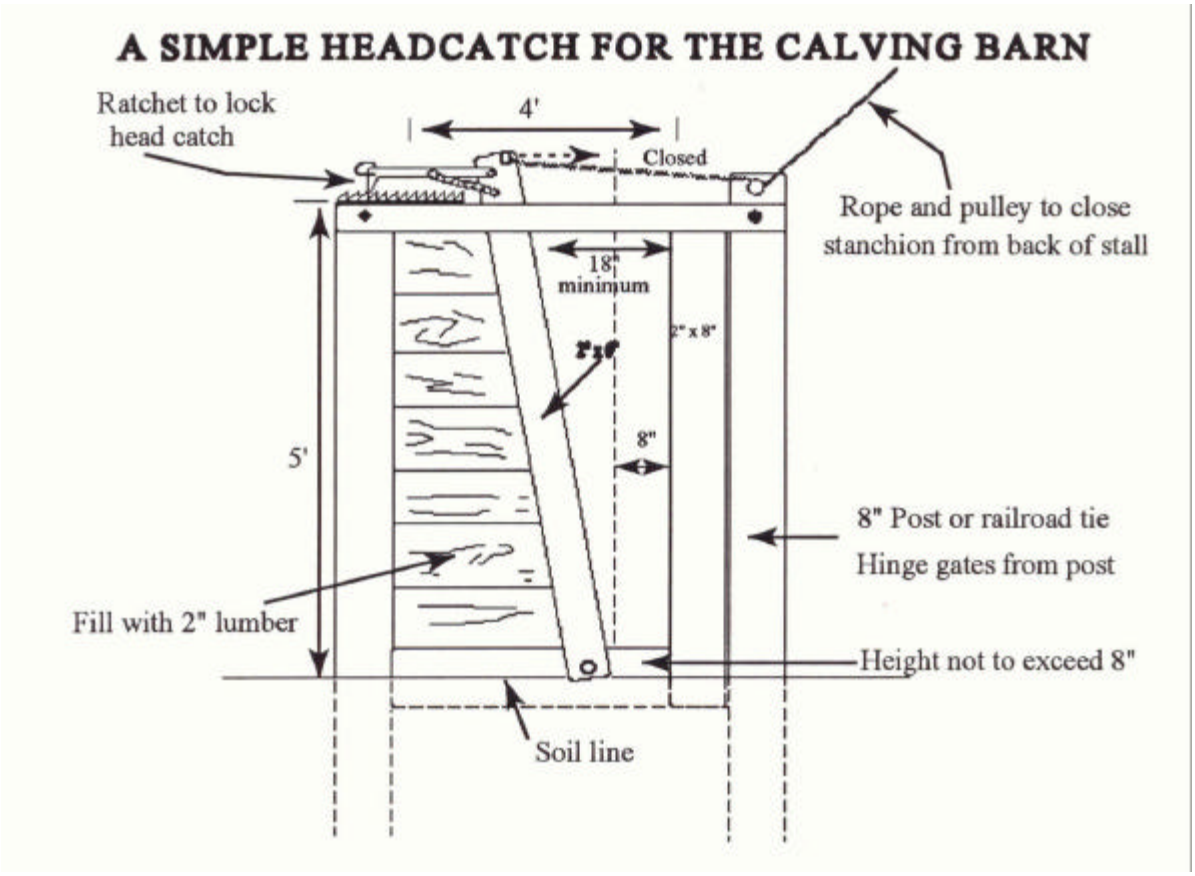
OSU
OSU
OSU
OSU
OSU
OSU
OSU
OSU
OSU
OSU
OSU

CALVING SCHOOL HANDBOOK

BILL ZOLLINGER
Dept. of Animal Sciences
212 Withycombe Hall
Corvallis OR 97331
541-737-1906

DON HANSEN
College of Vet Medicine
105 Magruder Hall
Corvallis OR 97331
541-737-6533

Animal Sciences
Publication 110
January 2003


A SIMPLE HEADCATCH FOR THE CALVING BARN
Ratchet to lock head catch
4'
Closed
Rope and pulley to close stanchion from back of stall
18" minimum
2" x 8"
8"
5'
8" Post or railroad tie
Hinge gates from post
Fill with 2" lumber
Height not to exceed 8"
Soil line

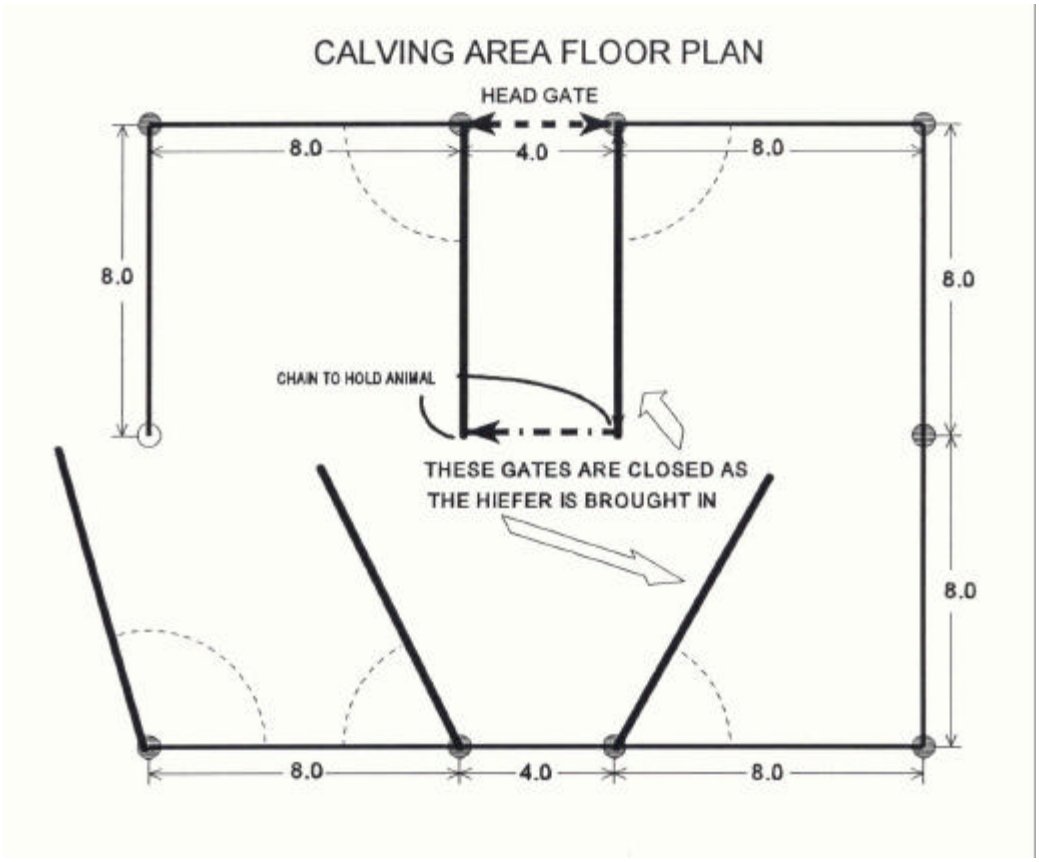

CALVING AREA FLOOR PLAN
HEAD GATE
8.0
4.0
8.0
8.0
8.0
CHAIN TO HOLD ANIMAL
THESE GATES ARE CLOSED AS THE HIEFER IS BROUGHT IN
8.0
8.0
4.0
8.0

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

The material in this book has been developed in a variety of ways. The Authors would acknowledge the following individuals as contributors to this book in several ways. The majority have contributed by allowing us to edit, "bend and twist", articles they wrote so that it fits in our materials. We acknowledge their contributions as significant to our effort.

David Chamberlain
Harney County Extension
Burns, OR

Don Hansen
Extension Veterinarian
Oregon State University
Corvallis, OR

Leon Pielstick, DVM
Harney County Veterinary Clinic
Burns, OR

Jack Whittier
Beef Cattle Specialist
Colorado State University
Animal Science Department
Fort Collins, CO

Bill Zollinger
Beef Specialist
Oregon State University
Animal Sciences Department
Corvallis, OR

CALVING SCHOOL

BILL ZOLLINGER
OSU Beef Extension Specialist
Department of Animal Sciences
Withycombe Hall 210
Corvallis, OR 97331
541-737-1906

DON HANSEN
Extension Veterinarian
Veterinary College
McGruder Hall
Corvallis, OR 97331
541-737-6533

Sponsored by Oregon State University Extension Service
Department of Animal Sciences
College of Veterinary Medicine
Corvallis, Oregon

Emphasis: Hands-on experience

TOPICS

A.M.

