Beef Cattle Reproduction on Reclaimed Strip-mined Land

William Dee Whittier, DVM, MS
Professor
Virginia-Maryland Regional College of Veterinary Medicine
Virginia Polytechnic Institute and State University, Blacksburg, VA 24061

Reproductive efficiency markedly affects the economics of beef cattle production units. The National Cattleman's Association-Integrated Resource Management- Standard Performance Analysis (SPA) evaluation has analyzed economic and performance data from beef herds across the United States. When herds that are in the first quartile for profitability are compared with those in the bottom quartile a weaning percentage of 85.2% is achieved over the 81.5% of the lowest quartile. This figure couples with the 42 extra pounds of weaning weight achieved by the high profitability producer to allow them to achieve a 14.2% return on assets at cost compared with a -4.75% for the lowest profitability group. When CATTLE-FAX prepared information indicating the economic impact of a 10% factors change in key affecting break-even prices on a dollars/CWT basis they documented that largest change in break-even prices occurs by increasing the weaned calf crop by 10%. This is closely followed by increasing weaning weights of calves by 10%. Other factors considered resulted in changes in break-even prices of only one-half to one-fifth as much.

Table 1 is a summary of losses occurring at the various stages of the beef reproduction cycle as reported in four independent studies. Note that in each case the largest losses occurred because cows failed to become pregnant during the breeding season. In these studies, 7-22% of cows exposed to bulls were not pregnant at the end of the breeding season. These figures are lower than the SPA data that probably comes from more motivated producers who are willing to keep and share extra records Note, further, from Table 1 that for each 100 cows exposed to a bull only 62.5-77 calves are eventually weaned. These figures indicate the magnitude of loss that is resulting from reproductive inefficiency and pinpoint the phases of the reproduction cycle where major losses occur. (Note also that traditional herd-health programs based mainly on vaccination programs designed to decrease gestational and growing calf loss aim at the two areas where fewest losses occur.)

For an individual cow to achieve maximum reproductive efficiency a calf must be produced every 12 months on the average. Remembering that gestation length in the bovine is approximately 285 days, only 80 days (on the average) may elapse between parturition and conception. The two major factors that will influence the cow's ability to achieve this are: 1) the amount of time which elapses between calving and the resumption of the estrus cycle and, 2) the percentage of matings which result in pregnancy--the conception rate. Major factors influencing cycling after calving and the conception rate will be considered in this paper in some detail.

Table 1. Calf losses related to stage of reproduction cycle.

Location & Length of Study	# of Cows in Breed-ing Herd Season (%)	Not Pregnant at End of Breeding (%)	Calves Lost During Gestation	Lost Near Birth (%)	Lost Birth to 2 Weeks (%)	Lost 2 Weeks to Weaning (%)	Calf Crop Weaned (%)
Miles City Montana (14 yr)	12,827	17.4	2.3	6.4	2.9	---	71. 0
Front Royal Virginia (2 yr)	822	12.0	3.5	6.0	3.0	1.5	71.5
Iberia Louisiana (2 yr)	462	22.0	4.0	3.5	4.5	0.5	62.5
Fort Robinson Nebraska (1 yr)	530	7.0	3.0	6.0	6.0	1.0	77.0

From: Wiltbank, J.N. (1983).

Factors Affecting After-Calving Cycling

If high pregnancy rates are to be achieved, a large percentage of cows must resume the estrus cycle early in the breeding season. This becomes apparent when considered in light of conception rates. If a 63-day breeding season is used and 70% conception is achieved, a 98% pregnancy rate could theoretically occur if all cows were cycling at the onset of the season. If the average cow does not begin cycling until 45 days into the season a pregnancy rate of only 81% would result. The following six factors which are believed to be the most important in promoting the initiation of estrous activity will be discussed.

-Time of calving
-Age of the cow
-Body condition of cows at calving
-Suckling
-Presence of a bull
-The use of exogenous hormones

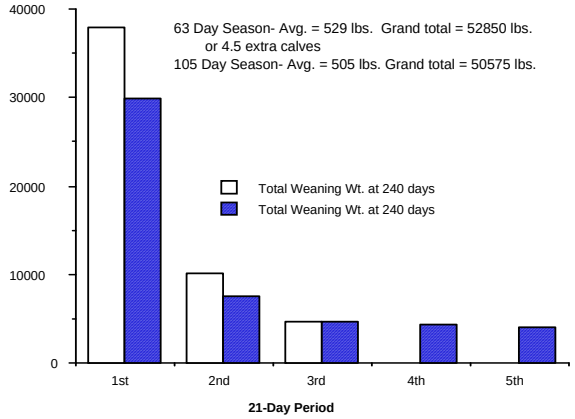
Time of calving

The time during the previous calving season that a cow calves greatly influences the time that the cow may manifest estrus in the succeeding breeding season. In herds that we work with it is typical to have only 30% of mature cows showing estrus at 40 days postpartum, but up to 95% showing estrus by 90 days postpartum.

