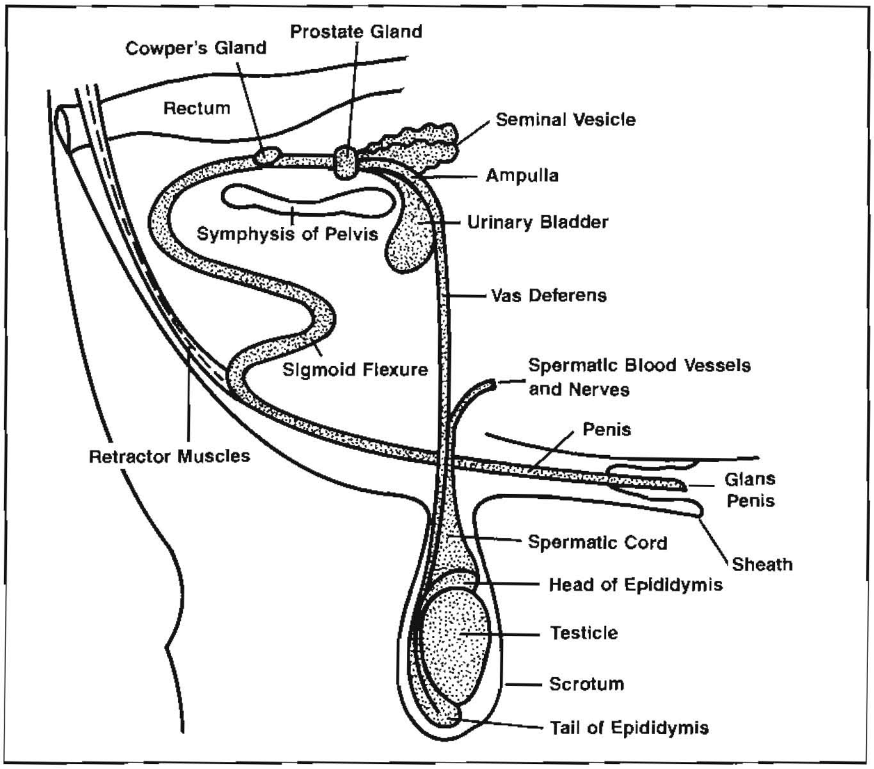
The scrotum provides physical protection to the testicles and helps to regulate testicular temperature for optimum spermatozoa development. This regulation is done by coordination of three structures:

1. A temperature-sensitive layer of muscle (tunica dartos) located in the wall of the scrotum that relaxes when hot and contracts when cold to move the testes closer or farther from the body.
2. The external cremaster muscle within the spermatic cord that controls the proximity of the testicle to the body by lengthening or shortening depending on environmental temperature.
3. The pampiniform plexus, which is a coil of testicular veins surrounding the testicular artery. The coil provides an effective mechanism for cooling arterial blood entering the testicle by transferring heat to the venous blood leaving the testicle.

One or both testicles occasionally fail to descend into the scrotum during fetal development and are retained in the body cavity. This condition is known as cryptorchism. Hormone production by cryptorchid males is near normal and the male develops and behaves like a normal male; however, notmal sperm production is virtually nonexistent. Therefore, the bull is generally infertile. This condition is genetically inherited, therefore such males should not be used for breeding.

The testicle contains many long, tiny, coiled tubes known as seminiferous tubules, where sperm are formed and begin to mature. Scattered throughout the tissue surrounding the seminiferous tubules are many highly specialized cells, the Leydig, or interstitial cells that produce testosterone. Hundreds of individual seminiferous tubules in the body of

Figure 4.
Reproductive
anatomy of the bull



the testicle unite to form tubules that exit from the testicle and pass into the epididymis.

Epididymis

The epididymis is a compact, flat, elongated structure closely attached to one side of the testicle. It is divided into three regions: the head, body and tail. The many tubules entering the head of the epididymis from the testicle unite to form a single tubule some 130 to 160 feet long. This tubule is convoluted and packed into the 6-inch to 8-inch epididymis. Four major functions occur in the epididymis:

1. Transport of developing sperm cells from the testicle to the vas deferens.
2. Concentration of the sperm by absorption of surplus fluids.
3. Maturation of developing spermatozoa.
4. Storage of viable sperm cells in the epididymis tail.

If sexual activity is slowed, resorption of sperm cells from the epididymis tail occurs.

The epididymis is the outlet for all the sperm. Any blockage of this tube will cause sterility. Temporary blockage due to swelling from an injury or infection (epididymitis) will result in short-term infertility. If the swelling or infection causes scar tissue to form in the tubule, it may permanently block the passage of sperm. If blockage occurs in both epididymides, the bull is no longer a useful breeder. Surgical removal of the tail of the epididymis (epidectomy) is a method of sterilizing males used for teaser (Gomer) bulls for estrus detection. Epidectomized bulls service cows in the usual manner, but will not deposit sperm in the female reproductive tract.

The vas deferens (also known as the ductus deferens) emerges from the tail of the epididymis as a straight tubule and passes through the inguinal canal into the body cavity. Spermatozoa are transported further along the reproductive tract to the pelvic region through rhe vas deferens by contraction of the smooth muscle tissue surrounding this tubule during ejaculation. Bulls may also be sterilized by a vasectomy. A section of the vas deferens is removed so that sperm cannot pass to the outside of the body.

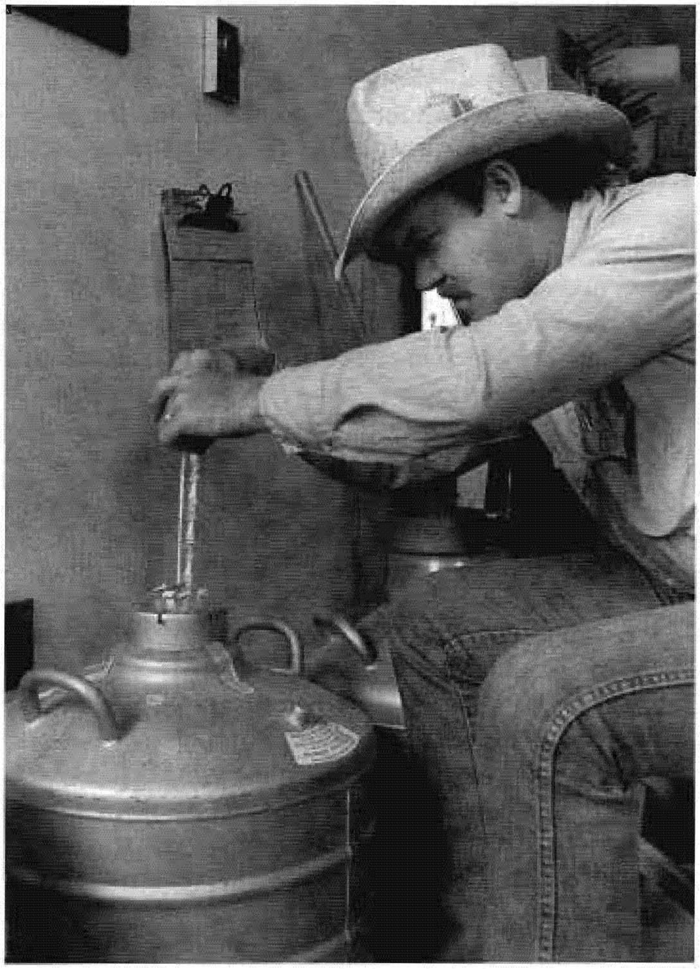
Vas Deferens

The two vas deferens eventually unite into a single tube (the urethra), which is the channel passing through the penis. The urethta in the male serves as a common passageway for semen from the reproductive tract and urine from the urinary tract.

