Breeding Standards and Pregnancy Management

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Value of Replacements

Heifers give birth to approximately 25–33% of all calves born on a dairy. This percentage can be increased by applying sex-biased semen from a number of superior sires, although conception rates are generally low, reaching about 60–80% of that achieved with conventional semen. Consequently, when using superior proven sires, heifers should represent the most advanced genetics in the herd. The genetic merit of artificial insemination (AI)-sired calves from heifers should be superior to that of AI-sired calves from older cows. Rearing and breeding of replacement heifers is critical to survival of the dairy farm because it represents 15–20% of total farm costs. Age at first calving is the single most important variable influencing the costs of raising heifers. Age at first calving could be defined as total days on feed since birth and is a function of the rate at which breeding weight (age) and conception are achieved. Once pregnancy is established, total days on feed become fixed. Costs associated with age at first calving include feed, labor, housing, interest on investment, breeding and veterinary health, and death loss. To reduce the costs associated with rearing heifers, one must reduce age at first calving or reduce feed costs because they represent approximately 60% of the total rearing costs. Reducing age at first calving is more easily achieved than saving on low-cost feeds given the lack of universal availability of inexpensive feeds to most producers. In a recent survey, the average cost to raise a home-grown heifer was US$100 more than that required to raise the heifer on a custom heifer-rearing operation.

Age at First Calving

Lifetime milk yield, 305-day lactation yields, and lifetime profit of replacement heifers are maximized when heifers calve for the first time between 23 and 24 months of age. An evaluation of 6 million US dairy cow records from 1960 to 1982, however, found no appreciable change in calving age for any of six dairy breeds. Mean ages (months) at first calving for 1960 and 1982 were as follows: Ayrshire, 28.4, 28.6; Brown Swiss, 28.2, 27.8; Guernsey, 27.6, 27.4; Holstein, 27.3, 27.8; Milking Shorthorn, 27.7, 27.8; and Jersey, 26.0, 25.9 months, respectively. Since 1980, however, age at first calving has decreased to current mean age ranging from 24 months for Jerseys to 28 months for Ayrshires, with the other dairy breeds falling in between these extremes. Holsteins had the smallest standard deviations for age at first calving (21.2–24.8 months) of any breed.

Puberty in heifers is dependent on many factors including, but not limited to, breed, age, and body weight. Nonetheless, age at puberty is generally not considered to be a limiting factor for age at first conception and thus age at first calving. Most dairy breeds achieve puberty by 11–12 months of age or sooner as long as they are fed according to the minimum standards suggested by the National Research Council for energy, protein, minerals, and vitamins.

Heifers less than 1 year of age should be fed to maximize growth without achieving excess body condition. Increased nutrient intake and average daily gain from 4 to 10 months of age improved feed efficiency and increased structural growth rates with a small increase in body condition of heifers by 10 months of age.

Feeding a high-energy diet for a short duration (3 or 6 weeks beginning at 11 weeks of age) altered body growth and fat deposition in a time-dependent linear manner consistent with feeding a high-energy diet for a long duration (12 weeks).

Feeding prepubertal heifers a high-energy diet for a longer duration resulted in a linear decrease in both the percentage of mammary epithelial cells that were proliferating and the mass of fat-free mammary parenchyma per unit of carcass. High-energy feeding and excessive prepubertal body gain hastened puberty and reduced the first and later lactation performance attributable to decreased mammary epithelial cell proliferation in areas of active ductal expansion.

Because feeding heifers a high-energy diet will likely reduce mammary parenchymal mass at puberty, controlling the rate of body weight gain is likely a key to reducing mammary tissue loss resulting from excess body condition. Feeding dairy heifers a high-concentrate (75%) diet (beginning at 125 kg of body weight and continued for 245 days) did not affect most structural growth characteristics and puberty attainment, and equaled or improved 150-day milk and milk component yield after calving compared with heifers fed a high-forage (75%) diet as long as both diets were fed for equal average daily gains. Little biological rationale exists opposing the use of

high-concentrate rations for dairy heifers, provided the daily gain is controlled and feed ingredients can be used to maintain a healthy rumen environment. Heifers on pasture have increased maintenance requirements, and depending on the nutrient quality of the pasture, less pasture nutrients may be available to support growth. If heifers have adequate high-quality forage, supplementing concentrates may not be necessary, particularly in pasture-based dairy systems. Therefore, monitoring and supplementing diets of pastured heifers before anticipated breeding occurs may prevent their underdevelopment before first breeding.