Introductions and Definitions

License to intervene

Building Pictures: Cow and Calf

The Birthing Function - Identifying Membranes and Fluids

Handling Abnormal Presentations: Dystocia, Pulling, and Proper Assistance

Calving Equipment and Its Proper Use

Calving Barn Facilities, Chutes, Etc.

NOON -- BRING A SACK LUNCH

P.M.

Special Handling of First Calving Heifers

Sire Selection Based on Data from Records (EPD)

Third-Trimester Management and Nutrition

Getting Them Bred Back on Schedule

Post-Calving Management: Calf survival

NOTE: We will stop all classroom presentations whenever a heifer starts to calve. Discussions will be held on emergency situations as they arise.

INTRODUCTION

This book is provided to you to ensure that you have a chance to review the materials covered in the calving schools held with OSU. You will find each subject covered in detail with the research result to support the conclusions talked about in the school. The following major divisions are included for you convenience (PLEASE TAB THE NOTEBOOK AS APPROPRIATE):

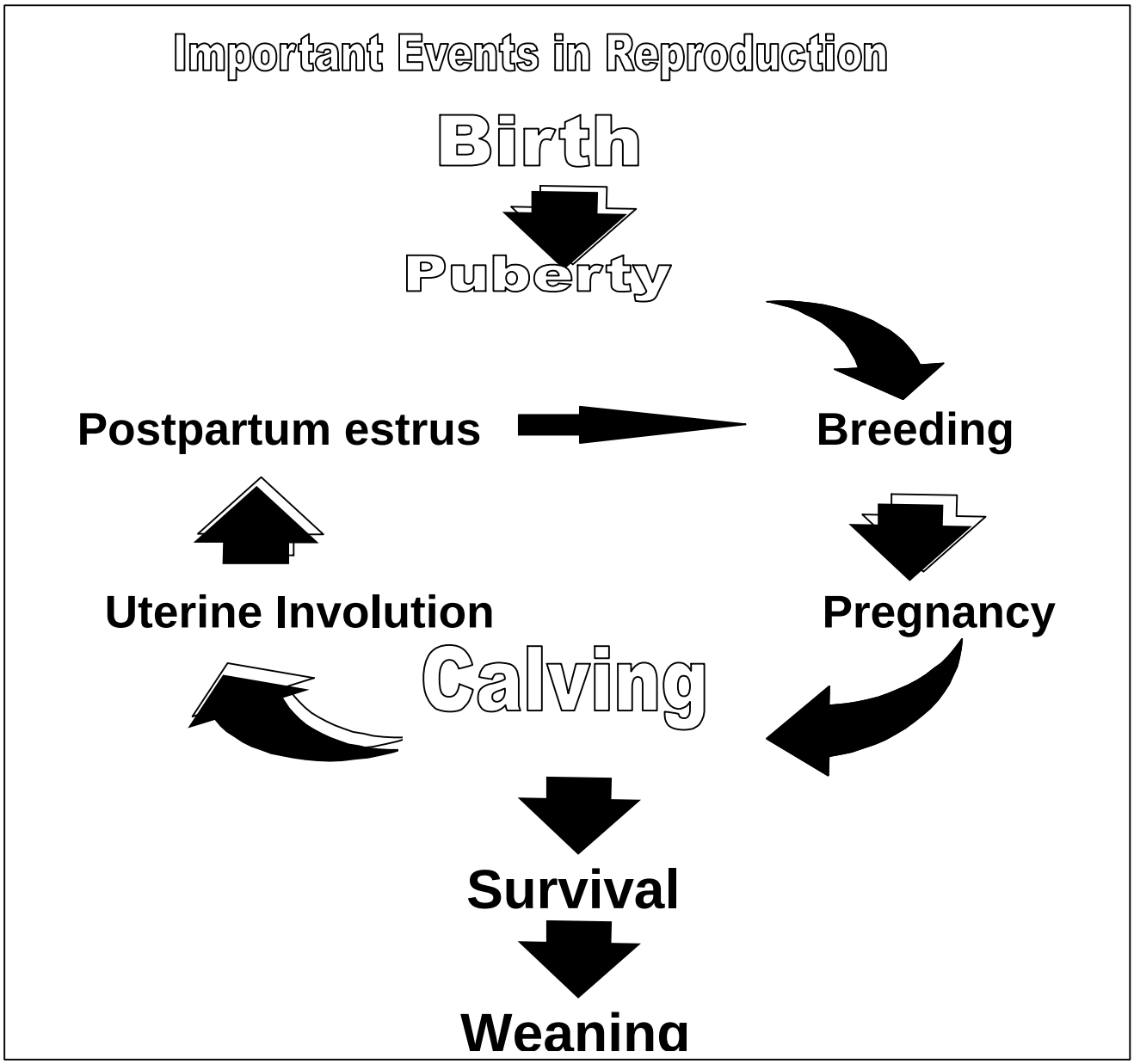
INTRODUCTION
GENERAL CONSIDERATIONS
CAUSES OF DYSTOCIA
HANDLING CALVING PROBLEMS
DEVELOPING HEIFERS
BODY CONDITION SCORES
COW NUTRITION
SELECTING SIRES
KEEPING CALVES HEALTHY

STATEMENT OF PURPOSE

Over the past several years we have conducted a number of surveys, formal and informal, as part of the IRM program. We discovered some interesting things. Probably of most significance is the discovery that the largest loss of calves occur near birth. As we looked at the causes of death and how we might change them, we discovered that a high percentage of the calves from two-year-olds were born with dystocia problems. We know that if a calf experiences dystocia at birth it is 13.6 times as likely to be born dead or die within the first 12 hours of life. If the calf is alive after a difficult birth, it is five (5) times as likely to die. Also, a calf is 2.4 times as likely to become ill in the first 45 days of life if it is born in a difficult birth.

Many of the problems at birth can be avoided if we make proper decisions relative to sires, development, nutrition, etc. We hope to help each of you understand the right responses to these challenges. We find this exciting and hope to help you as time progresses.

THE REPRODUCTIVE PROCESS IN CATTLE



It has been estimated that the relative economic value of reproductive performance to the beef cow-calf producer is 10 times greater than the value of production and 20 times greater than the product (Willham, 1974). This is not to say that production and product are unimportant, rather it is meant to emphasize the importance that having a live, healthy calf every year plays in a cow-calf operation. There are several important events that must take place for this to happen regularly and efficiently. These events are outlined in the diagram above.

Puberty - ***Biological Principles***

Before a heifer can conceive or a bull can sire a calf, they must first attain puberty. The process of sexual development is influenced by many factors such as age, weight and breed. Some of these factors can be controlled by management practices. This paper is a brief overview of what must take place physiologically in both the heifer and the bull.

Puberty is defined in heifers as the time when they first ovulate and show heat period. In bulls it is defined as the period when a collection of semen can be obtained with a concentration of 50 million viable sperm cells with a progressive motility of greater than 10%. The precise mechanisms associated with puberty are not fully understood. However, it is clear both males and females go through a similar physiological process as puberty approaches. This process involves sensitivity to and regulation of hormones and receptors in the brain and the sex organs or gonads (ovary in females and testes in males).

A prominent theory for puberty in heifers is that receptors in the brain become less sensitive to the hormone estrogen as it is released by the ovary. This decreased sensitivity in turn alters the secretion of a hormone known as LH (luteinizing hormone) from the hypothalamus. The frequency and amplitude by which LH is released from the brain into the blood stream regulates the onset of puberty. When the necessary pattern and level of LH occurs in the body, it allows the heifer to ovulate and begin a regular 21-day heat cycle which will occur throughout the remainder of her productive life until interrupted by pregnancy, lactation, disease, or nutritional stress.

Puberty - *Management Concepts*

The heifer. It is important for heifers to attain puberty early if they are to breed as yearlings and calve as two-year-olds. This practice has become much more vital as type of cattle, breeds, nutritional programs and economics have changed through the past 20 years.