Urethra

Two of the accessory glands are found in the general region where the vas deferens unite to become the urethra. Secretions from these glands make up most of the liquid portion of the semen. In addition, the secretions activate the sperm so that they become mobile. The seminal vesicles consist of two lobes about 4- to 5- inches long, each connected to the urethra by a duct. The prostate gland is located at the neck of the urinaty bladder where it empties into the urethra. In comparison to

Accessory glands



Storage of semen in liquid nitrogen permits selection of outstanding sires through artificial insemination.

other animals, the prostate is relatively small in the bull. It does not produce a very large volume of secretions.

The third accessory gland, the Cowper's gland, is a small, firm gland located on either side of the urethra. These glands produce most of the clear secretion that often drips from the penis during sexual excitement prior to service. This fluid flushes and cleanses the urethra of any urine residue that would hatm the sperm.

One of the accessory glands may occasionally become infected, resulting in semen samples that are yellow, cloudy and contain pus cells (seminal vesiculitis). Antibiotic treatment is sometimes necessary, but time will generally correct the problem.

Penis

The penis is the organ of insemination. The end of the penis is the glans penis and is richly supplied with nerves that are stimulated during copulation to induce ejaculation. Impairments of the glans penis (Figure 5) should be detected during a breeding soundness exam.

The sigmoid flexure is an anatomical structure that provides a means by which the penis is held inside the sheath except during time of service. Strong retractor muscles hold the penis in the "S" shaped configuration. Occasionally, these muscles are too weak to function properly, and a portion of the penis and sheath lining will protrude at all times exposing the male to injury. Avoid this characteristic when selecting a herd bull.

Hormonal regulation of the male reproductive tract

The normal functions of male reproduction are largely controlled by hormones that are secreted from the endocrine glands. The testicle functions as an endocrine gland because of its production of the male hormone, testosterone, by interstitial cells. Testosterone has several major functions:

1. It is largely responsible for development and maintenance of the male reproductive tract.
2. It causes the development and maintenance of the secondary sex characteristics associated with masculinity, such as the bull's crest and heavily muscled shoulders.
3. It is a major factor in the normal sex drive and behavior of the male.
4. It increases muscular and skeletal growth.
5. It is essential for normal sperm formation.

The testicle is, in turn, under the influence of hormones produced by other glands in the body. The same gonadotropic hormones that regulate ovarian functions in the cow also regulate testicular functions in the bull. The luteinizing hormone (LH) and follicle stimulating hormone (FSH) appear to be misnamed as they pertain to male reproduction, yet each carries out several important male functions.

LH and FSH are released from the pituitary and cause the testicle to secrete testosterone, which then acts on the germ cell lining of the seminiferous tubules to stimulate maturation of sperm cells. In addition, sperm cells need FSH to mature. Normal functioning of the male accessory glands require testosterone.

Not only is hormonal production by the testicle regulated by hormones released by the anterior pituitary, but the reverse is true also. Testosterone levels in the blood regulate the secretion of gonadotropic hormones from the anterior pituitary by means of a feedback system. A proper balance of all hormones is vital to successful reproductive functions.

Breeding soundness exams

Bulls should be examined for breeding soundness before the breeding season. It should be pointed out that a breeding soundness examination is simply a screening procedure to eliminate bulls that have a high possibility of being infertile. This examination is not a "fertility test" because there are no techniques available that accurately predict fertility. Results from an actual breeding season remain the only test of a bull's breeding ability.

The examination should be performed by an experienced, trained person, usually a veterinarian. Guidelines for a breeding soundness examination follow.

Physical examination

Examine the penis — during electro-ejaculation or natural mating — in an erected, extended state. Figure 5 illustrates possible abnormalities of the penis. Potential problems of the penis may include: hair rings which restrict circulation, a persistent frenulum or adhesion, lacerations, growths, scar tissue, deviations or a urethral fistula.

Palpate the scrotum and testes. The scrotum should be pendulous but well-supported. The testes should be firm and uniform in size and shape. Internal sex organs should be palpated rectally to ensure proper development and size. Good vision and sound feet and legs should also be considered when evaluating a bull's physical ability to breed.

Determine scrotal circumference. Scrotal circumference is an indication of a bull's ability to produce sperm and is related to younger age at puberty. Breeds differ in scrotal circumference, but 32 centimeters (12.8 inches) is generally accepted as the minimum size for yearling bulls to be sound breeders.

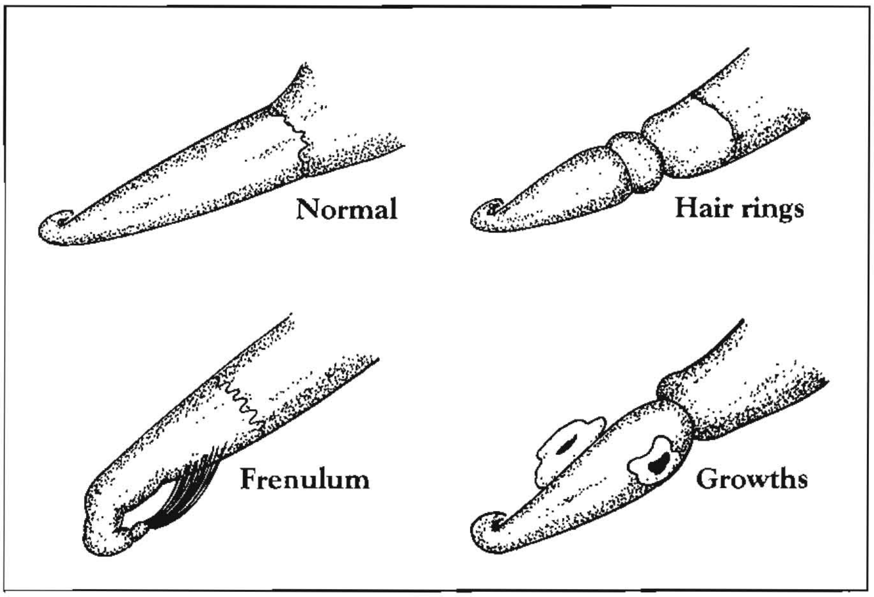


Figure 5. Impairments of the penis.