Attempts to reduce age at first calving much less than the recommended 23–24 months should be avoided. Unless grown adequately, heifers calving at younger ages (<22 months) are more likely to experience dystocia and are subsequently 3–4 times more likely to have a retained placenta, metritis, reduced reproductive efficiency, and are likely to be culled from the herd. In addition, first lactation milk yields may be compromised.

Reproductive Cycle and Breeding Standards

Research indicates that breeding for milk yield is more important than breeding for size because genes that control body size seem to be independent of those for milk yield. Dairy heifers reach puberty as indicated by the regular occurrence of estrus. The period of estrus and a new (or first) estrous cycle usually begins when heifers first stand to be mounted from the rear by another heifer. This period is about 10–18 h in duration and begins each new estrous cycle (day 0 of the cycle). About 90% of cycling heifers show a slightly bloody discharge (bloody tail or metestrual bleeding) from the vulva 1–2 days after estrus whether or not they were inseminated or conceived. This bloody discharge is a sign that they were in estrus.

The estrous cycle is about 21 days in duration and normally ranges from 18 to 24 days. The cycle consists of four stages: estrus (estrogen is the dominant hormone and initiates mating behavior), metestrus (time of ovulation and early corpus luteum development), diestrus (progesterone is the dominant hormone as the corpus luteum grows and matures), and proestrus (decreasing progesterone, increasing estrogen, and final follicular maturation). Cycles shorter than 18 days may occur in heifers after they experience their first estrus at puberty. The estrous cycle is cyclical because in the absence of fertile mating or AI during estrus, estrus will recur in approximately 3 weeks.

During normal estrous cycles in heifers, follicles grow in either two or three wave-like patterns, with the majority of heifers exhibiting three waves (**Figure 1**). Follicular waves are induced by increased follicle-stimulating hormone (FSH) secretion. The largest or dominant follicle of the third wave generally matures during proestrus because of increased pulse secretion of luteinizing hormone (LH) and secretes estrogen to induce estrus. A preovulatory surge of LH secretion then causes ovulation. Ovulation occurs approximately 24–32 h after the beginning of estrus and subsequently the oocyte (egg) is released into the oviduct. At the site of ovulation, the ruptured follicle transforms into a corpus luteum. The corpus luteum produces progesterone necessary to prepare the uterus for a potential pregnancy. In the absence of a viable conceptus about days 16–17 of the 21-day cycle, prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) is secreted by the uterus to cause death or regression of the corpus luteum (known
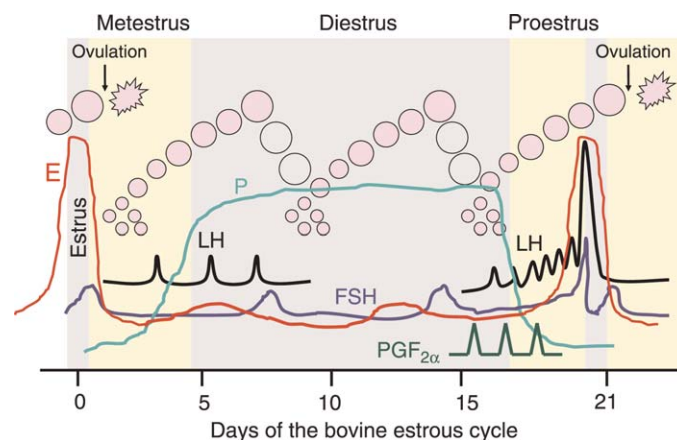
Figure 1   Characteristics of the bovine estrous cycle. Four stages of the cycle are illustrated (estrus, metestrus, diestrus, and proestrus) in addition to various hormonal changes that occur. Three follicular waves are illustrated (repeating patterns of circles) with the third wave producing the ovulatory follicle. Large dominant follicles of the first two waves become atretic and never ovulate during a normal cycle. E, estradiol or estrogen; FSH, follicle-stimulating hormone; LH, luteinizing hormone; P, progesterone; $PGF_{2\alpha}$, prostaglandin $F_{2\alpha}$.

as luteolysis). Diestrus ends as luteolysis is initiated and proestrus begins. Otherwise, the conceptus secretes a pregnancy signal (interferon-τ) to preserve the corpus luteum to allow pregnancy to continue. As the corpus luteum regresses in the absence of pregnancy, the dominant follicle continues to mature and will ovulate just after the heifer goes out of estrus, producing the egg that potentially will form a new conceptus upon fertilization. Thus, the cyclic nature of the estrous cycle continues, only to be interrupted by pregnancy.