The only reliable way to assure that cows have had adequate time postpartum for cycling to begin is to enforce a short calving season (which of course corresponds to a short breeding season the previous year). At first glance it would seem that a longer breeding season would give cows more time to become pregnant. Figure 1 explains why this is not the case. Remember that in all cases we are working with a one-calf-per-year constraint. Therefore cows which conceive late in this season will be at a decided disadvantage for next year's breeding season. Circle A represents a one-year cycle in a beef herd with a 60-day calving period. Note that a cow calving on the first day of the calving season has until Day 140 to conceive. A cow which does not calve until the last day of the breeding season (Day 60), has only 80 days to conceive since the bull will be removed on Day 140. Circle B represents the same cycle except with 90-day calving and breeding seasons. A cow calving the first day of the calving season now has until Day 170 to conceive, a 30-day increase from an early cow in a 60-day situation. Note, however, that a cow that does not calve until Day 90 still has only until Day 170 (80 days) to conceive. Hence late calvers, those most likely, by far, to have difficulty becoming pregnant, are not given extra days to initiate cycling in the 90-day versus the 60-day program. Neither are late calvers in either program penalized by a shorter season except during a transition period when the length of the season is being reduced. A 60-day breeding season forces all cows to be earlier calvers since those not meeting the goal fail to conceive and are hence culled.

Getting cows to calve earlier has other major advantages. Probably the most important is that the average calf will be older. Since age of the calf is a major determinant of weight of the calf at weaning, early calving produces heavier average weaning weights. Figure 2 graphically illustrates this. If calves in a given setting gain 1.75 pounds/day from birth to weaning and are born in a typical pattern for a 63-day calving season versus a 105-day calving season, the result is a heavier calf. In this example the average calf is 24 pounds heavier and the total pounds of calf weaned from this 100-cow herd is equivalent to 4.5 extra calves. Early calving thus makes a substantial contribution to the second most important contributor to break-even cost: weaning weights. A beef herd with a shorter calving season is also more uniform so that management practices such as calving watches, vaccination, implanting, flushing, etc. can be more effectively applied. A more size-uniform group of calves also has considerable advantage in marketing.

Figure 2. Percent of calves born in each 21-day period and its effect on weaning weight and total weight marketed.



A herd with a prolonged calving season may achieve a shorter season by applying three principles. The three principles are: 1) moving cows back (getting a calving to calving interval

of less than twelve months); 2) letting cows drift forward by extending the calving to breeding interval; and 3) culling some cows. By applying the other principles of reproductive management cows can, on the average, be "moved back" one month each year. Using this principle only, a continuously calving herd could remove the bull for one month the first year, two months the second and continue this practice until a 60-day season was achieved in ten years. More rapid progress towards a 60-day season can be made if cows that calve in the few months before the newly selected calving season are left to stand open for an extra period of time. Cows that calve many months away from the selected calving season may be culled as an alternative to either many years of being "moved back" a month at a time, or being left open for a long period. An individual plan must be formulated for each herd based on herd factors including existing calving pattern, potential for culling, management capabilities, etc. In most instances a calving season can be greatly reduced in length over a period of one to four years without large expenses from culling.

Age of the Cow

Heifers that have just calved for the first time represent a special challenge to a successful reproduction program. In addition to the demands that all beef cows have, these heifers are continuing to grow, and they have less body capacity and therefore consume less energy when fed high roughage rations. They are slower to return to estrus than mature cows.[11] Without special management considerations, an inordinate number of these heifers will be culled for reproductive inefficiency when they fail to conceive during the controlled breeding season. Those conceiving late become late calvers and therefore a detriment to continued reproductive efficiency.

While heifer management systems will not be treated in detail here, a successful program is reported by Spitzer et al. (1980). This program resulted in heifers and cows calving earlier over a five-year period and provided a 33-lb. increase in calf weaning weights. Basically the program provided for exposing considerably more heifers to bulls than would be needed as replacements. A 45-day breeding season was used and only heifers conceiving during this time period were used as replacements. Heifers were fed to reach predetermined target weights (when most heifers would have reached puberty) prior to the beginning of the breeding season. Such target weights vary between breeds since age of puberty is influenced by both weight and breed but are generally in the range of 65% to 70% of mature body weight. Having heifers reach these target weights also provides insurance against dystocia problems at calving. Heifers were placed with bulls 20 days earlier than the breeding season for the cow herd. (Some authors recommend 30 days). This system resulted in a group of first-calf heifers that were well grown, had calved early, had been selected for fertility and had extra post calving days to begin cycling before the second breeding season began.