Breeding heifers to calve first at 2-and-one-half years of age is possible in herds that have a split spring and fall calving season. In such herds, spring-born heifers can be developed at a slower rate and bred to calve in the fall herd. The reverse strategy can be used with heifers born in the fall. This approach will reduce some of the need for early attainment of puberty, but caution must be used so puberty is not delayed too long.

Several research studies and producer experiences have clearly shown heifers which calve early in the calving season with their first calf will continue to calve early in successive calving seasons (Lesmeister et al., 1973). An important step in having heifers calve early their first year is to make certain they reach puberty at a young age. Byerley et al., 1987, evaluated heifers bred for the first time on either their first (pubertal) or third estrus and found fertility to be greater with the third estrus. Additionally, overall pregnancy rate was 21% greater for heifers bred first on their third estrus (57% vs 78%).

The bull. Probably the single best indicator of a bull's likelihood of reaching puberty at a young age is his scrotal circumference (SC). As SC increases, age at puberty decreases. Lunstra et al., 1978 found that although substantial differences in age and weight at puberty exists, SC was a very good indicator of puberty in bulls, regardless of the breed studied. Another important point related to SC is there is a favorable correlation (.71, Brinks et al., 1978) between SC and age at puberty in heifers (Table 1).

Each decrease in breed average for SC is accompanied by an increase in breed age at puberty, thus suggesting they are essentially the same trait. This is not surprising since both male and female gonads originate from the same embryonic cells and also are stimulated by the same hormones (LH and FSH).

Table 2 illustrates the association of SC in the bull with other reproductive traits in the heifer and cow. This information implies improvement in a number of female reproductive traits could be made through selection for SC in their sires.

Researchers at Cornell University (Hahn, et al., 1969) reported a correlation of .81 between SC and sperm output in young dairy bulls. Scientists (Brinks et al., 1978) similarly found as SC increased, motility, percent normal sperm, semen volume, semen concentration and total sperm output also increased while percent abnormal sperm decreased.

Heritability estimates for female reproductive traits are generally low to moderate, while heritability estimates of testicular traits are moderate to high (approximately .60 to .68). Additionally SC is easily obtained at a young age. Selection intensity in the male can be much higher than in females because few breeding males are needed.

This would lead to the conclusion that improvement in female reproduction (especially age at puberty) by using SC as a criteria might be feasible.

Breeding - *Biological Principles*

The act of breeding may occur in cattle when the female becomes sexually receptive to the male. This period, known as estrus, may range in length from 12 to 30 hours, with an average of 18 hours. During the estrous period the cow will exhibit several characteristic behaviors such as restlessness, head butting, bellowing, etc. She will only stand to allow the bull or other cows to mount during about half of this time period.

Approximately 30 hours after the onset of estrus, the brain releases a large concentration of LH which finalizes the development process of the ovum and causes it to be ovulated from the follicle on the ovary. Ovulation generally takes place toward the end of the time the cow will allow the bull to mount and breed. During ovulation the ovum is released from the rupturing follicle and picked up and channelled down the oviduct toward the uterus.

Successful breeding or mating occurs when 1) a bull determines a heifer or cow will stand to be mounted; 2) the bull enters and penetrates the female's reproductive tract; and 3) sperm and other seminal fluids are deposited within the cow's reproductive tract. Artificial insemination (AI) requires basically the same approach in that insemination must occur at the proper time following estrus and ovulation. However, when AI is used the semen is deposited just through the cervix while the bull deposits it in the vagina. However, detection of estrus and proper timing become much more the role of the producer and less the role of the bull with AI. Hence more management is needed.

Breeding - *Management Concepts*

The cow. Recently scientists have become aware that the viability of the egg when ovulated by the cow is affected by events that take place as many as 60 days before ovulation (Britt, 1991). This is not surprising since it has long been understood the quality of a bull's semen is affected if the bull experiences high or low environmental temperature, fever, sickness or related stresses within 60 days prior to a semen collection. This recent information indicates nutritional stress during the time between calving and breeding will cause the egg to be lower quality and therefore decrease the likelihood of conception.

Cows may experience two irregularities in their heat period: ovulation without estrus behavior (silent heat) and estrus behavior without ovulation (non-ovulatory heat). Either of these problems would reduce the likelihood of pregnancy if they occur during critical times during the breeding season. There do not appear to be direct management practices that can be used to stop this from happening, but the incidence of both irregularities is higher during the first one or two estrous cycles at puberty or after calving. Therefore managing the cows and heifers so they have more than one heat cycle before they must breed to stay on an annual calving schedule will reduce the delay in pregnancy that may be caused by silent or non-ovulatory heats.

Matching the physical size of the bull to the cows or heifers to be bred is a consideration that should not be overlooked in a discussion of breeding management. Extremely large, heavy, mature bulls may injure smaller, lighter heifers. Very small, short bulls may not be able to reach large, tall cows for breeding. While it is often surprising to find the number of obstacles that must have been overcome to result in a pregnancy in some situations, the fewer number of obstacles encountered, the greater the breeding success that will be achieved.

The bull. If successful mating is to occur, the bull must be physically capable of servicing. This capability includes: 1) adequate semen quality and quantity; 2) sex drive or libido, which is not the same thing as aggression, and the two are not correlated; 3) soundness of feet, legs, back and male reproductive organs; and 4) satisfactory eyesight, since this is the prominent way of finding cows in heat. Regular evaluation of bulls for these characteristics is important for successful breeding. All bulls should undergo an annual visual examination to determine if they meet the standards set for physical confirmation, eyes, teeth, jaws, muscles, feet, legs, prepuce and penis.

Observation of the bull during the breeding process is particularly important to make certain he is capable of successful mating. A certain percentage of bulls have all the outward capabilities for breeding but are unable to penetrate properly and therefore will not successfully impregnate cows. These observations are important early in the breeding season and with inexperienced bulls. If problems are detected a change in bulls can be made before an entire breeding season passes without a high number of pregnancies.

Providing the adequate number of bulls for the number of cows to be bred is important both from a production and financial standpoint. Historically the cattle industry has been rather conservative with this number. Recent reports have indicated ratios of one bull per 20 to 25 cows underestimate the serving capacity of most bulls. Research (Boyd, 1991) indicates that increasing these ratios to as high as 1 bull per 50 cows will not reduce the effectiveness of getting cows pregnant. Most importantly, a ratio of 1:50 decreased the investment in bulls by one-half. When natural service sires are used in heat synchronization programs, the bulls to cows ratio may be higher than conventionally thought. Cattle producers are encouraged to consider these data as they assess their bull power needs.

Conception and Pregnancy - *Biological Principles*

Within 15 minutes after semen is deposited in the female reproductive tract during mating, a few sperm cells reach the site of fertilization, the oviduct. Fertilization may take place at any point following this up to approximately 28 hours, when the viability of the sperm and ovum declines. The sperm cells are transported through the female reproductive tract by a combination of three processes: 1) sperm motility by the tail of the cell; 2) a beating movement of tiny hair-like projections from the lining of the cervix, uterus and oviduct; and 3) contractions of the smooth muscles of the female reproductive tract. During the transport process from the vagina to the oviduct and before they are capable of fertilizing the egg, the sperm cells must undergo two important steps in the maturing process; capacitation and the acrosome reaction. These steps enable the sperm to penetrate the membranes of the ovum during fertilization. Due to an extremely specialized series of events, as soon as one sperm cell penetrates the zona pellucida (outer membrane of the egg), all other sperm cells are locked out. This provides a check mechanism to prevent more DNA from entering the ovum and interfering with the delicate genetic balance of chromosomes.

During the fertilization process the genetic material from the sire is injected into the ovum and merges with the genetic material from the dam. The newly fertilized embryo remains free floating in the oviduct of the cow for 7 to 10 days after ovulation. The embryo has migrated into the uterus and begins to elongate. Fetal membranes begin to develop and form an association with the uterus to provide needed exchange of nutrients, gases and waste products between the developing fetus and the dam. The membranes and associated fluids also provide a shock absorber to protect the fetus and produce hormones to maintain the pregnancy and assist in fetal development. The outer fetal membrane develops a number of "button holes" (cotyledons) that hook over "buttons" (caruncles) in the uterus to provide exchange sites during gestation.