The recommended age to begin a breeding program with heifers is about 12–14 months, provided the heifers are adequately grown and cycling. Growth rates are important to reach targeted body weights and frame sizes (skeletal growth measured by wither height) by breeding age as well as expected calving at 22–24 months of age (Table 1). Breeding body weight as a percentage of first postcalving body weight should be in the range of 60–65% for most breeds. Hence recommended median body weights and median wither heights at first insemination of replacement heifers are as follows: Ayrshire (318–340 kg and 117–122 cm); Brown Swiss (340–363 kg and 122–130 cm); Guernsey (318–340 kg and 117–124 cm); Holstein (340–363 kg and 122–127 cm); Jersey (238–261 kg and 109–114 cm); and Milking Shorthorn (340–363 kg and 117–122 cm), respectively. If heifers are inseminated too young or before adequate growth occurs, their first lactation yields will be compromised.

Furthermore, overconditioned (fat) heifers do not reproduce well and will not produce milk to their genetic potential. Waiting to inseminate heifers when older than 14–15 months negatively affects their lifetime milk production. It is important that heifers calve at or near 2 years of age, which reduces their rearing costs and also results in milk production at an earlier age.

Proper feeding management for adequate growth is necessary to ensure puberty has occurred before breeding age. Adequate growth is even more critical for seasonal breeding systems because the window of opportunity for breeding and hence timely calving is limited. It is needless to say that growth rates of heifers on pasture should be similar to those raised in confinement. Thus, raising cattle on pasture necessitates management decisions about grazing and forage systems and supplementation regimens to support proper growth of dairy heifers.

Collectively, in addition to age, body weight of heifers at breeding and immediately before or after calving plays a role in their subsequent lactational performance. Thus, age at first calving is considered to be less than 24 months and postcalving body weights of at least 82% of mature weight is recommended for all breeds. In seasonal breeding dairy systems, calving at the beginning of the calving season is more critical to survivability and economic return than age at first calving.

Management of Breeding

Age at first breeding and at first calving may be managed more precisely through the combined management of estrous cycle before AI. Well-managed heifers exhibit greater conception rates than lactating cows, resulting in lesser costs per pregnancy generated and per replacement heifer produced. Therefore, the most effective management strategy to increase genetic progress and maximize profitability on a dairy is to use estrus or ovulation synchronization before AI. This is particularly critical in seasonal, pasture-based dairy systems that require heifers to calve at the beginning of the herd-calving season when forage supplies are optimal. Seasonal breeding requires an efficient and effective use of labor and other resources

Table 1 Recommended median body weights (kg) for dairy heifers by age (months) and by breed

| Age | Breed | | | | | |
	Aryshire	Brown Swiss	Guernsey	Holstein	Jersey	Milking Shorthorn
2	90	85	70	85	55	90
4	130	120	120	125	100	135
6	165	195	170	175	125	180
8	210	250	210	220	160	225
10	225	310	260	265	195	275
12	290	340	295	310	220	320
14	330	380	335	350	250	370
16	375	450	385	395	280	410
18	410	465	410	445	305	450
20	440	495	445	475	330	490
22	485	550	485	515	350	520
24	510	560	500	530	370	545

Adapted from Heinrichs J and Lammers B (1998) *Monitoring Dairy Heifer Growth*. Accessed http://das.psu.edu/dairy/pdf-dairy/ud006.pdf.

related to detection of estrus, breeding program, and calving at specific times of the year.

Before 1980, a few or no hormonal products were available to synchronize estrus and ovulation in heifers. Therefore, breeding of heifers entirely depended on visually detecting estrus before AI. Today, various products include orally active (feed additive) or intravaginally placed progestins, gonadotropin-releasing hormone (GnRH), and $PGF_{2\alpha}$. Managing the estrous cycle to the convenience of the breeder is now possible even in large heifer developer operations where replacements are raised on contract for individual dairy producers or are raised for sale to other producers.