Semen evaluation

Semen is evaluated fot volume, concentration, motility and morphology. Ptoper training is required to accurately evaluate semen.

The evaluation guidelines and form used to evaluate breeding soundness were revised in 1992. Revisions include discontinued use of a numerical system in favor of recommended minimum standards for scrotal circumference, sperm motility and sperm morphology.

Breeding soundness examinations presently do not evaluate a bull's sexual drive, or libido. Libido testing is time consuming and difficult to conduct on a large scale. Females in estrus are required for the tests. Procedures are being investigated by several researchers to better evaluate the willingness and desire of bulls to mate.

Improving reproductive performance in beef cattle: Artificial insemination

Artificial insemination (AI) is a management tool that entails collecting semen from the male and inseminating it into the female. Artificial insemination is used with many species of animals, particularly food-producing animals. The dairy industry has dramatically increased milk production pet cow with AI. And a growing number of seedstock producers are turning to AI for breed improvement, although it is currently used on less than 10 percent of the nation's beef cow herd. Many commercial cattle operations are incorporating AI into their management systems, especially in replacement heifer development.

Numerous advantages for using AI in beef herds can be identified. Among these are:

- The potential for genetic gains both within a breed and in the development of new breeds or crossbreds.
- Allows more cows to be bred to a superiot sire than by natural service.
- Allows use of outstanding bulls, often the best in the industry, and it generally provides access to them at moderate prices.
- If you only have a few cows, you have as great a selection of genetics as someone with 1,000 cows.
- By using sire summary information in your selection, you can breed heifers to bulls known to reduce the risk of calving difficulty.
- Using top bulls will result in top replacement heifers.
- You don't have to keep a bull around all year.
- AI forces you to keep records. Accurate decisions result from accurate records.
- Eliminate the need for several breeding pastures to manage a crossbreeding plan.
- AI encourages improved management. There is no sense committing the labor and resources if you are not going to do it right.

To get the most out of an AI program, cows must be in good body condition and a high percentage of them must be cycling normally. Take caution before introducing an AI program on your operation if more than 20 percent of your cows are open at the end of the breeding season with natural service or more than 50 percent of your calves are born after the first 40 days of the calving season.

To ensure success, follow these guidelines:

- Make sure your feeding program is meeting the nutrition needs of your cows.
- Trained personnel must detect heat, handle the cows, care for the semen and inseminate the cows.
- Heat detection and insemination are time consuming and confining. They have to be done correctly and they have to be done on schedule.
- Cows must be individually identified so those in estrus can be sorted and inseminated on schedule.
- Records must be kept if accurate ancestry is required.
- Facilities must be adequate to handle the cows with a minimum of stress.
- AI training is a continuous process. Even if you have been to an AI school, you will need periodic retraining and updating.
- You may need to buy a semen tank and supplies.
- The success or failure of any AI program is up to the person managing it. One study comparing AI programs showed that conception rates vary from 25 percent to 100 percent. The difference was management.

Heat detection

Changing from a natural breeding program to artificial insemination increases labor demands. Heat detection is one of the most labor-intensive chores. To master this skill, you must understand the behavioral changes a cow undergoes before, during and after estrus. Figure 6 outlines these changes.

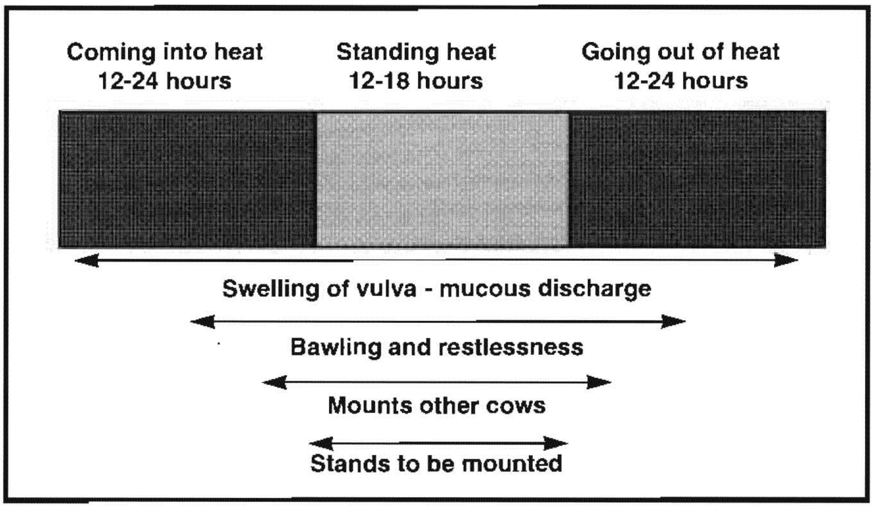


Figure 6. Signs of estrus

With these basics of heat detection in mind, you can pick the detection method that best fits your operation. The most important criterion is not to upset routine herd patterns. The following management procedures will help keep routines intact:

1. At least two weeks prior to the breeding season, move the herd into small detection pastures. Females become familiar with surroundings and cycling will not be upset.

2. Record the date of all observable heat periods before the onset of the breeding season. This will tell you which females are cycling and will provide some indication of expected breeding dates after onset of the AI period.
3. Determine which cows will be eligible to breed during the planned AI period. Cows need a minimum of 45 days between calving and the beginning of the AI period.
4. Feed females near the breeding facilities and at the same time each morning to aid in heat detection and reduce handling.
5. A keen-eyed observer who understands cow behavior is most essential for heat detection. There are certain signs to look for (See Table 1). Various aids also can improve detection accuracy. Carefully consider which means of heat detection you will use. Methods include a surgical alteration of bulls, such as a vasectomy or penectomy, or merely the use of pen-o-blocks in the sheath to prevent mating. Detection aids such as chinball markers or KaMaR devices can also help determine estrus.
6. Allow the cows to become accustomed to the heat observer moving among them. Use a manner similar to that being used during the breeding season.

Observe Changes In:	Coming into Heat	Standing Heat	Going out of Heat
Appetite	Noticeable decrease	Sharp decrease	Slowly returning
Nervous and restless behavior	Very noticeable	Very noticeable	Noticeable
Fence walking or wandering	Frequent	Less frequent	Frequent
Bawling	Frequently	Much less frequent	Very little
Persistent trailing of other animals	Yes	Yes	Very little
Temperament toward other animals	Very antagonistic	Less antagonistic	Almost back to normal
Head butting	Quite frequent	Much less frequent	May increase frequency
Licking other animals	Yes	Yes	Yes
Mounting behavior	Will jump others, but not stand to be ridden	Will jump others and will stand to be ridden	May jump others and will not stand to be ridden
Response to observers	Cautious, at times "spooky"	Interested; friendly	Shy; avoiding
Mucus consistency	Very watery, clear	Cohesive strands, clear	Cohesive strands, clear
External genitalia (vulva)	Red and puffy	Red and puffy	Less swollen with some redness
Bloody discharge	Not usually	Not usually	May be observed 1 or 4 days after end of estrus

Table 1. Stages and description of estrus behavior in cows.