Pregnancy - *Management Concepts*

Conventional wisdom says reducing stress near the time of breeding will result in higher conception rates. While this concept seems to be logical and field experience supports this philosophy, little scientific data exits. Yaves and Reeves (1992) reported that one hour of stress from transportation, either before or after AI, did not lower conception rates of heifers. While more information is needed to confirm this finding, it is possible that we have overemphasized this point in breeding management.

Calving - *Biological Principles*

The "trigger" that starts the calving process is currently unknown. It is thought that development of the calf's respiratory and endocrine system drive this process. When the calf's pituitary gland is mature enough and is signaled to release a hormone (ACTH) which travels through the calf's blood system to cause the adrenal glands of the calf to secrete a hormone called cortisol. Cortisol, reportedly acts on the placenta to cause a cascade of hormone regulation which ends in delivery of the calf. In this way the calf actually determines when it will be born, not the cow.

The calving process can be divided into three stages:

1. Stage 1 - Preparatory Stage. During this stage the rhythmic uterine contractions begin and the cervix dilates.

2. Stage 2 - Expulsion of the Fetus. Contractions continue with the uterine contractions exerting 90% of the force and the abdominal contractions accounting for 10% of the force needed to expel the calf. This stage continues through the rupture of the membranes and until the calf passes through the cervix and vagina and is expelled from the cow.

3. Stage 3 - Expulsion of the Placenta. Separation of the cotyledons on the placenta from the caruncles on the uterus begins almost immediately after the calf is delivered.

Calving - *Management Concepts*

Much could be said about the management of calving, particularly control and management of calving problems or dystocia. Suffice it to say birth weight is the largest single contributor to calving difficulty. Below is a listing of factors that affect birth weight (Holland and Odde, 1992). Management to control birth weight can be thought of as management to control calving problems.

Effect	Comments
Sire and Dam	It is generally thought that the genetic material is supplied equally from the sire and dam. However, this can be debated since mitochondrial DNA of maternal origin is present within the cytoplasm (fluid in the egg) of the ovum.
Breed	Anderson and Plum (1965) reported a difference of nearly 64 pounds in the average birth weight of purebred cattle. More recently expected progeny differences (EPDs) are used to predict birth weights. A summary of EPD information from 1990 and 1991 reported the Gelbvieh breed had the greatest range in birth weight EPDs (27.6 lbs), while the Simbrah breed had the lowest range (8.5 lbs).
Heterosis	Heterotic effects observed between crosses of British and European breeds ranges from 0 to 5%. Reported heterosis estimates range from 10 to 20% when *Bos taurus* cattle are crossed with *Bos indicus* cattle.
Inbreeding	Inbreeding generally results in lowered birth weights. Birth weight will be reduced approximately .15 lbs for every 1% increase in inbreeding of the calf.
Sex of Calf	Bull calves weigh from 4 to 8% more than heifer calves.
Maternal Body Weight	Birth weight as a percentage of dam weight averages approximately 7% in cattle, with a range of 5 to 10%.
Dam Age	The lowest birth weights are found in two-year-old heifers. These weights then gradually increase through five to six years of age, and decline after the cow reaches nine to 11 years of age.

Maternal Ability	Maternal ability is defined as the capacity of a cow to nourish and sustain the developing fetus. Limitations in the capacity of the uterus, placenta and blood flow to these organs has been proposed as a method of birth weight control, particularly in Brahman cows (Ferrell, 1991).
Pregnancy Location	A 1.8 lb greater birth weight has been reported for Holstein calves (Foote et al., 1959) and 1.3 lb for Angus calves (Foote et al., 1960) from right versus left uterine horn pregnancies.
Gestation Length	Correlation between birth weight and gestation length is considered to be positive and is low to moderate in magnitude, with estimates ranging from 0 to .61. As mentioned above, the maturity of the fetal pituitary gland is thought to control the onset of calving. With this in mind, gestation length may more accurately be a function of birth weight (fetal maturity) than birth weight a function of gestation length.
Dam Nutrition	The effects of maternal nutritional status on birth weight have long been a topic of controversy. Holland and Odde (1992) conclude while both energy and protein intakes during the last one-half to one-third of gestation may alter birth weight, the effects are variable and, on average, relatively small, with generally greater effects observed for energy than for protein intake.
Environmental Temperature	Long-term exposure to high temperatures reduces birth weight. Conversely, evidence in other mammals suggests exposure to low temperatures results in increased birth weights. However, definitive studies with cold stress in cattle have not been done.
Season of Birth	Several authors have reported heavier birth weights of calves born in spring than in fall, with weight differences ranging from 1.1 to 6 lbs. The lower birth weights in the fall may be influenced by temperature, since gestation would occur during the hot period of the year.

Retained placentas. The placental membranes are normally expelled within two to eight hours after birth. Occasionally, however they fail to separate from the uterine attachments (the "buttons" don't "unbutton"). This condition may pose a health threat to the cow and cause problems in rebreeding. Not all reasons for retained placentas are presently known, but a high incidence may indicate a disease or nutritional problem. They commonly accompany calving difficulty, multiple births and abortions.

There are differing opinions as to the best treatment for retained placentas. Research has shown manual removal can cause complications that would not have happened otherwise. For cows with good appetite, good milk production, and no signs of abnormal vaginal discharges, no treatment may be best of all. If antibiotics are placed in the uterus, care must be taken to prevent introduction of bacteria into the uterus through contaminated instruments or equipment. Boluses may reduce fertility of the cow.

Uterine Involution - *Biological Principles*

Following calving there is a period of time in which the uterus must involute and repair itself prior to being capable of housing another fetus. This time period is generally thought to be about 20 days in cattle. Return of the uterus to a normal, nonpregnant state includes: 1) return of the uterus to the pelvic region of the cow; 2) return to the

nonpregnant size; 3) recovery of normal uterine tone; and 4) recovery and repair of the lining (endometrium) of the uterus.

Uterine Involution - *Management Concepts*

Lack of uterine involution has been shown to prevent fertilization during the early postpartum period (first 20 days in cattle). Short et al., 1990 concluded that uterine involution is a restriction to fertility for a short time after calving because it presents a physical barrier for sperm transport. A review by Kiracofe (1980) concluded that uterine involution has no relationship to length of the postcalving anestrus period.

From a practical standpoint, uterine involution is not a problem for beef cattle because it does not affect anestrus. Very few cows exhibit estrus early enough after calving for uterine involution to interfere with conception so long as disease conditions do not prevent or delay normal involution.

Postcalving Estrus - *Biological Principles*

The regular 20- to 21-day estrous cycle of a cow stops when she becomes pregnant. There is also a period between when a cow calves and when she will begin her estrous cycle again. This period is known in academic circles as the postpartum anestrus interval (PPI). During this interval, the hormonal regulation of the cow must re-establish itself so a normal cycle will progress.
The physiological mechanisms of postpartum anestrus are complex and not precisely known. However a prominent theory is that there is a blockage of the "pulse generator" that releases a hormone called gonadotropin-releasing hormone (GnRH) from the brain in rhythmic pulses or doses. The pattern of release and the level of GnRH control most of the other hormones of the estrous cycle.

The primary cause of postpartum infertility is probably different for different stages after calving. Among these primary causes for postpartum infertility are the following:

1. General infertility which is common to any estrous cycle and reduces potential fertility 20% to 30%.

2. Lack of uterine involution prevents fertilization early postpartum (first 20 days in cattle) and is not related to anestrus.

3. Short estrous cycles which prevent fertility during mid postpartum (<40 days in beef) and causes a return to estrus before pregnancy recognition occurs, thereby interrupting the pregnancy.

4. Anestrus which is thought to be the major component of postpartum infertility.

The duration of postpartum anestrus is affected by both major and minor factors. Among the several minor factors are: season of the year, breed, number of calves they have had, dystocia (cows that have calving difficulty take longer to cycle than cows that calve easily), presence or absence of a bull, and carryover effects from previous pregnancy (i.e. fast-growing, larger calves and/or calves consuming more milk have dams with longer intervals to estrus).

The length of the anestrus period is also affected by two major factors: suckling and nutrition.

