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MANAGEMENT STRATEGIES FOR IMPROVING THE REBREEDING OF THE COW

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INTRODUCTION

What are the primary factors that influence the ability of cows to rebreed following calving? From a broad perspective, two key factors influence when conception occurs. First, cows must initiate estrous (heat) cycles following calving to provide the proper conditions for conception to be possible. Secondly those events involved in conception must occur. We will discuss what has to occur before estrous cycles are initiated. The influence of the presence of bulls on initiation of estrous cycles is emphasized. In the second section of the paper, we describe conception rates in 2 and 3 year old cows during the early post calving period. In addition, we describe management decisions which influence net income in cow/calf operations.

Initiation of Estrous Cycles Following Calving

Why is it important that estrous cycles be initiated before conception can occur? Prior to the initiation of estrous cycles, the ovary does not release eggs nor does it produce the hormones needed to prepare the reproductive tract for gamete (egg and sperm) transport. In addition, these hormones induce behavioral estrus (heat) and provide an environment within the reproductive tract that will allow for embryonic development. Therefore, estrous cycles are Nature's way of allowing for union of the sperm and egg and providing the environment for fertilization and subsequent embryonic development after the cow has sufficiently recovered from the birthing process.

What has to occur within the cow before estrous cycles are initiated? Estrous cycles are driven by four primary organs. Two of these organs lie at the base of the brain - hypothalamus and pituitary. These two organs produce the hormones - gonadotropins - that drive the function of the ovaries. Specifically, these two hormones are called follicle stimulating hormone (FSH) and luteinizing hormone (LH). These two hormones stimulate the growth and development of the ovarian follicles. The follicles contain the egg and produce the estrogen that causes behavioral estrus. In addition, the two gonadotropins induce ovulation and LH causes the development of the corpus luteum by transforming follicle cells into luteal cells. The corpus luteum produces the hormone progesterone. Progesterone inhibits behavioral estrus and along with estrogen acts on the female reproductive tract to prepare it for sperm and egg transport, fertilization and embryonic development. If conception does not occur the uterus produces a substance - prostaglandin F_{2a} - that causes the corpus luteum to die. If this occurs, estrous cycles will continue to ensue until conception occurs. Therefore, the four primary organs driving the estrous cycle are the hypothalamus, pituitary, ovary and uterus.

What inhibits estrous cycles from being initiated in the cow following calving? Nature has put a series of inhibitory and stiniulatory regulators in place that determine when a cow will reinitiate estrous cycles. The period of anestrus following calving serves as a protective mechanism to inhibit conception from occurring until a cow can carry a pregnancy to term and properly nourish her calf. The reason why cows do not initiate estrous cycles immediately following calving is because there is not enough gonadotropin released from the pituitary to drive development of ovarian follicles to the point they can ovulate and produce enough estrogen to cause behavioral estrus. Therefore, the factors that impact regulation of initiation of estrous cycles act on the hypothalamus. The hypothalamus regulates pituitary release of the gonadotropins. The hypothalamus determines when the balance of stimulatory and inhibitory factors is proper for initiation of estrous cycles.

What are the factors that influence time of initiation of estrous cycles following calving? Several factors that impact on the hypothalamus to regulate initiation of estrous cycles in cows include: (1) Genetic make-up, (2) Age, (3) Nutritional status, (4) Lactational status, (5) Season of the year when cow calves, and (6) Social status - is the cow segregated or in the presence of bulls. All of these factors impact on the hypothalamus to inhibit or stimulate the initiation of estrous cycles. The hypothalamus does not induce enough gonadotropin secretion to stimulate the initiation of estrous cycles in most beef cows before 40 days following calving. After 40 days following calving, the balance of the various factors impact on the hypothalamus to determine when estrous cycles are initiated.

We have performed several studies which deal with how presence of bulls influences time of initiation of estrous cycles. In our initial research we found that mature cows exposed to bulls at calving initiated estrous cycles 21 days earlier than cows not exposed to bulls until 53 days following calving (Zalesky et al., 1983).