Insemination methods

AI techniques can be learned with proper instruction and practice. Most breeding associations periodically offer week-long schools on AI methods. Such associations include:

American Breeders Service
Regional Office
2111 Cherry Valley Road
Neward, OH 43055

The Genetic Horizons Group
Missouri Cattle Breeders, Inc.
Rural Route #7, Box 148
Columbia, MO 65202

Twenty-First Century
Genetics Cooperative
Regional Service Center
Route 3, Box 295-100
Strafford, MO 65757

Select Sires, Inc.
KABA/Selection Sires
1930 Herr Lane
P. O. Box 22146
Louisville, KY 40222

Tri-State Breeders Cooperative
Route 3, Box 50
Baraboo, WI 53913-9990

Estrous synchronization

Estrous (heat) synchronization can help beef producers improve both production efficiency and economic returns. Its purpose is to control estrus and ovulation in cycling females so that breeding can be completed in a short period of time. Instead of cows being bred throughout a 21-day period, synchronization may shorten the breeding period to 10 days or less, depending on the program selected. As with many other modern beef production techniques, estrous synchronization requires top management for success.

You should understand the benefits and disadvantages of synchronization, how the different products and programs work and the results and costs involved before you initiate the practice. You should set goals for the practice, especially on what you expect to gain from it.

Potential benefits

Estrous synchronization:

- Reduces time and labor for heat detection in AI programs.
- Allows greater use of superior sires with either AI or natural service.
- Helps ease selection of sires of various breeds for crossbreeding through AI.
- Improves scheduling of labor for AI.
- Shortens breeding seasons.
- Concentrates breeding and calving periods.
- Produces a more uniform calf crop due to similar calf age and calf sire.
- Makes management of cows and calves more uniform.

Requirements for successful estrous synchronization

Management considerations include:

- More intensified labor at breeding and calving time.
- Producer must allow for bad weather during concentrated breeding and calving periods.

- Requires adequate corrals, facilities and additional labor for handling cattle during treatment and breeding.
- Need very active, healthy, fertile bulls for concentrated breeding if AI is not used.
- Need quality semen for AI and experienced inseminators.
- Requires additional costs of synchronization product and semen for AI.
- May result in poor conception rates if requirements are not followed.
- Must have good management and planned program for successful results.
- Heifers and cows need to be cycling normally before treatment and be on a good nutrition program.
- Cows need a minimum of 45 days post-calving before treatment.

Table 2 shows products approved by the Food and Drug Administration for estrous synchronization that have no adverse side effects on fertility or general health. Two types of products are available — one is a prostaglandin and the other a combination of progestin and estrogen. These products work differently on the ovary and are administered differently, so an understanding of their actions is necessary. Several management alternatives must also be considered to fit the products and programs to your operation and capabilities.

Table 2. Products for estrous synchronization.

Product	Company	Type	Administration	Dose (cc)	Available from
Lutalyse	Upjohn	prostaglandin	IM injection	5	vet.
Estrumate	Mobay	prostaglandin	IM injection	2	vet.
Bovilene	Syntex	prostaglandin	SC injection	2	vet.
Syncro-mate B	Sanofi-CEVA	progestin + estrogen	Implant + IM injection	2	AI supplier
MGA	Upjohn	oral progestin	In feed	--	Feed dealer

Prostaglandin products

Three products, Lutalyse, Bovilene and Estrumate are approved for estrous synchronization of beef and dairy cows and heifers. All three are prostaglandins and work similarly, but they differ slightly in chemical makeup and dosage levels.

When injected at the recommended dosage, these products rapidly regress the CL on the ovaries of females that are in day six to day 16 of their estrous cycles. In other words, the products decrease the function of the CL, which allows these females to return to estrus within two to five days and synchronizes their estrous cycles. Females injected during day 17 to day 20 will be in estrus normally (within one to four days) and therefore will also be synchronized. Females in day one to day five do not have a mature CL and will not respond to the injection; neither will females that are not cycling. Therefore, one injection will synchronize only about 75 percent of the cows cycling in a herd.

Label precautions on these products indicate the drug will cause abortions in pregnant cows and should not be handled by pregnant women or persons with asthma or bronchial problems.

A variety of programs can be used depending on facilities, time and labor, heat detection, AI experience and cost limitations. Carefully consider all programs to determine which will be most beneficial for your operation and goals.

One-injection program

This program (Figure 7) is the most popular. Its advantages are lower drug and semen costs and less risk because a producer has a good indication of the percent of cows cycling in the herd before the injection is given. However, it requires more labor for heat detection and involves a 10-day breeding period.

The program consists of five days of conventional heat detection and AI. On day six, the producer decides whether or not to inject the remaining females based on the percent cycling during the first five days. About 20 to 25 percent of the cows should have cycled during this period to justify injecting the remainder. The injected cows are then heat detected and bred AI for the next five days.

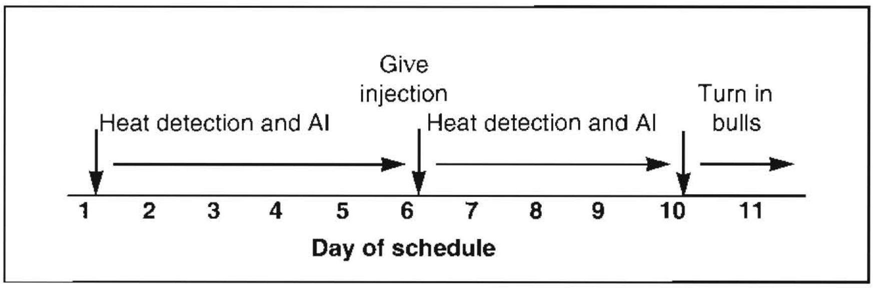


Figure 7.
One-injection program.

Two-injection program

The two-injection program (Figure 8) is a popular program because it has a short breeding period with little or no heat detection. But it involves more drug and semen costs and may yield low conception rates if a high percentage of the females are not cycling. This program best fits the producer who knows a high percentage of the herd is cycling and is willing to risk the higher drug costs for less time and labor spent on heat detection.