Special care should be continued to these first-calf heifers after they are bred. Nutrition should be sufficient to allow them to reach 85% of mature body weight by calving. All of the factors discussed in this article for cows must be given extra consideration for the first calvers. In most instances this care is best accomplished by housing and managing these animals

separately from the mature cow herd. This extra care will assure that these heifers, probably the group with the best genetics, will remain in the herd to make their contribution.

Body Condition at Calving

Body condition, essentially the body fat storage, is the third major factor influencing the time from calving to cycling. Table 2 summarizes data reported by Whitman et al.[9] correlating body condition at calving with percentage of cows showing estrus at various times postpartum. The effect of condition is significant. Note, for example, that by Day 60 postpartum 90% of cows in good body condition had shown heat while only 61% and 46% of moderate and thin cows respectively had shown heat. Even by 120 days after calving only 77% of thin cows had shown estrus.

Table 2. Body Condition at Calving and Heat after Calving

		Days After Calving							
Body Condition At Calving	No. of Cows	40	50	60	70	80	90	100	120
		% Showing Heat							
Thin	272	19	34	46	55	62	66	70	77
Moderate	364	21	45	61	79	88	92	100	100
Good	50	31	42	91	96	98	100	100	100

From: Whitman, R.W. (1975)·

A system of scoring cows for body condition based on an examination of the spine, short ribs and the appearance of the tail head area has been developed. This is summarized in Table 3. A score of **1 or 2** correlates with "thin", **3 or 4** is "borderline", **5** is "moderate", **6 or 7** is "good" and **8 or 9** is "fat". Dunn et al. (1983) reported high correlations between body condition score and carcass fat depth, percent carcass fat and total carcass energy.

Condition scoring cows when calves are weaned and at calving time allows one to begin managing this aspect. Weight gains required to achieve "moderate" to "good" body condition at calving have been described for each body condition score.

Even cows that already have adequate condition must gain about 100 pounds in pregnancy related tissues during gestation. Average daily gains can then be calculated and nutrition provided toward this end. Early calf weaning, especially of thinner cows, may be necessary. Provision of good quality pasture and supplementation of hay and pasture with concentrate or silage may be needed to aid cows in gaining sufficient condition. In general, condition should be put on cows before calving occurs. The great increase in energy demand of milking makes significant weight gains difficult in cows that have just calved with feedstuffs available on most beef cattle operations. Greatly increasing nutrition after calving also tends to stimulate increased milk production so that energy is used for milk production rather than body condition gains.

Table 3. CHARACTERISTICS DESCRIBING BODY CONDITION SCORES

Score	Characteristics
1,2	The spine and short ribs are sharp to the touch and can be distinguished visually.
3,4	The processes of the spine can be identified individually by touch. They feel rounded--not sharp and the space between the processes is less pronounced.
5	The processes can be felt with slight pressure. The ends feel rounded. Space between the processes can be distinguished only with firm pressure. Areas on either side of the tail head are filled.
6,7	The ends of the processes can be felt only with firm pressure. Spaces between the processes cannot be distinguished at all. Abundant fat cover round the tail head with some patchiness.
8,9	Bone structure cannot be felt at all. The tail head is buried in fatty tissue.

Suckling Inhibition of Estrus

Suckling has long been known to inhibit return to estrus. Cassida (1968) reported a 42-day difference in return to estrus for nursed versus non-nursed beef cows. Obviously, management practices and considerations dictate that calves must be reared by nursing cows.

Wiltbank and associates have developed a system that allows some escape from the inhibition of suckling. They found that removing calves from cows for 48 hours at the beginning of the breeding season, when coupled with a flushing program, significantly improved pregnancy rates. Calves experience almost no ill effects when provided with feed and water during the period. Individual cow responses to the flushing and calf removal treatment vary depending on time after calving and body condition. Cows 50 days after calving and in moderate body condition showed an increase of from 45% cycling with no treatment to 79% cycling with treatment. It should be noted that thin cows respond only minimally to flushing and 48-hour calf removal. Wiltbank's flushing technique involved feeding 10 pounds of corn/head/day 14 days prior to beginning of breeding and for 21 days thereafter.