Table 1. Effect of Bull Presence on Duration of Aestrus in Mature Cows Following Calving

	Exposed to bulls		Isolated from bulls	
	1981	1982	1981	1982
Average calving date[a]	April 2 ± 2	March 5 ± 4	March 31 ± 3	March 5 ± 4
Average date estrous cycles started	May 15 ± 2	April 12 ± 4	June 2 ± 2	May 4 ± 5
Average days calving to first estrous cycle	43 ± 2	39 ± 2	63 ± 2	61 ± 3

Subsequently, we evaluated how nutritional status of the cow before calving influences the effect of presence of bulls after calving. Cows were fed to maintain (8 pounds) or gain weight (60 pounds) the last 90 days of pregnancy and were exposed or isolated from bulls after calving (Stumpf et al., 1988). Cows fed at levels to maintain body weight initiated estrous cycles at the same time after calving as cows that gained weight and were exposed to bulls. However, in cows isolated from bulls initiation of estrous cycles was later in cows fed to maintain weight than in cows that gained weight.

Table 2. Effect of Nutritional Status and Bull Presence on Duration of Anestrus Following Calving (Days)[a,b]

	Exposed to Bulls	Isolated from Bulls
Gained Weight	44.1	49.8
Maintained Weight	43.6	57.7

[a]Standard error = 1.8 days
[b]Average of two years data

We have also evaluated the duration of anestrus following calving in cows exposed to yearling or mature bulls and compared them to cows isolated from bulls (Cupp et al., 1991). Cows pastured with yearling and mature bulls had shorter periods of anestrus after calving than cows isolated from bulls.

Table 3. Effect of Age of the Bull Present with Cows on Duration of Anestrus Following Calving Days Postpartum

	Days Postpartum			
Treatment	1987	1988	1989	MEAN
Isolated from Bulls	67.7	72.8	77.2	72.3
Exposed to Mature Bulls	60.0	52.0	65.8	59.5
Exposed to Yearling Bulls	55.4	60.0	69.1	61.8

Standard error = 1.7 days

Presence of bulls also hastens resumption of estrous cycles following calving in lactating cows at two years of age (Gifford et al., 1989; Custer et al., 1990). We are presently evaluating the influence of fenceline exposure to bulls on duration of postpartum anestrus. Presumably the presence of bulls stimulates the release of the gonadotropins which drive ovarian function. This probably occurs as a result of pheromonal signals produced by the bulls and detected by the cows. These pheromonal cues would be received by the hypothalamus via neurons and would be interpreted as a positive signal to enhance release of gonadotropins. However, evidence indicates the presence of bulls does not enhance release of LH in cows (Custer et al., 1990). Further research will have to be performed if we are to determine the route through which bull presence serves as a cue to stimulate the initiation of estrous cycles in cows. It is obvious that many factors integrate within the hypothalamus to determine the proper time for estrous cycles to be initiated.

Factors Influencing Rate of Conception in a Cow Herd

If duration of anestrus is more than 60 days after calving the cow can only have a single opportunity to conceive and maintain an annual calving interval of 365 days. If the duration of anestrus exceeds about 80 days, the cow will not be able to maintain an annual calving interval. If a 65% conception rate at first service is assumed, then 65% of the cows with a postpartum interval of anestrus between 60 and 80 days will calve within 365 days. It has been stated that cows with shorter periods of anestrus following calving will have more opportunities to breed and thus, are more likely to maintain a 365 day calving interval. However, in some cases, cows with short postpartum intervals of anestrus will not have an opportunity to conceive until after the start of the breeding season even though these cows have initiated estrous cycles at an earlier date.

A common practice in cow-calf production is to begin breeding of cows on the same date each year. The goal is to maintain an average interval of no more than 365 days between dates of calving. Previous studies have determined that calving interval is biased when it is used as a measure of reproductive performance. Calving interval tends to be longer for cows which give birth early during the calving season because they have more days to re-initiate reproductive function before initiation of the breeding season. Likewise, calving interval tends to be shorter for those cows which calve late during the calving season. The bias of a fixed date and length of breeding season can be removed by exposing cows to fertile bulls within one week of calving. The objective of some of our recent research was to determine effects of parity and year on calving interval in cows exposed to bulls immediately after calving rather than in cows mated during a fixed breeding season.