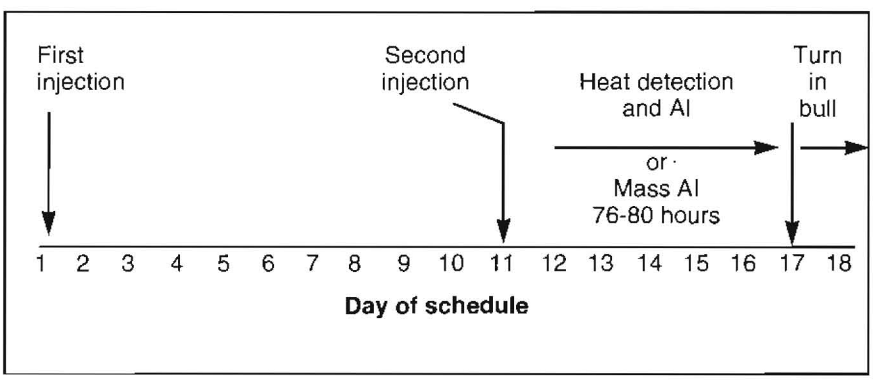


Figure 8.
Two-injection prostaglandin program.

The program consists of two injections of prostaglandin given 11 days apart. Insemination can then be handled two ways: use conventional heat detection and AI for the next five days following the second injection, or mass-inseminate all females within 76 and 80 hours after the second injection. Adequate facilities, labor and strict scheduling are needed if mass AI is to yield satisfactory results. Table 3 compares the various synchronization programs.

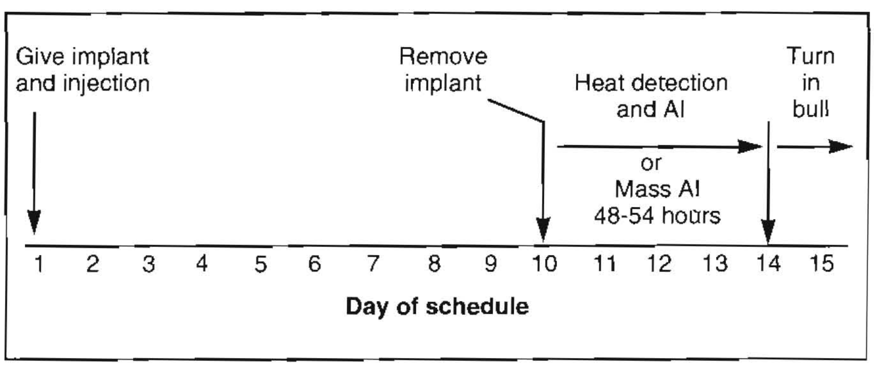
Progestin products and programs

Syncro-mate B (SMB) consists of an ear implant containing a synthetic progestin and an injection containing an estrogen and a progestin. It is a nonprescription drug and is approved for use in cycling beef cattle and nonlactating dairy heifers. The implant is about one-eighth inch in diameter and three-fourths inch long. It is inserted under the skin in the middle of the back side of the ear. The injection is given intramuscularly in the rump at the time of implanting. Nine days later, the implant must be removed.

The SMB program can be used on females in all stages of the estrous cycle. It works by regressing the immature CL during early stages and by blocking estrus activity in all stages until the progestin implant is removed. Females will cycle within one to three days after the implant is removed. SMB has been shown to stimulate cycling in some non-cycling females, although conception rates may be lower in these females. It has the advantage of not causing abortions in pregnant animals, but it is more difficult to administer because you must insert and then remove the implant.

Figure 9 diagrams the SMB program. The implant and injection are given at the same time, and then the implant is removed after nine days. Females can be heat detected and bred AI for the next four days or mass inseminated at 48 to 54 hours after implant removal. Most estrus activity will occur between 24 and 40 hours after implant removal, so mass AI fits this program well. The advantages are a short breeding period with little or no heat detection labor. Disadvantages are that the costs for drug and semen are higher, and the risk is higher because the percentage of females cycling is unknown. A comparison of this program with the others is shown in Table 3.

Figure 9.
The Syncro-mate B program



MGA-prostaglandin program

MGA, melengestrol acetate, is a common, inexpensive oral progestin used in feedlots to suppress estrus of heifers and improve feed efficiency. MGA allows ovarian follicular development but inhibits estrus and ovulation. After a long-term MGA treatment, females have a synchronized estrus, but the estrus is subfertile. Therefore, a program was developed combining MGA with a prostaglandin to produce a synchronized estrus with high conception rates. Research has shown that heifers given prostaglandin in the late stages of the estrous cycle (days 10-15) will have a high estrus response and high fertilility.

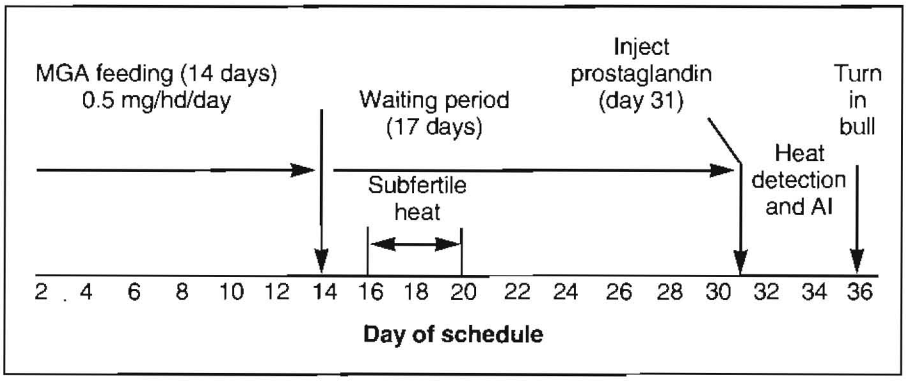


Figure 10.
MGA and prostaglandin program

Figure 10 shows the outline of the MGA-prostaglandin program. Heifers are fed 0.5 mg/head/day of MGA for 14 days. The MGA can be purchased in pellet form and mixed with a grain ration. This mixture can be fed alone or top-dressed over other feed in bunks. MGA can also be purchased in a protein cube and fed in bunks or on the ground. It is critical to have enough bunk space so that all heifers can consume their share of the MGA feed each day. If they do not eat the MGA each day, they will exhibit estrus and will not respond to the program. After the MGA feeding period, heifers will have a subfertile estrus period during the next five days. They should not be bred at this time. Wait 17 days (range 16 and 18 days) after the end of the MGA feeding petiod before injecting prostaglandin. Heifers will show estrus during the next five days (synchronization period) and can be heat detected and bred by AI. Most estrus activity will occur between 48 hours and 84 hours after the injection. Kansas State University reported 32 percent conception in heifers that did not show signs of estrus but which were time-inseminated 72 hours after injecting prostaglandin using this system.

The MGA-prostaglandin program has the advantages of low drug cost, easy administration, reduced handling and good pregnancy rates. The program also has an advantage of inducing estrus in a portion of prepubertal heifers and anestrous cows. The disadvantages are that more advanced planning is needed because the program requires about 30 days to implement and all females need to consume MGA feed every day. A comparison of this program with others is shown in Table 2.