Progestins

Feeding melengestrol acetate (MGA: 0.5 mg per heifer per day) for 14 days synchronizes estrus (see (1) in **Figure 2**). Depending on the stage of the estrous cycle in which any heifer begins the MGA feeding period, a few may have a functional corpus luteum after 14 days of feeding. Most heifers show estrus within 2–6 days after withdrawing MGA from the feed. This estrus is quite infertile in those heifers that began MGA feeding after day 10 of the cycle. Because the identity of the less fertile heifers is unknown, this first estrus after MGA withdrawal is passed over and heifers are given an injection of $PGF_{2\alpha}$ 17–19 days after MGA withdrawal. Insemination of heifers based on detected estrus usually occurs between 2 and 5 days after $PGF_{2\alpha}$ administration. It is possible to time inseminate any noninseminated heifers at 72 h after $PGF_{2\alpha}$ administration but conception rates will be approximately 60–75% of those achieved based on observed estrus.

Progesterone Inserts

Insertion of a progesterone-impregnated intravaginal insert (progesterone-releasing intravaginal device (PRID) or controlled internal drug release (CIDR) insert) in addition to $PGF_{2\alpha}$ effectively synchronizes estrus in a short-term, 5- or 7-day period (see (2) in **Figure 2**). $PGF_{2\alpha}$ lyses any functional corpus luteum when injected at removal of the insert. Generally, inseminations occur after detected estrus during a 2- to 5-day period after its removal.

In an attempt to further control estrus and ovulation, ovulation can be synchronized by inducing synchronous emergence of a new follicular wave in the presence of high blood concentrations of progesterone. This method is similar to the previous method (2); however, the progesterone insert is placed intravaginally in conjunction with a first injection of GnRH, and $PGF_{2\alpha}$ is injected with removal of the insert 5 or 7 days later. If timed AI (TAI) is desired, a second injection of GnRH should be administered 48–56 h after $PGF_{2\alpha}$ injection and insert removal, with AI occurring 12–20 h later.

Prostaglandin F$_{2\alpha}$

A simpler and less expensive method (see (3) in **Figure 2**) includes detection of estrus during 6 days and then inseminating any estrual heifers according to the signs of estrus. On the seventh day, $PGF_{2\alpha}$ is injected into any noninseminated heifer to induce luteolysis and estrus for subsequent insemination. The success of this method depends on the accuracy and efficiency of visual detection of estrus.

A more complicated method involves administering two injections of $PGF_{2\alpha}$ 14 days apart. One can inseminate only estrus-detected heifers after the second of two injections (see (4) in **Figure 2**) or inseminate after both injections (see (5) in **Figure 2**) and reduce the number of second injections to all noninseminated heifers. Timing of inseminations without regard to detected estrus at 72–80 h after $PGF_{2\alpha}$ produces lesser conception rates than those made after detected estrus.

Prostaglandin F$_{2\alpha}$ + Gonadotropin-Releasing Hormone

Another technique (see (6) in **Figure 2**) combines injection of GnRH to induce the release of FSH and LH plus injection of $PGF_{2\alpha}$ 7 days later followed by visual detection of estrus and AI. The GnRH injection in some heifers better controls follicular development and synchronizes it with luteolysis that follows $PGF_{2\alpha}$. About 10% of heifers show estrus within 24 h of $PGF_{2\alpha}$, and therefore, for optimal results, detection of estrus should begin 24–48 h before $PGF_{2\alpha}$.

An alternative (see (7) in **Figure 2**) to the previous method allows for a single TAI after the injection of $PGF_{2\alpha}$. This protocol (i.e., Ovsynch) synchronizes ovulation (rather than estrus), thereby allowing for AI at a fixed time without detection of estrus. One gives a second injection of GnRH to all heifers at about 48–56 h after $PGF_{2\alpha}$ and then inseminates about 12–20 h later without regard to detected estrus. Of course, if estrus is observed before $PGF_{2\alpha}$ or the second GnRH injection, one may inseminate the heifer based on visual signs and discontinue the remainder of the injections.