Suckling probably has the most dramatic effect on PPI and was the first factor to be related to postpartum reproduction. While it is not exactly clear why it occurs, it is evident that the stimulus of a calf nursing a cow has a suppressive effect on the cow's ability to return to estrus after calving. Cows which have their calves weaned at birth have shorter PPI than cows that are suckled. The frequency of nursing also impacts the cow. Cows which were suckled only once each day had shorter PPI than cows whose calves suckled regularly throughout the day. If calves are weaned after birth but before estrus cycles begin (20-40 days post calving), one should expect estrus in a few days.

Nutritional effects on reproduction are caused by complex interactions of many variables, i.e. quantity and quality of feed intake, nutrient reserves stored in the body and competition for nutrients by other physiological processes. Effects of nutrition are most commonly measured using energy as a variable. Other nutrients such as protein and minerals also play a role, but are less

documented. There are several compensating mechanisms built into the body such as the ability to store nutrients in time of plenty for use during time of need. The body also has a way of allocating nutrients to various physiological demands, nutrient partitioning.

A more detailed explanation of how nutrition impacts reproduction will be given in papers that follow in this publication. In general it can be said pre-calving nutrition impacts length of PPI and post calving nutrition impacts fertility.

Post calving Estrus - *Management Concepts*

Management options to decrease the impact of postpartum anestrus and infertility include:

1. Restricting the breeding season removes late calving cows (short anestrus periods) from the herd.
2. Managing nutrition so body condition score (BCS) is 6 before calving.
3. Minimizing the effects of dystocia.
4. Stimulate estrous activity with a sterile male and estrous synchronization systems.
5. Judicious use of complete, partial or short-term weaning.

Restrict the breeding season. Cows go through an annual cycle of reproduction as they progress from one calving to the next. A defined breeding season will cause all cows in the herd to be in roughly the same stage of this cycle at any point in time. This will enable the cattle manager to target his feeding program to the particular needs of the cowherd at various times during the year. Secondly, if cows all calve during a relatively short period of time, they will have sufficient time after calving to return to estrus early in the breeding season so that they can begin the annual cycle.

Manage nutrition. Having cow in a body condition score (BCS) of 6 before calving has a direct positive impact on how soon after calving they will cycle back. Evaluating BCS at weaning time will enable adjustments to be made so cows calve in the appropriate condition.

Minimize effects of dystocia. It has been clearly shown that cows which have calving problems take longer to return to estrus than cows that calve normally. The negative effects of dystocia can be minimized by proper selection and development of replacement heifers, sire selection, proper management of cows and heifers before and after calving and by providing appropriate obstetrical assistance in a timely manner.

Stimulate estrous activity. Other management practices, such as exposing the cows to a sterile bull, have been shown to stimulate cows to return to heat more quickly than non-exposed cows (Zalesky et al., 1984). Additionally, treatment of cows with progestin-type estrus synchronization products, like Syncro-Mate-B and MGA, will stimulate estrus and in effect "jump-start" cows nearing normal return to estrus.

Complete, partial or short-term weaning. Manipulation of suckling has been used effectively to increase the number of cows which cycle and become pregnant early in the breeding season (Smith et al., 1979). Manipulation of suckling by short-term calf removal (48 hours) has proven to be a very effective method, particularly when coupled with Synco-Mate-B estrous synchronization schemes. Partial or complete weaning of calves solely to stimulate return to estrus should be considered as a last resort since it will likely have more serious economic and management consequences. To be effective, suckling manipulation must be accomplished before the breeding season starts, which means no less than 85 days after the first calves are born. However, in times of scarce feed (drought, etc.) early weaning later in lactation can be an effective method for managing BCS for next year.

Summary and Conclusions

The beef cattle industry is notorious for its limited adoption of available technology. There are obvious reasons for this, including many "part-time" cattle operations, competition for labor and management resources by other farming enterprises, etc. On the other hand beef cows are an asset that will survive with limited inputs and a low level of management. Selective incorporation of the practices described in this paper, based on individual circumstances, could make a difference between profit and loss in an enterprise, especially as prices for cattle decline and costs continue to increase during the upcoming cattle cycle.

Table 1. Breed Comparisons of Bull Testicular Size and Heifer age at Puberty.

		Scrotal circumference of yearling bulls	
Breed	Heifer age at puberty	Average (cm)	Range (cm)
Gelbvieh	341	34.8	30.2-42.2
Braunvieh	347	34.3	31.0-39.6
Red Poll	352	33.5	29.7-37.1
Angus	372	32.8	26.1-38.4
Simmental	372	32.8	26.1-39.1
Hereford	390	30.7	26.1-36.1
Charolais	398	30.5	25.4-37.6
Limousin	398	30.2	24.4-34.3
AVERAGE	368	32.4	24.4-42.2

(*Brinks et al., 1982.*)

Table 2. Correlation of Female Reproductive Traits with Sire's Scrotal Circumference.

Trait	Correlation with SC
Age at first conception as yearling heifer	.69
Age at first calving when bred to calve as 2-year-olds	.62
Heifer pregnancy rate	.64
First rebreeding after calving	-.11
Calving interval	.12

(*Toelle and Robinson, 1985)*

GENERAL CONSIDERATIONS

CALVING MANAGEMENT

PRE-BREEDING:

* Feed heifers to 55-65% of mature weight prior to breeding
* Select replacements for pelvic size prior to breeding (measure pelvis just prior to breeding)
* Save 50% more heifers than needed for replacements

POST-BREEDING:

* Pregnancy exam
* Select only early bred heifers or breed for only 45 days
* Feed to gain weight, esp. during the last trimester! Heifers and cows should be in body condition 5 or 6 at calving

PRE-CALVING:

* Heifers should be gaining weight
* Calving lots should be clean and have not been used during the past 10 months
* Bring only springing heifers into the lot unless the lot is large enough to keep all the heifers scattered
* Clean calving barn & stalls daily
* Vaccinate heifers and cows for scours and enterotoxemia
* Give Vitamin A injection unless supplement is being fed

NEWBORN CALVES:

* Give 2-3 quarts colostrum (fresh or frozen) within 6 hours of birth. This should be the first thing given to the calf.
* Iodine navel - 7% or tamed Iodine INTO THE NAVEL OPENING.
* Selenium injection (Bo Se) (as needed)
* Vitamin A injection - 1 ml (as needed)
* Oral vaccine for rota/Corona viral scours
* Oral E. coli antiserum
* Care of newborns while wearing clean clothes (do not go from scours area or treatments to newborn area without cleaning and disinfecting)

AFTER CALVING:

* Move pairs at one day of age into large well-drained post calving lot
* Increase feed (cows need 50% or more increase in protein and energy after calving)
* Have a second large, well-drained area to move newborn pairs if scours occur in the first lot

FACTORS INFLUENCING DYSTOCIA

The largest losses in percent calf crop were a result of: (1) failure of cows and/or heifers to conceive or early embryonic death, and (2) calf death largely due to dystocia (calving difficulty). Along with decreased calf crop, calving difficulty is also associated with increased cow mortality, increased veterinary and labor costs, delayed return to estrus and lower conception rates.

The management and genetic factors associated with dystocia include:

(1) calf birth weight
(2) dam's pelvic area
(3) sex of calf
(4) gestation length
(5) age and parity of dam
(6) dam's breed and/or size
(7) sire breed
(8) dam's sire
(9) nutrition and BCS of dam
(10) implant effect
(11) geographic region
(12) exercise
(13) endocrine (hormonal) aspects.

CALF BIRTH WEIGHT

Birth weight is the major factor causing calving problems. Research from Montana lists birth weight as the trait most highly correlated with dystocia, followed by sex of calf, pelvic area, gestation length and cow weight. Table 1 illustrates how the incidence of dystocia increases as birth weight increases.

Attention should be given to factors that influence birth weight to understand those effecting dystocia. Many of the management and nutritional factors outlined in this paper relate to birth weight and should be considered.

Genetics and breed of sire play the most important role in determining calf birth weight; however, the maternal genetic influence should not be overlooked. For example, the heritability of birth weight is nearly 48 percent. Therefore, by putting selection pressure on bulls for birth weight and *calving ease*, it would be possible to alleviate many existing calving problems within a herd.

Cattlemen should be particularly concerned about mating high birth weight heifers to bulls with a genetic history for high birth weight. Because birth weight is so heritable, this mating practice could result in extremely large birth weights in their progeny.