Another version of this program is to omit the prostaglandin injection and use natural breeding, which is discussed in the next section. This program can also be used in conjunction with calf removal to stimulate cycling in anestrous cows, a subject that is discussed later.

Table 3. Comparison of estrous synchronization programs using AI.

Program	Injections (no.)	Times cattle handled (no.)	Heat detection (days)	AI breeding period (days)	Est. AI preg. rate[a] (%)	Est. Costs/ preg. fem.[b] ($)
One inject.	1	2	10	10	55	37
Two inject. w/heat detection	2	3	5	5	50	39
Two inject. w/o heat detection (mass AI)	2	3	0	1	45	44
Syncro-mate B w/detection	1[c] + R	3	4	4	60	37
Syncro-mate B w/o detection (mass AI)	1[c] + R	3	0	1	55	40
MGA + prostaglandin w/detection	Feed + 1	2	5	5	60	34

[a]Estimated pregnancy rates of total group during synchronization period based on research results on heifers from well-managed herds.

[b]Costs include drugs, semen, AI supplies, labor, clean-up bulls, interest and other expenses for a 70-day breeding season as published in 1990 Neb. Beef Cattle Report (Loseke et al.). These costs can be compared to $32 for natural service without synchronization.

[c]Includes an injection plus implant.

R – Removal of implant.

Using bulls in synchronization

Because the main advantages for using synchronization are to get more females pregnant early in the breeding season and to use superior sires, AI is usually the preferred method of breeding. However, some producers would like the benefits of synchronization but cannot use AI. Research has shown that natural service can be a viable alternative to AI if managed properly. Bulls should be selected for high fertility and sexual aggressiveness. All bulls need to pass a breeding soundness examination and preferably a libido exam. For a four- to five-day synchronization period, place one bull per 15 or 20 females in a small pasture or drylot for 24 hours, then replace him with another bull. Watch bulls closely during the breeding period to make sure they are servicing the females and that injuries do not occur. Large groups of females should be divided into smaller groups (40-60 head) in small pastures or lots during the synchronization period. Research has shown much variation in number of females serviced per bull (five to 20 head) during a 24-hour period. Pregnancy rates during the synchronization period have ranged from 60 to 80 percent, and during a 30-day breeding season, from 75 ro 95 percent.

Bulls can be used in all synchronization programs, but the most popular programs are: 1) give an injection of prostaglandin and then place the bulls with the cows, or 2) feed MGA for 14 days, wait 17 days, and then place the bulls with the cows (see Figure 11).

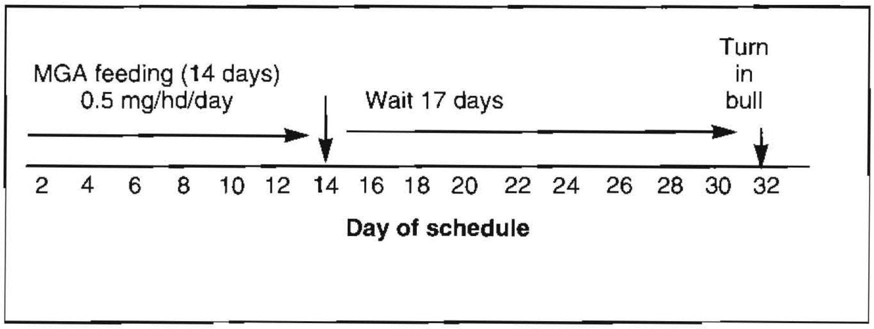


Figure 11.
MGA and natural service.

The advantages of these programs are low-drug cost, no heat detection and a less-concentrated breeding period so the bulls have more time to service the cows. Another advantage of feeding MGA is that it helps stimulate cycling in prepubertal heifers and anestrous cows. Producers who desire to get more females bred early in the breeding season can benefit considerably from these synchronization programs.

Cost/benefits of synchronization

Many factors influence the costs of a synchronization and AI program. These include availability and cost of labor for heat detection and AI, available facilities, cycling status of the herd, conception rates, as well as costs for drugs, supplies and semen.

Breeding results during the synchronization period can be predicted by using the following formula: (percent cycling in herd) x (percent responding to treatment) x (percent conception rate) = percent pregnant. As shown in Table 3, pregnancy rates can vary according to the program selected. Programs using mass AI can yield lower pregnancy rates and higher costs because some cows that are bred are not cycling.

Depending on the program selected and its results, the breeding costs per AI calf can range from $25 to $60 compared to $30 for natural service by bulls without synchronization. The greatest benefits (and approximate value) of AI synchronization calves over naturally sired calves may include:

- Better quality heifers for replacements ($50 premium).
- More calves saved due to selecting sires with calving-ease traits and due to group calving (3 percent).
- Heavier calves at weaning due to better genetics or crossbreeding (25 lbs.).
- Older calves at weaning due to earlier calving (5-8 days).
- Fewer bulls needed for cow herd (one-third fewer).
- More efficient use of labor and management.

Producers should weigh the cost/benefit ratio and decide if synchronization and AI will be profitable in their operation. Estrous synchronization is not a cure-all for breeding or management problems. It will not replace good management and will not be successful under poor management. Anyone interested in beginning a program should consult with experienced producers, veterinarians and AI representatives to obtain additional information and determine the most beneficial program.

Requirements for success

The following need special attention to make a synchronization program successful:

1. **Cycling heifers and cows** — Synchronization will work only on cycling, fertile females. Cattle must be healthy, in good body condition and gaining weight prior to synchronization treatment. Yearling heifers and mature cows are the best candidates for good synchronization results. Results on 2-year-old heifers are usually poor since they are slow to cycle and rebreed after their first calf. Yeatling heifers need to be of sufficient age and weight for a high percentage to be cycling before the breeding season. Cows should be at least 45 days post-calving before treatment is started. Observe females for cycling activity for several days prior to treatment to determine if a high enough percentage are cycling to justify treatment costs (4 to 5 percent per day).
2. **Program and procedures** — Select the program best suited to your objectives and resources. Careful planning and scheduling of the program with accurate timing of injections and breeding are essential. Follow procedures closely, especially with injections (and implants) and mass AI.
3. **Semen and inseminators** — Select only high-quality, fertile semen from superior sires that will add genetic value to your herd. Follow directions for proper semen handling. Use experienced, well-trained technicians. Several technicians are needed when a large number of cows are inseminated so that technician fatigue does not lower conception rates.
4. **Facilities and equipment** — Adequate working facilities are needed for rapid handling of a group of cattle. The breeding chute should allow easy passage of cattle and easy access by inseminators with a minimum of noise and labor. Two chutes may be necessary if a large number of cattle are mass inseminated during a short time period.
5. **Top management** — High-quality management of the cow herd and the synchronization program is vital. Overall herd management, including nutrition, health, breeding and reproductive programs, should be above average. A well-planned program prepared in advance with special attention to details for implementation will increase the degree of success.