It is apparent that in all systematic breeding programs, the conception rate at first AI will not reach 100%. First-service conception rates should range from 50 to 70% in heifers. Therefore, some heifers will need additional inseminations in order to become
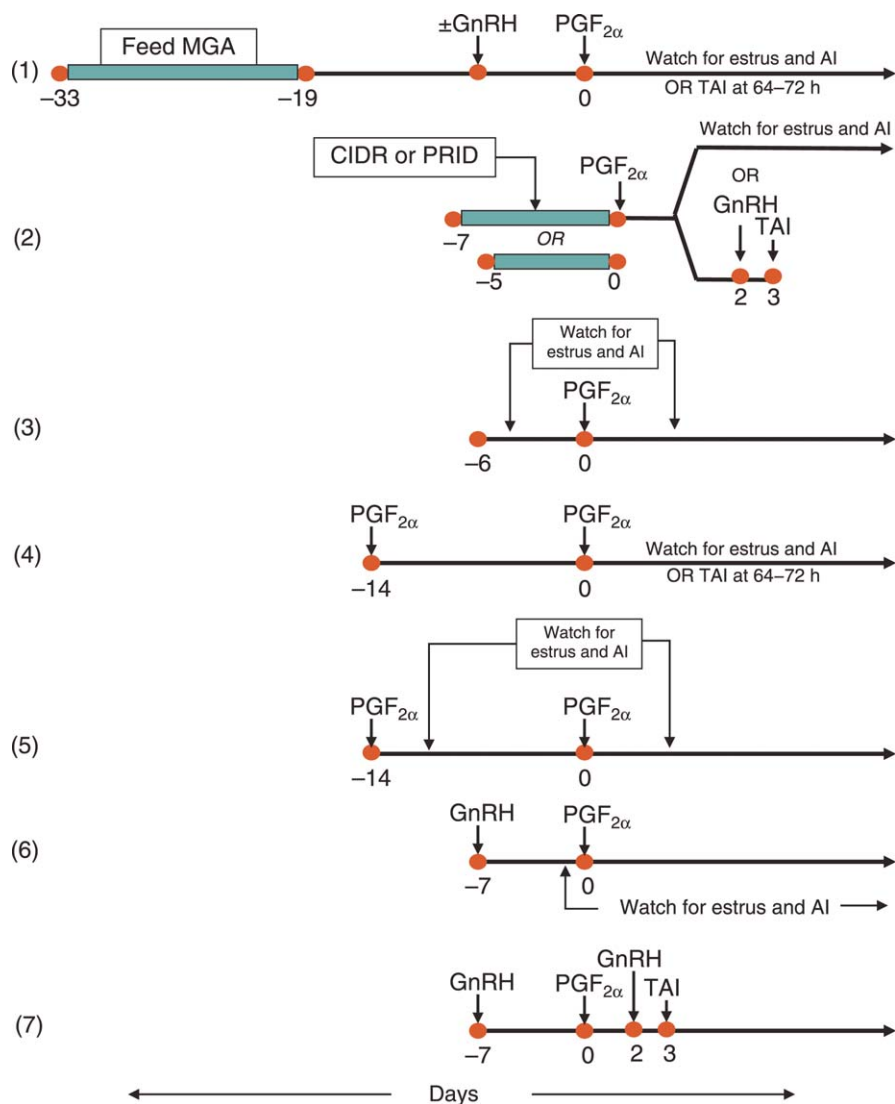
Figure 2 Seven programs for synchronization of estrus or ovulation are illustrated for dairy heifer replacements. (1) Feeding of melengestrol acetate (MGA) for 14 days and passing over the estrus expressed upon MGA withdrawal followed by an injection of prostaglandin $F_{2\alpha}$ ($PGF_{2\alpha}$) given 17–19 days after MGA. AI, artificial insemination; GnRH, gonadotropin-releasing hormone; TAI, timed AI. (2) Intravaginal insertion of a progesterone-releasing insert (progesterone-releasing intravaginal device (PRID) or controlled internal drug release (CIDR) insert) for 5 or 7 days with $PGF_{2\alpha}$ injection administered at insert removal; or injection of GnRH at insert placement, injection of $PGF_{2\alpha}$ at insert removal, followed by second injection of GnRH given 48–56 h after $PGF_{2\alpha}$ with one TAI 12–20 h later. (3) Visual detection of estrus for 6 days before injecting all noninseminated heifers with $PGF_{2\alpha}$ on the seventh day. (4) Two injections of $PGF_{2\alpha}$ given 14 days apart with inseminations occurring after the second injection or (5) inseminate after either injection. (6) An injection of GnRH 7 days before an injection of $PGF_{2\alpha}$. (7) Same as (6) but a second injection of GnRH is given 48–56 h after $PGF_{2\alpha}$ with one TAI 12–20 h later.