Presence of Bull

Recent evidence suggests that the presence of a bull hastens the return to estrus in postpartum cows. The need to maintain a 60-day calving season would probably dictate that the use of such a bull be made only after the bull was rendered infertile by some technique such as those used to produce teaser bulls.

The Use of Hormones

Considerable study has been directed in recent years towards the use of exogenous hormones to increase the reproductive efficiency of cattle.

Estrus synchronization programs based on the use of prostaglandin products, while holding promise for use in genetic improvement programs because they facilitate the use of artificial insemination, impact little on overall reproductive efficiency. A one-dose prostaglandin-synchronization program shortens the cycle of about one-half of the animals in the herd by less than one-half of a cycle. Two-injection programs provide little or no shortening of the cycle. Prostaglandin products have no effect on cows that have not begun to cycle after calving.

For some time investigators had limited success in stimulating heat in cows using various combinations of exogenous steriods. More recently, a steriod treatment involving an injection of 3 mg of norgestomet is and 6 mg of estradiol valerate, coupled with implantation of a polymer containing 6 mg norgestomet is commercially available (Synchromate B®). The implant is removed after 10 days. This treatment has shown some efficacy in increasing cycling after calving. Most of this effect is limited to cows in "moderate" or "good" body condition. This effect is accentuated on cows in marginal body condition when the Synchromate B treatment is coupled with 48-hour calf removal. The coupling of Synchromate B and calf removal is now termed the "Shang" treatment.

More recently GnRH injections as part of the Ovsynch program have been documented to increase cycling in cows. These are now being coupled with progesterone given orally (MGA) or via a vaginal insert (CIDR-B).

Conception Rate

The second major factor known to influence reproductive efficiency in beef cattle is conception rate. If shortened breeding seasons are used, as advocated above, high fertility must be achieved to secure high pregnancy rates. Cows will only be serviced two or three times during a breeding season. Three major factors are known to influence fertility in beef herds (in the absence of major disease entities):

-Time of calving
-Weight changes in cows near breeding
-Use of fertile bulls

Time of Calving

Conception rates are known to increase for approximately 90 days after calving in cattle. All of the considerations of early calving become doubly important since days after-calving influences markedly both cycling and conception. One study reported conception rates at 39% from 0-30 days postpartum, 53% from 31-60 days postpartum, and 62% from 61-90 days postpartum. Considerations listed above to get cows to calve early (to enhance estrus cycle activity by the beginning of the breeding season) will produce an extra benefit in terms of reproductive efficiency by also having cows at a stage of the cycle where conception rates will be maximized.

Weight Changes near Breeding

Table 4 summarizes data on two groups of cows classified according to weight gain or loss during the time of breeding. Pregnancy rates are listed at 20 and 90 days after breeding and first service conception rates are also provided. Results from the first study showed that cows losing weight had a first service conception rate of 43% versus 67% for cows showing no weight change. Thin cows gaining weight in the second study achieved an 87% conception rate as compared with 46% conception rate for cows merely maintaining their weight. Twenty and 90-day pregnancy rates reflect these differences in conception.

The flushing procedures described under "Factors Affecting After-Calving Cycling" become more important since they also influence cow fertility by encouraging cows to gain weight at breeding. Lush spring pasture may be used for this flushing and, in fact, time of calving season may be chosen so that such pasture will be available. A good program for reproductive management involves matching the reproductive events to the nutritional resources that are available on a given farm. It should be remembered that short, new grass with low dry matter content may not provide extra energy. If breeding occurs before good grass is available, provision of nutrition to produce weight gains must be made.

Table 4. Effect of Weight Changes near Breeding on First Service Conception and Pregnancy Rates in Mature Cows

		PREGNANT (%)			
		From First	After Breeding		Cows not Showing
CHANGE	NO.	Service	20 days	90 days	Heat (%)
Calving to breeding					
Losing weight	43	29		77	14
No change in weight	67	57		95	0
Difference	24	28		18	14
Weight change in thin cows					
Near breeding					
Gaining weight	87		--	100	0
No change in weight	46		--	70	15
Difference	41		--	30	15

From: Wiltbank, J.N. (1983)

Program to Improve Reproductive Efficiency

An understanding of the major factors influencing beef cattle reproduction performance allows the formation of a program to maximize reproductive efficiency. As with any program realistic goals must first be established. A goal of 95% of cows calving during a 60-day calving period is high but attainable. In order to achieve this 65-75% of the cows should calve in the first 21 days of the calving season. This necessitates 95-100% of the cows showing estrus in the first 20 days of the breeding season and conception rates of 70-80%. Obviously, this will require both high cow and bull fertility.