Producers need to emphasize the following performance traits when selecting a bull for calving ease (particularly for first-calf heifers):

A. EPDs for birth weight
B. EPDs for calving ease (in those breeds that provide this information)
C. Actual birth weight of the bull
D. Shape of the bull

Procedurally a producer should:

(1) decide which traits are important in the ranch program,
(2) set the range of EPD's to accomplish these goals,
(3) select only bulls that meet this EPD criteria,
(4) eliminate any with individual birth weight that is too high,
(5) eliminate bulls that are not correct in physical appearance.

In some breeds, such as Simmental and Gelbvieh, you can use EPD information for birth weight along with EPD information for direct calving ease. The simultaneous use of these two figures can help identify young bulls that can be used on beef females without causing major calving problems. Calving ease EPDs also have an advantage in that this measurement of performance is not affected by actual birth weight.

In utilizing actual birth weights, a producer should keep in mind that many factors cause actual birth weight figures to vary. For example, the birth weight of a calf out of a first-calf heifer will be less than from a mature cow, yet genetically they may be the same in terms of causing calving difficulty. In addition, bull calves born in the fall of the year will be lighter than bull calves born in the spring.

DAM'S PELVIC AREA

Dystocia occurs largely because of an incompatibility at birth between the size of the calf and the pelvic opening of the mother. Therefore, the pelvic opening determines the maximum birth weight that can be accommodated by individual cows before calving difficulty is experienced.

Heritability estimates for pelvic dimensions range from .40 to .53. Although moderately heritable, conflicting reports relating pelvic area to dystocia puts the usefulness of pelvic measurements in question. In general eliminating 10% of the heifers with the smallest pelvic size will result in a reduction in dystocia of only 2 to 3 percent. The OSU research report latter in this section will clearly show this effect.

Pelvic area appears to be highly correlated with heifer size. By selecting for larger, growthier heifers, producers are also indirectly selecting for a larger pelvic area. Unfortunately, when larger, growthier heifers are selected, there is a tendency for these heifers to have calves with heavier birth weights. Subsequently, the use of pelvic area has not been shown to be as clear-cut a criteria in predicting which heifers will experience calving difficulty as was once thought.

The need to check pelvic size does exist. This plus the fact that heifers need to be cycling by 12 months of age leads to the recommendation that all heifers be rectally palpated at a year of age for three criteria:

1) Adequate pelvic size
2) Physical abnormalities of the pelvis
3) Functioning reproductive tract

SEX OF CALF

Reports indicate bull calves outweigh heifer calves at parturition by up to 10.0 pounds and require a 10 to 40 percent higher assistance rate. Calf losses are higher in male (22.4 percent) than in female calves (16.3 percent) when difficult births were experienced. There was no difference in calf mortality between sexes when assistance was not given.

Dystocia rate in mature cows carrying male calves is twice that of cows carrying female calves. This can partly be explained by the fact that bull calves generally have a one-to-two-day longer gestation length which contributes to heavier calf birth weights.

GESTATION LENGTH

Gestation length would appear to have an indirect influence on calving difficulty. As gestation length increases, birth weight increases from .3 to .8 pound per day.

Nebraska research has indicated that gestation length is a trait that can be selected for. This means the potential exists to select cattle for shorter gestation length and subsequently lighter birth weights.

Another indirect benefit of a shorter gestation period is that cows calving at an average gestation length of 280 days as compared to 287 days have an additional 7-days postpartum to start cycling. This could have some influence on herd reproductive efficiency.

Although selecting for shorter gestational periods is possible, "selecting for growth and moderate birth weight was more effective as a means of increasing growth rate without a simultaneous increase in birth weight than selection for growth and shorter gestation."

AGE AND PARITY OF DAM

Age and parity (once a cow calves she is less likely to have problems) of dam influence the incidence of dystocia. Table 2 summarizes calving data from Nebraska and Colorado State University relating calving difficulty to age of dam.

Although first- and second-calf heifers experience more calving difficulty, they typically have lighter birth weight calves (by 2.5 to 5.0 pounds) than mature cows. This is because mature, multiparity cows have a fully-developed skeletal structure and body sizes compared to their heifer counterparts, and are therefore capable of giving birth to heavier calves.

DAM SIZE OR BREED

Body size (frame) is highly correlated with pelvic area, and pelvic dimensions determine birth weight limitations. It stands to reason, then, that larger

breeds of cattle will in turn have larger pelvic areas and produce calves with heavier birth weights. Therefore, a large difference in calving ease should probably not be expected between dams of various beef breeds that also vary in size.

Data from Nebraska show very little difference in incidence of dystocia when 15 breeds were compared. Exceptions to this theory include Jersey-X and two Zebu-X breeds (Brahman and Sahiwal) which experienced an average of 3.7 percent incidence of dystocia compared to an average of 14.1 percent for the other breeds in the study. The calving ease advantage expressed in Brahman cross cattle was similar; 13.5 percent calving difficulty compared to 39 percent difficulty in Angus X Hereford heifers.

SIRE BREED

Most producers are well aware of the impact a bull can have on the degree of calving difficulty and subsequent calf death loss. Traditionally, beef cattle producers have predominantly used British breed sires on first-calf heifers, unless it is a non-British breed purebred operation.

Unfortunately, as beef producers emphasized size and growth rate, many British breed bulls are now producing large birth weight calves. With proper bull selection and heifer development, this move away from British breed and even some continental breed bulls may not be necessary. Emphasis on multiple trait sires (bulls with acceptable birth weight, calving ease and growth EPDs) can minimize the degree of calving difficulty, while still maintaining beef type and growth.

Selecting replacement heifers out of bulls with low EPDs for birth weight should help reduce birth weight and calving difficulty. Canadian research shows that selecting heifers out of low birth weight sires tends to result in females with a lower mature size, which may, or may not, be desirable.

Commercial cattlemen are encouraged to evaluate important sire EPDs (birth weight, calving ease and daughter's first-calf calving ease) from heifers they are considering keeping as replacements.

NUTRITIONAL PROGRAM

Table 3 summarizes the effects of supplemental prepartum energy on these factors. Supplemental dietary energy fed for 90-100 days prior to calving will increase birth weight, but does not have an adverse effect on calving ease. Table 4 illustrates the incidence of calving difficulty was actually lower in the moderate- and high-energy groups than in the low-energy group. These data clearly demonstrate that "*You cannot starve calving difficulty out of cows and heifers*."

Table 5 shows additional effects of gestation energy level. When low energy was provided 90 days prior to calving, it took heifers an average of 41 days longer to return to estrus and cows 17 days longer. Pregnancy rates were also decreased in females receiving low energy diets by 33 and 3 percent for heifers and cows, respectively. These numbers demonstrate why it is important not to underfeed the productive beef female and particularly prepartum first-calf heifers, if you expect to maintain reproductive efficiency in the cow herd.

Cow condition has also been implicated as a factor that contributes to calving difficulty and is closely related to gestation feed level. Table 6 summarizes the effect of cow condition on dystocia.

Underfeeding cows to the point where they are emaciated will result in calving difficulty, as will overfeeding cows to the point of obesity. Fat cows appear to have increased dystocia due to a fat-filled birth canal and increased abnormal presentations, while thin cows don't have the strength to withstand the birth process and have weak, non-vigorous calves. Therefore, it becomes extremely important that cows are not over- or under-fed, but are provided adequate feed to meet their nutritional requirements. Depending upon body size, stage of pregnancy and climate, weaned heifer calves require 8 to 12 pounds of Total Digestible Nutrients (TDN) daily; pregnant two-year-old heifers, 9 to 13 pounds of TDN; and mature pregnant cows, 8 to 12 pounds of TDN. In recent years, interest has also been shown in protein supplementation and its effect on calving difficulty (Table 7).

Producers should be warned *not to underfeed* protein to the gestating cow in an effort to reduce

calving difficulty. Several studies showed that low protein feeding during gestation resulted in decreased calf vigor, delayed uterine involution, increased interval to estrus and decreased conception rates following calving. These problems appear to be compounded when energy is also deficient, illustrating the need for a properly balanced diet.

IMPLANTS AND FEED ADDITIVES

Numerous studies show that implanting heifer calves with zeranol (Ralgro®) increases pelvic area at breeding time. However, in most instances, this increase did not persist up to calving time and there was little effect on calving difficulty. However, these implants also resulted in a reduction in pregnancy rate by 16 percent (67 vs 78 percent) and did not improve age or weight at puberty.