pregnant. Producers should pay close attention 18–24 days after AI to detect heifers that return to estrus. All of these breeding programs only synchronize estrus or ovulation for the first AI. Subsequent estrous periods, however, are fairly well synchronized in those heifers that fail to conceive to the first AI. Estrus detection aids such as tail chalk or tail paint, heat mount detectors, or more sophisticated electronic devices can be used to detect estrus before insemination. Because heifers tend to display very pronounced signs of estrus, they can be easily detected by consistent twice-daily visual observations. About 5% of heifers eventually fail to conceive for various reasons and must be culled.

Early detection of pregnancy allows identification of those heifers that are not pregnant so that prompt reinsemination can occur. Pregnancy can be accurately determined by transrectal ultrasonography as early as day 28 after insemination or by transrectal palpation of the uterine contents by days 35–40. The other available

tool is a blood test to measure the presence of a pregnancy-specific protein (pregnancy-specific protein B or other pregnancy-associated glycoproteins (PAGs)). These PAGs are produced by the conceptus and can accurately determine pregnancy status as early as 18–30 days after breeding. The objective of this diagnosis is to find nonpregnant heifers so that they can be treated promptly to induce a new fertile estrus. Treatments utilized on nonpregnant heifers can include any of those short-term hormonal methods described previously. Historically, when transrectal palpation occurs, the heifer is given an injection of $PGF_{2\alpha}$ when a functional corpus luteum is palpated and subsequent behavior is monitored for visual signs of estrus. When synchronization of estrus is performed before first AI, the day of estrus is generally known when palpation occurs. If palpation occurs at 35 days after AI, one is generally correct in assuming that an estrus was not detected at 20–21 days post-AI; hence the heifer is on cycle days 14–15 when pregnancy diagnosis occurs. This is an ideal time to give $PGF_{2\alpha}$ to induce a fertile estrus. Given similar costs of palpation and a $PGF_{2\alpha}$ injection, any nonpregnant heifer is generally given $PGF_{2\alpha}$ and observed for subsequent signs of estrus. Injections of $PGF_{2\alpha}$ cause abortions in pregnant heifers, so caution is warranted.

Management of Pregnancy

Once pregnant, replacements should not be forgotten and allocated to pasture or other areas without observation. Some embryonic and fetal losses occur after conception. It is recommended to reconfirm pregnancy by 90–100 days of pregnancy to preclude maintaining an open replacement until she is found not pregnant at her projected calving date.

Pregnant heifers should continue to grow at rates recommended by the National Research Council to achieve adequate body weight and size by calving time. Depending on the breed, ration formulations to attain daily gains of 0.50–0.80 kg are usually adequate to achieve desired first-calving weights.

Regardless of when first breeding begins in heifers, once pregnant, heifers should be fed to calve in good body condition. Without adequate body reserves of fat, it becomes very difficult to achieve good first-lactation milk yields. Which heifers will use body reserves to maximize milk yield is difficult to predict. Those that consume greater amounts of dry matter tend to be those that produce more milk.

Precautions should be taken to prevent disease and injury to gestating heifers. Adequate shade during hot months of the year prevents low birth weights and subsequent poor milk yield and reproductive performance after calving. Furthermore, adequate shelter to eliminate windchill during cold months minimizes frostbite to teats when udder and tissue edema occur during late gestation.

Immunizations before first breeding and again between 50 and 60 days before expected parturition for prevention of infectious bovine rhinotracheitis (IBR), parainfluenza (PI_3), bovine viral diarrhea (BVD), bovine respiratory syncytial virus (BRSV), clostridial spp., leptospirosis (five way), and calf scour pathogens (*Escherichia coli*, *Clostridium perfringens* (type C), rotavirus, and coronavirus) are recommended. Reimmunization against calf scour pathogens is recommended at 3 weeks precalving. Depending on the location of heifers (pasture vs. concrete confinement facilities), dewormers (to prevent gastrointestinal roundworms) should be administered at or near calving.