Calving dates were recorded for 178 crossbred (Shorthorn, Angus, and Hereford) beef cows at two, three and four years of age during 1981 to 1988 (Werth et al., 1990). As yearlings, heifers were exposed to bulls for a 35-day period. Following the date of their first calving, cows were exposed to bulls for up to 200 days and allowed to mate at their first estrus after calving. The cows grazed pastures during the growing season and corn stalks in the fall and winter. Supplemental hay was also fed during the winter. Similar management was used after the second and third calving. Calving interval was determined as the difference between the dates of calving in two successive years, therefore two calving intervals were determined: (1) interval between calving dates at 2- and 3-years of age, and (2) interval between calving dates at 3- and 4-years of age. Groups were compared across years and across parities (first, second, or third calving).

The changes in the average calving dates are shown in Table 4. Calving interval was affected by year of calving, parity of the cow, as well as the interaction between year and parity. Differences between years were significant. For example, 2-year-old cows in 1981 had an average calving date of March 11; in 1982, the average calving date of these cows at three years of age was February 20. Another group of two-year-old cows had an average calving date of March 12 in 1985; in 1986, these cows had an average calving date of March 30. Therefore, calving interval was reduced by 19 days in the group of cows calving first in 1981; however, calving interval was increased by 18 days in the second group (1985).

Differences between years may result from year-to-year changes in the environment, and the quality and availability of feed resources. The goal was to feed cattle to meet their nutritional requirements each year, however, the stress of extreme temperatures and winter conditions in 1984 and 1985 resulted in thinner 2-year-old cows at calving and these cows did not conceive as early as cows in other years. The average change in calving interval between two- and three-years of age across the six years in which this study was performed was -4.3 days. In other words, 3-year-old cows calved 4.3 days earlier in the calving season than they did as 2-year-olds.

Table 4. Average Date of Calving for Cows at 2, 3 and 4 Years of Age and the Change in the Average Date of Calving among Groups.

Year of first calf	No. of cows	Average date of calving by age of cow				
		2 years		3 years		4 years
1981	39	March 11	(-19)[a]	Feb. 20	(-26)[b]	Jan. 25
1982	22	March 8	(-19)	Feb. 17	(-7)	Feb. 10
1983	34	March 8	(-1)	March 7	(-15)	Feb. 21
1984	21	March 10	(8)	March 18	(-24)	Feb. 23
1985	25	March 12	(17)	March 30	(-23)	March 7
1986	37	March 7	(-12)	Feb. 23	(-24)	Jan 30
		March 8	(-4.3)	March 5	(-19.5)	Feb. 14

[a,b]Difference in average calving date between the 1st and 2nd calving (a), and the 2nd and 3rd calving (b), (numbers have been rounded).

Parity of the cow also affected the length of the calving interval. Cows calving at three and four years of age tended to calve earlier and therefore have a shorter calving interval as compared to 2-year-olds. Using the example stated earlier, the cows giving birth to their first calf in 1981 had an average calving date of January 25 in 1983 when they were four years of age. Therefore calving interval was reduced by 26 days between the second and third calves of these cows. Similarly, the cows calving first in 1985 had an .average calving date of March 7 in 1987 as 4-year-olds which was 23 days earlier than the average calving date in 1986. The average change in calving interval between three- and four-years of age across the six years in which this study was performed was -19.5 days. Therefore, the total change in average calving date between two- and four-years of age was 24 days, i.e., the cows calved 24 days earlier in the year when they were four as compared to when they were two years of age.

As a cow matures, her ability to withstand stresses at calving improves, however, this is still affected by body condition. Cows at two-years of age tend to have a longer interval of anestrus to conception. At least two explanations exist. First, as a two-year-old the cow is still growing during gestation when the fetus is also competing for nutrients. If the cow is stressed nutritionally, nutrient needs of the fetus are met first and any of the mother's energy stores are subject to depletion. After calving, the young cow must satisfy her own growth, maintenance, and lactation requirements, as well as improve her own depleted energy stores to prepare her reproductive system for rebreeding. These results indicate that 2-year- old cows can maintain a 365-day calving interval. The average postpartum interval to conception for 2-year-old cows in this study was about 75 to 80 days.

In usual management systems, the cow's interval between calving is restricted because the first day of the breeding season is fixed by the day when the producer initiates breeding. Cows may be exhibiting estrous cycles before the first day of the breeding season; however, they do not conceive because the breeding season has not been initiated. Thus, early initiation of estrous cycles may not be reflected in a shorter calving interval when fixed breeding seasons are utilized. If allowed the opportunity to breed at her first estrus after calving, cows tend to give birth to their next calf earlier during the following year. Our research indicates that this is dependent upon the parity of the cow, the effect of year, and the interaction between year and parity.