Similar results have been reported when Synovex-C® implants were used on suckling heifer calves. Research with estrogenic implants substantiates an early increase in pelvic size in implanted beef heifers but this advantage disappeared once heifers reached 14 months of age. If heifer calves are implanted at birth, a subsequent reduction in first-service conception rates is often observed. Likewise, heifer calves receiving multiple implants experience greater reductions in fertility.

These results suggest that the original recommendation not to use zeranol or other implants in replacement females still holds true. Conversely, evidence indicates that feeding an ionophore such as monensin (Rumensin®) or lasalocid (Bovatec®) decreases age at puberty. However, research has shown these compounds have no effect on gestation length, calf birth weight, pelvic area, or dystocia. These results indicate that these products do have positive effects on heifer development and should be used as long as the diet is adequate for growth and development.

GEOGRAPHICAL LOCATION

Several studies have shown calf birth weight increases in colder environments as compared to warmer, southern climates. Northern states tend to experience a higher rate of calving difficulty than their southern neighbors. The exact reason for this phenomenon is unknown. A good illustration of this is in genetically similar Hereford cattle in which part of them were calved in Montana and part in Florida. Each group was then moved to the other location and 10 years later, birth weight data were collected. Results of this study are in Table 8 and clearly show the effect of colder environments on increased birth weights.

EXERCISE

Forced exercise for several weeks prior to calving has been shown to improve the calving ease of closely confined dairy heifers. These heifers responded favorably to forced exercise by exhibiting an improved calving ease score, reduced placenta retention time and less days open following calving (Table 9).

However, Miles City researchers could find no difference in calving ease between heifers maintained in a typical feedlot and those forced to walk 2 miles a day.

It stands to reason that increased muscle tone in heifers and cows would lead to easier calving. Researchers seem to be in agreement that a difference in ease of calving due to exercise is dependent on previous shape and condition of the cattle and the management system to which they were accustomed.

Many beef heifers are grown and developed in semi-confinement, drylot conditions similar to dairy operations. Where this is the management system, it's possible heifers could benefit from increased exercise prior to calving. This could be accomplished simply by placing water and feed supplies at a distance from each other that would encourage more movement and exercise.

It was concluded that unless beef heifers are under extremely close confinement, exercise is of no benefit in reducing dystocia.

ENDOCRINE (HORMONAL) ASPECTS

Little information is available concerning the hormonal influences on calving difficulty. Some hormones that have been studied, however, include relaxin, prolactin, estrogens and progesterone.

SEASON OF YEAR

There is considerable year-to-year variation in birth weight and calving difficulty using the same sires and females. This is partially explained by nutrition and environmental conditions.

Fall-born calves usually are lighter and born with less assistance than spring-born calves. This is because hot summer temperatures tend to reduce birth weights, whereas cold temperatures increase birth weights.

SUMMARY

* Mate yearling heifers to low risk calving-ease bulls and mature cows to multiple-trait sires that are adequate for calving ease but excel in growth traits. Sire summaries and use of EPDs are helpful here.

* If actual birth weight is used to evaluate the genetic potential of a sire, take into account the environment and management his dam was subjected to prior to his birth.

* Feed pregnant females balanced diets; do not over- or underfeed. Remember first- and second-calf heifers require additional nutrients for growth and development!

* Breed over a short period (45-60 days) and breed heifers 2 to 3 weeks prior to the cow herd. These practices concentrate the breeding season so you can give more time and attention to calving and allow heifers more time to rebreed the following year.

* Manage first- and second-calf heifers separately from the mature cow herd. This allows you to feed more, and higher-quality feedstuffs to heifers and assures that mature cows don't get more than their fair share of feed.

* Know how and when to give assistance at calving. Don't try to pull calves from cows that have not yet achieved complete cervical dilation.

Table 1. Effect of Birth Weight on Ease of Calving in Percentage Simmental Females

	Ease of Calving			
	Normal Birth	Hand Pull	Mechanical Puller	Caesarean
No. of Females	68	34	16	2
% of Total	56.7	28.3	13.3	1.7
Birthweight (lbs)	81.1	88.3	100.3	121.0

Table 2. Effect of Dam's Age on Calving Difficulty

	Research Station	
	MARC	CSU
Dam's Age	Percent Calving Difficulty*	
2 yr	54	30
3 yr	16	11
4 yr	7	7
5 yr and over	5	3

Table 3. Summary of Supplemental Prepartum Energy Effects on Calving Difficulty, Subsequent Reproductive Performance and Calf Growth

Researcher	Supplementation*	Summary of Effects
Christenson et.al., 1967	HE vs LE for 140d Prepartum	HE increased birth weight, dystocia, milk and estrus activity
Dunn et.al., 1969	ME vs LE for 120d Prepartum	ME increased birth weight and dystocia
Bellows et.al., 1972	HE vs LE for 82 d Prepartum	HE increased birth weight but had no effect on dystocia or weaning weight
Laster & Gregory, 1973	HE vs ME vs LE for 90 d Prepartum	HE increased birth weight but had no effect on dystocia
Laster, 1974	HE vs ME vs LE for 90 d Prepartum	HE increased birth weight but had no effect on dystocia
Corah et.al., 1975	ME vs LE for 100 d Prepartum	ME increased birth weight, estrus activity, calf vigor, and weaning weight but had no effect on dystocia
Bellows and Short, 1978	HE vs LE for 90 d Prepartum	HE increased birth weight, estrus activity, pregnancy rate and decreased post-partum interval but had no effect on dystocia
Anderson et.al., 1981	HE vs LE for 90 d Prepartum	HE had no effect on birth weight, milk or weaning weight
Houghton et.al., 1986	ME vs LE for 100 d Prepartum	ME increased birth weight and weaning weight but had no effect on dystocia

HE = high energy (over 100 percent NRC), ME = moderate energy (approximately 100 percent NRC), LE = low energy (under 100 percent NRC).

Table 4. Effect of Pre-Calving Energy Level on Birth Weight and Dystocia in 2-Year-Old Cows

Energy Level	Birth Wt, lb	Dystocia (percent)
Low (10.8 lb TDN)	58.0	26
Medium (13.7 lb TDN)	61.5	17
High (17.0 lb TDN)	63.9	18

Table 5. Effects of Gestation Feed Level on Reproduction

Dam	Gestation Feed Level*	Interval, Calving to First Estrus (days)	Pregnancy Rate (%)
Heifer	Low	100	50
	High	59	83
Cow	Low	77	78
	High	60	81

* Low = 8.0 lb; high = 15.0 lb.

Table 6. Summary of Cow Condition Effects on Calving Difficulty, Subsequent Reproductive Performance and Calf Growth

Researcher	Summary of Effects
Wiltbank et.al., 1961	Obesity caused increased dystocia and calf mortality
Hight, 1966	Thin cows had calves with decreased birth weight, vigor and suckling activity and cows exhibited a 20 percent decrease in pregnancy rate; dystocia was not reduced
Nelson & Huber, 1971	Obesity caused a 10-20 percent increase in dystocia over moderately conditioned and thin cows
Arnett et.al., 1971	Obesity increased dystocia, calf mortality and services/conception and decreased weaning weight and calves weaned
Houghton et.al., 1986	Thin cows had calves with decreased birth weight and weaning weight; dystocia was not reduced

Table 7. Summary of Supplemental Prepartum Protein Effects on Calving Difficulty, Subsequent Reproductive Performance and Calf Growth

Researcher	Supplementation*	Summary of Effects
Wallace & Raleigh, 1967	HP vs LP for 104-137 d Prepartum	HP increased cow weight, calf birth weight and conception rate but decreased dystocia
Bond & Wiltbank, 1970	HP vs MP throughout Gestation	HP had no effect on birth weight or calf survivability

- MORE -

Table 7 (Cont). Summary of Supplemental Prepartum Protein Effects on Calving Difficulty, Subsequent Reproductive Performance and Calf Growth

Researcher	Supplementation*	Summary of Effects
Bellows et.al., 1978	HP vs LP for 82 d Prepartum	HP increased cow weight cow ADG, calf birth weight, dystocia, weaning weight and decreased conception rate
Anthony et.al., 1982	HP vs LP for 67 d Prepartum	HP had no effect on birth weight, dystocia or postpartum interval
Bolze, 1985	HP vs MP vs LP for 113 d Prepartum	HP had no effect on birth weight, dystocia, weaning weight, milk or conception rate but decreased the postpartum interval

HP = high protein (over 100 percent NRC), MP = moderate protein (approximately 100 percent NRC), LP = low protein (under 100 percent NRC).