Embryo transfer

The first successful transfer of a bovine embryo from a donor cow to a host, or recipient, cow occurred in 1951. In 1964, limited success was reported with the non-surgical transfer of an embryo between cows. Since that time, advancements have made embryo transfer almost commonplace on many beef and dairy operations. Techniques of freezing, thawing and sexing embryos continue to improve, but success is still limited.

Embryo transfer is now a commercial proposition in many countries of the world. Many companies provide "on-farm" as well as "at-clinic" embryo transfer.

Table 4. Typical hormone schedule for inducing superovulation in embryo transfer donor cows.

Day of normal estrous cycle	Days of injection regimen	Time	Injection number	Milliliters of FSH solution	Milligrams of FSH
10	1	AM	1	1.25	6.25
		PM	2	1.25	6.25
11	2	AM	3	1.0	5.0
		PM	4	1.0	5.0
12	3	AM	5	.75	3.75
		PM	6	.75	3.75
Note: Recipient receives a prostaglandin injection in the PM on the third day of the donor regimine.					
13	4	AM	7	.5	2.5
		AM	8	Donor receives prostaglandin injection here	
		PM	9	.5	2.5

The donor cow should be in heat 36-60 hours after injection #8. She should be inseminated at 12 hour intervals while in standing heat (usually 2-3 times).

Preparation of the donor

Embryo transfer has the greatest chance of success if the recipient animal is at the same day of her cycle as was the donor on the day her embryos were collected. For immediate transfer of fresh embryos, the donor and recipient should have been in heat on the same day or within a day of each other. This can be achieved by synchronizing the recipient with prostaglandin or an analogue. If frozen embryos are to be transplanted, the recipient should be in the same stage of the cycle as the donor when the embryos were recovered, usually day seven of the estrous cycle (day zero equals estrus).

The chances of success in embryo transfer are improved if the recipient cow is healthy, well-fed and free from reproductive diseases. A minimum of 10 recipient cows are recommended to be synchronized for each donor cow to be transferred, if the majority of the embryos are to be transferred fresh. It is also possible to bank frozen embryos from donors throughout the year, then transfer them into the breeding herd during the normal breeding season.

Other practices for improving reproductive performance

Nutrition

A cow goes through a nutritional cycle through the year that parallels her stage of production. The most critical periods for a mature cow is from three months before calving to three months after calving, with the period from calving to rebreeding being the most critical. Cows that are undernourished at these critical times generally have poor conception rates. Most research indicates that inadequate nutrition prior to calving extends the time from calving to the first estrus after calving. Poor nutrition after calving results in low fertility when cows are bred, even though they may cycle soon after calving.

A more complete discussion of how to feed the breeding herd at different stages of reproduction can be found in MU publication M151, *Nutrition*.

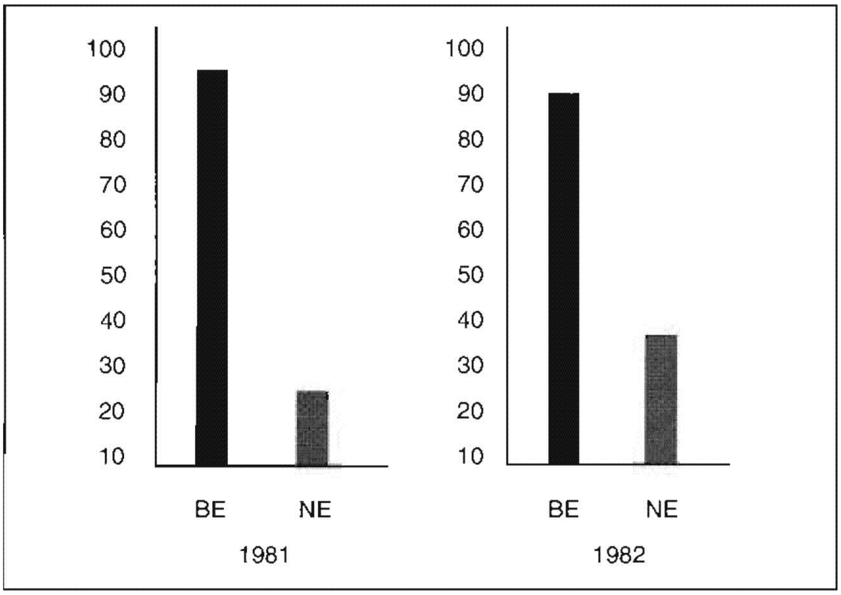


Figure 12. Percentage of bull-exposed (BE) and non-exposed (NE) cows exhibiting estrous cycles by Day 53 postpartum for each of the two respective years the study was conducted.

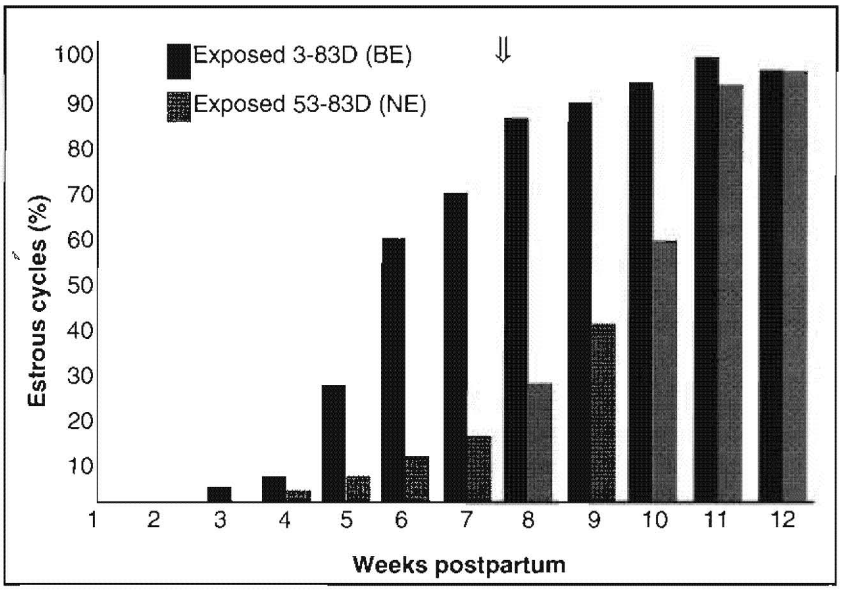


Figure 13.
Cumulative percentage of BE and NE cows exhibiting estrous cycles as time postpartum progressed (fl indicates Day 53 postpartum, the day NE cows were exposed to bulls.)

Bull exposure

Researchers in Nebraska found that placing bulls with cows after calving stimulated the cows to return to estrus 20 days sooner than non-exposed cows. This research has been confirmed in other states and has been effective with both intact and sterilized bulls. However, sterile bulls are better suited to this task. Sterile bulls can be placed with the cows at calving time and remain with them until the start of the breeding season, then intact bulls can be placed with the cows.