It becomes obvious that the reproductive physiology of the cow and duration of fixed breeding seasons can interact to influence efficiency of production in beef cow calf operations. Short breeding seasons have been advocated to improve the efficiency of the cow herd because a more uniform calf crop is produced. For short breeding seasons to be effective, a high percentage of cows must be capable of conceiving early during the breeding season. Cows that give birth late during the calving season and/or have extended intervals of anestrus after calving may not have an opportunity to conceive during a short breeding season. Some of these cows would conceive if the breeding season were extended. Long breeding seasons result in higher overall pregnancy rates; however, more cows will calve late resulting in younger, and thus lighter calves if all calves are weaned at the same date. With this in mind, we developed two computer models to evaluate what the best management decisions are to take advantage of the reproductive system of the cow and enhance net economic income (Werth et al., 1991). A biological model of reproduction and a cow-herd economic simulation model were used to evaluate how management decisions and reproductive performance interact to influence net income in a cow-calf operation (1,000 cows) for 1 year of production. One model was used to determine herd performance when length of breeding season (45, 70, or 120 days) interacted with three intervals of anestrus (48, 65, or 90 days) and three conception rates at first service (60, 70, or 80%). Short (48 days), moderate (65 days), and long (90 days) intervals of anestrus were used to reflect differences in reproductive performance. In addition, replacement heifers were bred beginning either 3 weeks ahead of the cow herd or at the same time as the cow herd. Fifty-four simulations were generated. Inputs into the economic model were herd performance, livestock and feed prices, nonfeed costs, and feed requirements for 1 year of production. Feed requirements were calculated separately for each interval of anestrus to reflect three different body condition scores - thin, moderate, and good - to correspond with long, moderate, and short intervals of anestrus.

Net income was compared within each interval of anestrus (48, 65, and 90 days) for each length of breeding season, conception rate at first service, and time of breeding yearling heifers. Net income ranged from -$138,399 to -$203,237. In this project, all costs and expenses were incorporated into the economic model, including those for which there is no cash outlay. Fixed costs for labor and interest on breeding animals were included in total other costs; however, these costs may not be incurred if all labor is provided by the operator and family and the cow herd is owned without debt. In addition, the period between 1980 and 1989 includes years when prices for feed inputs were high relative to prices received for livestock. Toward the end of the decade, feeder cattle prices began to climb and feed prices decreased; however, these changes in price trends were not enough to offset the high cost of inputs that occurred earlier.

Interval of Anestrus. Net income was greatest with moderate intervals of anestrus when results were averaged across all scenarios. Net income was influenced by length of breeding season within each anestrus interval. The 70-day breeding season resulted in the greatest net incomes when results were averaged across scenarios with short and moderate anestrus intervals (Tables 5 and 6). Conversely, the longer breeding season (120 days) was favored with long anestrous intervals. In addition, the magnitude of the difference in net income due to length of breeding season was much greater with long than with short intervals of anestrus (data of Table 5 compared with data of Table 7).

Table 5. Expected Net Income When Cows Were Managed for Short Intervals of Anestrus (48 days) Holding Conception Rate at First-Service Constant

Time of breeding heifers[a]	Breeding Season (days)	Net Income ($)	Replacement rate (%)	Total feed costs ($)	Total other costs ($)	Total income[b] ($)
HBW	70	-154,221	14.6	333,146	193,619	372,544
HBE	70	-154,510	14.7	333,462	193,598	372,550
HBE	45	-155,864	21.1	346,484	200,979	391,599
HBW	120	-155,960	12.1	327,978	190,589	362,606
HBE	120	-157,609	12.1	328,302	190,542	361,235
HBW	45	-157,783	21.2	349,652	202,684	394,552

[a]HBW = heifers bred at same time as cows; HBE = heifers bred 3 wk before cows.
[b]Total income less purchase of replacement livestock.