In considering the major factors contributing to high pregnancy rates (cycling, cow fertility and bull fertility) it must be remembered that the factors are multiplicative and not additive. For example, if a figure for number of cows becoming pregnant in the first 20 days of the breeding season is to be estimated, then values for percent cycling, cow fertility and bull fertility must be known. Suppose all three figures are 90%. The expected pregnancy percent is then 90% x 90% x 90%, or 72% pregnant--not (90% + 90% + 90%) divided by 3, or 90% pregnant cows. This means that one low factor has a very negative influence on the overall result. If, in the above example, cow fertility is only 50%, the expected pregnancy percent is 90% x 90% x 50%, or 40.5% pregnant cows, not (90% + 90% + 50%) divided by 3, or 77% pregnant. Overall performance will never be higher than the lowest variable.

All of these principles can be distilled into a reproductive program:

1. A 65-day breeding season is enforced.

2. A nutritional program to ensure that cows are in "moderate" or "good" body condition (BCS 5-6) at calving time begins.

3. A nutritional program to ensure that cows are gaining weight before the breeding season and for the first three weeks of the breeding season is used.

4. Use of hormones for estrous synchronization at the beginning of the breeding season which enhance cyclicity of cows.

5. Cows are bred to fertile bulls (scrotal circumference of >32 cm and >70% normal sperm).

6. Additional measures are used as needed to achieve high reproductive rates. Examples: Calves are removed from cows for 48 hours at the start of the breeding season. Teaser bulls are used to increase cyclicity.

Application Reproductive Principles on the Powell River Project

The Beef Cattle Program on the Powell River Project involves a herd of about fifty cows that are managed primarily on forages that grow in reclaimed strip mined lands. The following practices have been successfully employed in there management as pertains to reproduction:

- Breeding is carried out during a season beginning near the end of May so that calving will begin near the beginning of March. The breeding season lasts sixty-five days.
- These seasons take advantage of the natural high quality of the forages in the beginning of the grazing season to provide for a positive energy balance beginning a few weeks before the breeding season.
- Calves are weaned in the fall early enough so that cow body condition is maintained. If dry conditions dictate early weaning is practiced to provide for reduced nutritional diamond on the project. Stockpiled forages provide adequate nutrition during the winter so that cows maintain a body condition of 5 to 6 on average by calving time. Relatively limited supplementation of harvested forages in the form of hay has been sufficient to maintain body condition adequate for excellent reproductive outcomes.
- Cows are synchronized using the 5-Day CIDR protocol that involves the use of GnRH, the Eazi-Breed CIDR® and prostaglandin F2α at the beginning of the breeding season.
- Cows are artificially inseminated with frozen semen from high quality bulls using this timed-AI protocol.
- A single bull has been sufficient to do clean-up breeding following the AI and is placed with the cows about three days following the timed AI.
- The bull is subjected to a breeding soundness examination prior to the beginning of the breeding season and replaced if he fails to meet the standards set the American Society for Theriogenology.
- Replacement heifers are developed so that they have achieved at least 65% of mature size prior to the breeding season and then are managed as per the cows as described above.

Results of the Breeding Program at the Powell River Project

Parameter	Number of Cows	Number Pregnant	Percent Pregnant
2008			
Pregnant During the Breeding Season	50	47	94%
Pregnant to Artificial Insemination	49	26	53.1%
Pregnant to the First Natural Service Cycle	24	19	79.2%
Percent Open at the End of the Breeding Season	3	47	6 %
2009			
Pregnant During the Breeding Season	47	43	95.7 %
Pregnant to Artificial Insemination	47	28	59.6 %
Pregnant to the First Natural Service Cycle	19	13	68.4 %
Percent Open at the End of the Breeding Season	4 (incl. 2 abortions)	43	8.5%

Summary

Applying the principles of beef cattle reproductive performance has resulted in excellent outcomes at the Powell River Beef Cattle Project. These excellent outcomes have been achieved on forages produced under typical beef cattle practices on reclaimed strip-mined land. Nutrition has been adequate, with minimal hay supplementation to achieve high levels of reproductive performance. Artificial insemination has been successfully applied using a fixed-time synchronization protocol which requires minimum labor and has resulted in very acceptable pregnancy rates. Followed by a natural service period with a single bull overall pregnancy rates have been in the realm of ninety-five percent. Application of these principles will allow for profitable reproductive outcomes with reasonable inputs on operations in the coalfields areas of Southwest Virginia.