Figures 12 and 13 show the percentage of bull-exposed (BE) and non-exposed (NE) cows that were in estrus as time following calving progressed (fl indicates Day 53 postpartum, the day NE cows were exposed to bulls).

Reproductive diseases

Healthy, disease-free animals are much more likely to become pregnant and give birth to offspring. Several diseases that adversely effect reproductive performance are described in the section entitled *Herd Health Maintenance*.

Short-term calf removal

It has long been known that the act of a calf nursing stimulates a suppressive effect on the cow's hormone system and delays the cow's return to estrus after calving. Early weaning, once-a-day suckling, and 48-hout calf removal are three approaches that have been used to reduce this suppressive effect.

- Early weaning of calves (30 to 60 days of age) removes the suckling suppression and allows the enetgy that would be used to produce milk to be used instead to rebuild the cow's body condition. This is particularly helpful for thin and very thin cows. However, early weaning creates a problem: what do you do with an early weaned calf? Special consideration and management is needed if early weaning is practiced on a large scale.
- Limiting the time each day that a calf is allowed to nurse the cow has proven effective in decreasing the time from calving to first estrus. Calves can be separated from the cow each morning and retutned each evening. This requires a lot of labor at first. But if good facilities are available, the cows soon learn the routine and will leave their calves quite easily. Additional feed should be supplied to the calf if this practice is used.
- The 48-hour removal of calves from the cow also has been shown to start cows cycling after calving. Calves should be at least 30 days old and need only be separated from the cows by a fence; it is not necessary to remove them from sight or sound. Give calves a high-quality hay or grain supplement and plenty of fresh water. Calves generally withstand this short-term separation quite well; it is usually harder on the producer than the cow or calf. It is typical for cows to "short cycle" following calf removal. That is, the cow may cycle soon after the calf is returned, but she will recycle within 8 to 12 days following the first cycle. If this occurs (expect it in about 50 percent of the cows) the first cycle is not fertile. If artificial insemination is used, wait for the second cycle before breeding. This practice has shown good results to start cows cycling that have not cycled for some time. This will enable them to breed earlier in the breeding season and then calve early in the calving season.

Troubleshooting reproductive failures

Income from your beef cow-calf enterprise is highly dependent on the total pounds of calves weaned. This is especially true if calves are marketed at weaning and do not undergo a backgrounding phase as part of the beef enterprise. Figure 14 illustrates the factors that influence the pounds of calf weaned. Reproductive performance of the cow is not the least of these factors. This diagram can help you more effectively evaluate and pinpoint failures in reproduction during a given season, year, or longer period of time and allow you to establish a plan to overcome the problem.

Total pounds of calf weaned from a beef herd are dependent upon two factors: the number of cows weaning calves in a given time frame and the weaning weight of each calf. Both of these are important. However, the following example illustrates the importance of a herd's reproductive performance, which governs to a large extent, the number of cows weaning calves.

If the average weaning weight of a calf in your heard is 450 pounds and there are 50 cows that wean calves in a season, the herd produces 22,500 pounds of weaned calves. If only 45 cows wean calves, those calves must weigh an average 500 pounds for the herd to produce the same total pounds of weaned calves. This means you must put an extra 50 pounds on each and every calf.

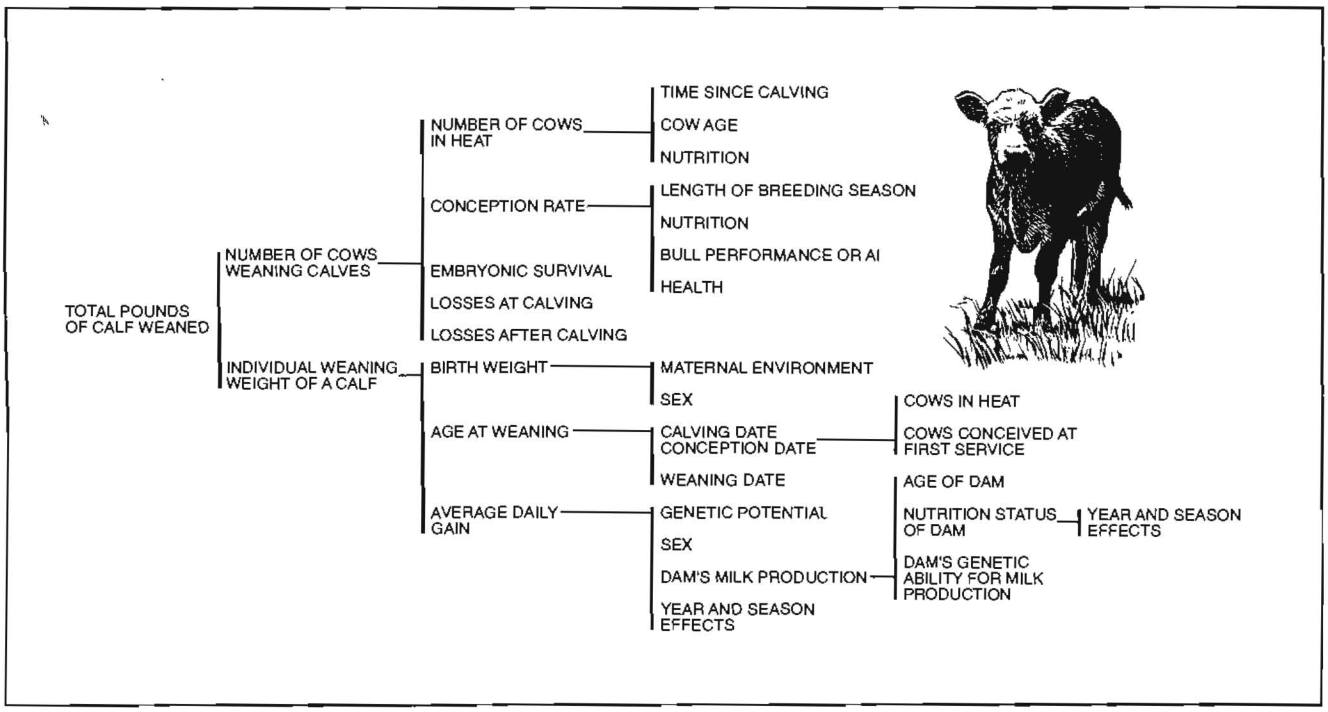


Figure 14. Factors that influence pounds of calf weaned.

University Extension
UNIVERSITY OF MISSOURI
COLUMBIA

■ Issued in furtherance of Cooperative Extension Work Acts of May 8 and June 30, 1914 in cooperation with the United States Department of Agriculture. Ronald C. Powers, Interim Director, Cooperative Extension Service, University of Missouri and Lincoln University, Columbia, Missouri 65211. ■ An equal opportunity institution.

M 149, New 9/93/7M
Printed on recycled paper with soybean oil ink