Table 6. Expected Net Income When Cows Were Managed for Moderate Intervals of Anestrus (65 days) Holding Conception Rate at First-Service Constant

Time of breeding heifers[a]	Breeding Season (days)	Net Income ($)	Replacement rate (%)	Total feed costs ($)	Total other costs ($)	Total income[b] ($)
HBE	70	-149,428	15.4	322,225	193,936	366,733
HBE	120	-149,920	12.2	315,954	190,381	356,414
HBW	120	-150,972	12.4	315,898	190,491	355,418
HBW	70	-152,322	16.1	323,750	195,043	366,471
HBE	45	-157,015	23.2	338,180	202,699	383,863
HBW	45	-161,383	25.1	345,405	205,971	389,993

[a]HBW = heifers bred at same time as cows; HBE = heifers bred 3 wk before cows.
[b]Total income less purchase of replacement livestock.

Table 7. Expected Net Income When Cows Were Managed for Long Intervals of Anestrus (90 days) Holding Conception Rate at First-Service Constant

Time of breeding heifers[a]	Breeding Season (days)	Net Income ($)	Replacement rate (%)	Total feed costs ($)	Total other costs ($)	Total income[b] ($)
HBE	120	-147,882	13.1	299,991	190,888	342,998
HBW	120	-157,421	14.4	301,959	192,262	336,800
HBE	70	-159,857	23.1	319,941	201,127	361,210
HBW	70	-174,779	30.9	336,066	208,966	370,254
HBE	45	-179,812	40.6	357,513	218,776	396,477
HBW	45	-192,427	53.0	392,395	234,742	434,710

[a]HBW = heifers bred at same time as cows; HBE = heifers bred 3 wk before cows.
[b]Total income less purchase of replacement livestock.

The lowest net incomes resulted with 45-day breeding seasons combined with long anestrous intervals (Table 7). Replacement rates were greatest because a large number of cows were not in estrus or did not conceive during a short breeding season due to their long anestrous interval. Fewer calves were sold at weaning because a large number of heifer calves were retained for replacement purposes. The number of heavy calves at weaning was influenced by several factors when the interval was long. The number of heavy calves was lowest with short breeding seasons due to the large replacement rate. As a result of the large replacement rate, the average age of the herd was younger because it was composed of more cows 2 or 3 years of age. Calves weaned from cows 2 or 3 years of age weighed less at weaning than calves from mature cows. Therefore, more light and medium-weight calves were weaned in scenarios in which replacement rates were high. The number of heavy calves increased as length of the breeding season increased because the cow herd was composed of a greater number of mature cows, which weaned heavier calves. Length of breeding season did not influence the number of heavy calves at weaning in scenarios in which the anestrus interval was short or moderate. However, the number of light calves gradually increased as the breeding season was extended from 45 to 70 to 120 days. With longer breeding seasons, more cows calved later, resulting in more younger and lighter calves at weaning.

Simulations of long intervals of anestrus had the lowest feed requirements on a per-cow basis because the cows were assumed to be maintained in thin body condition and required less feed to maintain their lighter weight. Likewise, when short anestrous intervals were simulated, cows were assumed to be in good condition and feed requirements were calculated based on the heavier weight of the fleshy cows.

Estimates for the amount of forage intake when cows grazed summer pasture were calculated to reflect management practices that would maintain cows in a predicted level of body condition. Thin cows were assumed to require less forage to maintain their weight (930 lbs) than cows in moderate condition (1050 lbs) or good condition (1170 lbs); however, cows in thin condition may still consume the same amount of forage as cows in moderate or good body condition. Therefore, the cows in thin condition were assumed to be grazing pastures that were managed with higher stocking rates than cows in the other two groups, and thus the feed intake of thin cows would be limited. The long term effects of high stocking rates on quality of forage are not included in the economic model.

Conception Rate at First Service. Net income increased as conception rate at first service increased, regardless of anestrous interval. The greatest net income resulted with 80% conception rates at first service; likewise, the poorest net incomes resulted with 60% conception rates at first service within any length of breeding season. Conception rate at first service influenced the distribution of conception dates within the cow herd, which influenced pregnancy rate and mean calving date. Higher conception rates at first service resulted in greater pregnancy rates, and thus replacement rates were lower. Fewer heifer calves were retained at weaning as a result; therefore, total feed costs were lower. More calves were born during the first 21 days of the calving season as conception rate at first service increased. The greatest number of heavy calves weaned occurred with 80% conception rates at first service and the greatest number of light calves weaned occurred with 60% conception rates at first service.