Parturition

In addition to milk yield, milk components, and physical type traits, sire selection for heifers is critical for what occurs at calving. It is recommended to choose calving-ease sires for heifers. The United States Department of Agriculture (USDA) produces sire summaries with calving-ease information on all sires whose semen is available for purchase from semen-producing organizations or bull studs. The information reported is the percentage of difficult births in heifers as reported by observers attending calvings. Calving difficulty scores assigned at calving range from 1 to 5 (1 = no assistance; 2 = slight problem; 3 = needed assistance; 4 = considerable force; 5 = extreme difficulty). The calving-ease percentage reported for each sire is based on the percentage of births in heifers when the calving difficulty scores were 4 or 5. In the Holstein breed, the average calving-ease percentage is about 9%. For heifers, one should use sires with calving-ease percentages that are less than average while not compromising selection for excellent production traits of sires. Preventing calving difficulty or dystocia is important. Dystocia may predispose heifers to placental retention, metritis, breeding inefficiency, and greater culling rates.

Most births do not require assistance (82%) and rushing delivery can injure the dam; however, waiting too long, after the water breaks, may deprive the calf of sufficient oxygen and cause death. Heifers should be observed frequently as due dates approach because some heifers may need assistance at calving. Observation of calving can reduce the number of stillborn calves and increase survival rates. The calf is born with no protection from disease or infection; hence, every effort must be made to limit its exposure to pathogens. Passive immunity is bestowed on the newborn by ingesting colostral milk antibodies shortly after birth.

Calving areas should be clean, dry, well lit, draft free, free of hazards, provide good footing, and spacious to allow the heifer to move about and position herself without pinning herself against an obstruction in the calving area in which the calf has no room to be delivered. When assistance is required for a large calf, twins, or breech births, arms, hands, and instruments should be sanitized. Plenty of lubricant should be used. When a calf jack or obstetrical chains are used, one should only pull when the abdominal muscles of the mother contract, therefore working with her contractions. Applying too much force can injure the heifer and damage the calf. Heifers and calves that experience difficulty need extra attention.

The absolutely most important measure and end point of successful reproduction is survival of the calf at birth and at various intervals thereafter. Immediately after birth, proper management of the newborn is critical to its survival. This includes high-quality colostrum (IgG concentrations $>60 \, mg \, ml^{-1}$) feeding immediately after birth, navel-dipping (7% tincture of iodine) to prevent navel invasion of microorganisms, immunizations, and other treatments. Delay in colostrum feeding can significantly diminish or preclude immunoglobulin absorption through the gut. Moreover, calves should be immediately identified for good record keeping. It is extremely important to disinfect calving pens between calvings. All contaminated bedding should be removed and the surface cleaned with a disinfectant.

Conclusion

Because replacement heifers represent the future genetic investment of any dairy herd, their management is critical to herd survival and longevity. Associated costs and investments in replacements are significant at 15–20% of all farm costs. Timeliness of establishing pregnancy can be significantly improved by using various hormonal schemes to program the estrous cycle to facilitate the use of AI and ensure a greater proportion of heifers calve by 23–24 months of age. The key to efficient reproduction is proper growth and body weight by calving time. Sire selection should emphasize production traits and calving ease to maintain good production but facilitate fewer problems at first parturition. Because heifers are more fertile than their lactating counterparts, the best available proven sires should be used with a much greater cost–benefit ratio. Perhaps, the most effective management strategy to increase genetic progress and maximize profitability on a dairy is to use synchronization of estrus and ovulation before AI in all dairy heifers. Furthermore, using gender-selected semen in replacement heifers available from several of the AI companies is the most cost-efficient application of this new technology because of the greater fertility in heifers than in lactating dairy cows. However, one can expect a reduction in fertility associated with gender-selected semen of 60–80% of that achieved with conventional semen, with the realization of 85–90% of the resulting calves to be females.

See also: **Replacement Management in Cattle**: Growth Diets; Growth Standards and Nutrient Requirements; Health Management; Pre-Ruminant Diets and Weaning Practices. **Reproduction, Events and Management**: Control of Estrous Cycles: Synchronization of Estrus; Control of Estrous Cycles: Synchronization of Ovulation and Insemination; Estrous Cycles: Puberty.

Further Reading

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