Length of Breeding Season. The optimum length of breeding season depended on the anestrous interval. Moderate breeding seasons (70-days) were most profitable with short or moderate anestrous intervals, which is in agreement with the results of Deutscher et al., (1991). They reported a 5-year study conducted in the Nebraska Sandhifls that evaluated the effects of three breeding programs (30, 45, and 70 days) on calf performance and reproductive performance of the cow. Weight of calf weaned per cow was highest with 70-day breeding seasons due to higher pregnancy rates and weaning rates compared with 30- and 45-day breeding seasons. The computer simulation model described earlier were used in a previous project to evaluate how conception rate at first service interacts with length of breeding season to influence net income. When conception rates at first service were high (70 to 80%), there was little difference in net income due to length of breeding season. When conception rates at first service were lower (50 to 60%), longer breeding seasons (120 days) were more profitable because a greater number of cows became pregnant and subsequently weaned calves. In the present study, long breeding seasons resulted in the greatest net income with long anestrous intervals because pregnancy rates were greater than when 45- and 70-day breeding seasons were used. A larger proportion of young, light calves at weaning achieved through increased pregnancy rates was economically better than weaning fewer calves.

Time of Breeding Yearling Heifers. Net income was greatest due to lower replacement rates when the breeding season for heifers was initiated 3 weeks ahead of that for the cows rather than concurrently with that for the cows. The lactating cow at 2 years of age has more time to return to estrus before the start of her second breeding season if she is bred to calve 3 weeks ahead of the mature cow herd. Therefore, in this simulation, more 2-year-old cows were in estrus and could conceive during the breeding season, which resulted in increased pregnancy rates compared with situations in which heifers were bred beginning at the same time as the cows.

Net income was greatest with 70-day breeding seasons when anestrous intervals were short or moderate in length assuming that cows were in good to moderate body condition. However, net income was only slightly lower when breeding seasons were extended to 120 days. If short breeding seasons are used and a large number of cows are removed from the herd because they do not become pregnant, then the breeding season may need to be extended to increase the pregnancy rate and increase net income. Results from this study indicate that selling a light calf that was born late is more profitable than selling a nonpregnant cow and replacing her with a heifer calf. Above all, management practices that maintain a greater percentage of mature cows in the herd should optimize both reproductive and economic efficiencies because more calves that are heavier are produced relative to the quantity of feed necessary for maintenance and lactation.

Producers need to understand the reproductive pattern of the cow to achieve optimal reproductive efficiency and enhance net income. Producers should also consider the management systems they use and how these systems influence the reproductive pattern of the cow. If producers understand the cows reproductive pattern and their management constraints then they should be able to make wiser decisions on how to choose management practices that can enhance their net income. Figure 1 is a summary of our conceptual model of how management decisions and reproductive performance influence the biological production of the cow herd, which ultimately influences net income of the herd.

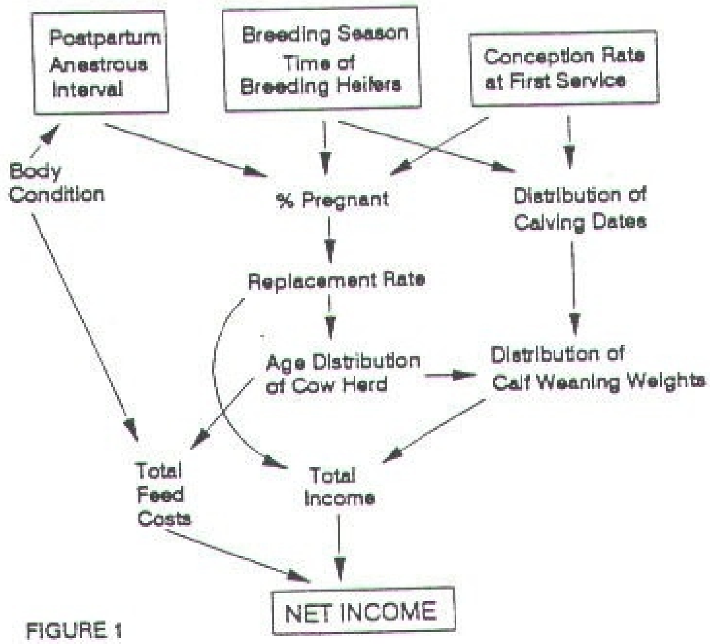

FIGURE 1

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