Table 8. Genetic X Environmental Interaction Effects on Birth Weight in Hereford Cattle

Breeding	Herd Location	No. Calves	Birth Wt. (lb)
Line 1	Montana	727	81
	Florida	677	64
Florida	Montana	405	77
	Florida	363	66

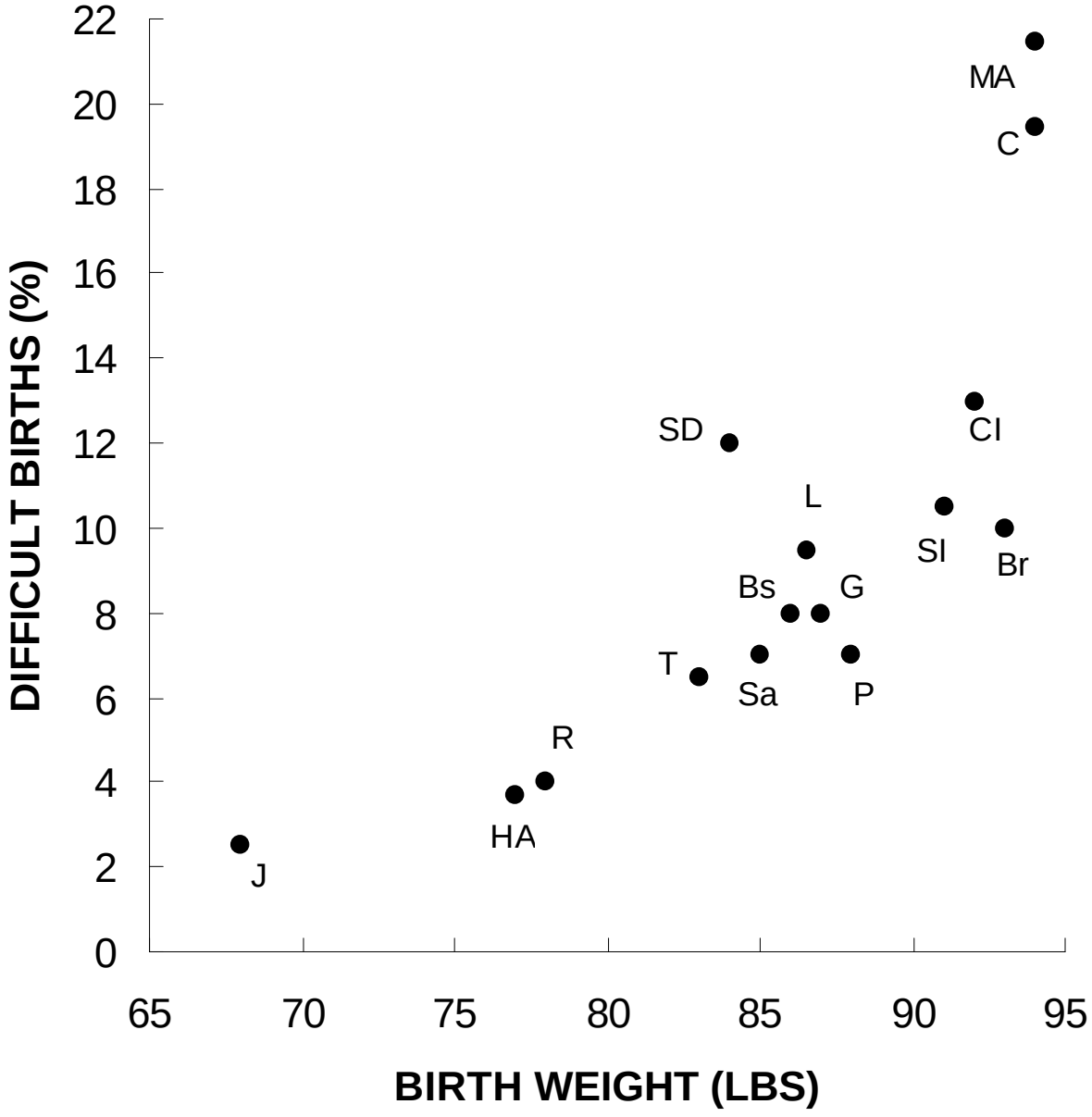
Table 9. Effects of Exercise During Gestation on Calving and Reproduction in Dairy Heifers

Group	No.	Calving Ease Score	Placenta Release Time	Days Open
Control	14	2.1	4.2	159
Exercise*	26	1.4	2.5	111

* Walk of 1 mile daily at 3.5 mph for 4 weeks prior to calving.

BREED OF SIRE EFFECTS ON BIRTH WEIGHTS

Relationship of dystocia and average calf birth weight by breed of sire on Hereford and Angus females calving at 4 years of age and older (Cundiff, 1986)



FACTORS ASSOCIATED WITH DYSTOCIA IN BEEF HEIFERS

AN OREGON STUDY

H. A. Turner, M. L. McInnis, R.F. Angell, and D.W. Weber

(Original format changed for this handbook)

Numerous factors have been examined as possibly influencing the frequency and severity of dystocia. Feto-pelvic incompatibility is likely the main reason for calving difficulty in heifers. Calves with heavy birth weights and large frames experience more difficulty at birth than average sized calves. Pre-calving pelvic area has been correlated to dystocia, and heifers with pelvic openings less than about 200 cm^2 are high risks for difficulty. Other factors positively correlated with dystocia are prolonged gestation, sex of calf, birth weight of the sire, and dam weight.

The objectives of this OSU research were to: 1) determine the effects of various factors on incidence of dystocia in 2-year-old commercial beef heifers, and 2) develop classification functions, which will aid management decision processes directed toward alleviating dystocia problems in heifers.

MATERIALS AND METHODS

Data were obtained on 1178 first-calf heifers from 11 commercial beef cattle ranches and three experimental herds throughout Oregon. Data collection included only spring-calving (January to April) herds. All data were collected in the same year. Heifers were of various breeding and management systems, but all were bred to calve at 22 to 25 months of age. The following variables were recorded, if known, immediately prior to the breeding season; heifer age, birth weight, internal pelvic area (pelvic height x pelvic width), condition score, and weight. All pelvic measurements were taken by one technician using a Rice Pelvimeter. Height represented the linear distance between the dorsal surface of the cranial end of the symphysis pubis and the ventral surface of the midsacrum, and width the maximum distance between the shafts of the ilia. Condition scores, utilizing a 1 to 9 system with 1 being emaciated and 9 extremely fat, were estimated by palpating subcutaneous fat over the backbone, ribs, and tailhead.

The following data were collected at parturition: calf birth date, birth weight, sex, and severity of dystocia. Calves were weighed within 24 h after birth. Severity of dystocia was scored from descriptions at parturition as follows: 1 - no difficulty, birth unassisted; 2 - slight difficulty, nonmechanical assistance required; 3 - considerable difficulty, hard pull by hand or mechanical assistance required; 4 - extreme difficulty requiring caesarean section; and 5 - malpresentation of calf (deleted from all the statistical analysis). Additional data recorded were gestation length, sire birth weight, and PA/Bwt ratio calculated as pelvic area divided by calf birth weight. Breed of dam, sire, and calf were also recorded, when available, but not analyzed due to the wide array of breeds represented and number of breeds within individuals which made categorization very difficult.

Correlation coefficients (r) were calculated between all variables. Calf sex was coded 1 for male and 2 for female. Analysis of variance was used to test the effects of pelvic area, heifer condition score, heifer prebreeding weight, calf birth weight, PA/Bwt, and gestation length on severity of dystocia. An analysis of variance was conducted with each dependent variable tested separately. The data were blocked by ranches in a randomized complete block design. Total degrees of freedom for the analyses were 55 with 13 for block, 3 for treatment and 39 in the error term for each analysis. Tukey's procedure was used to distinguish differences among dystocia score groups within variables ($P<0.05$). Chi-square was used to test the null hypothesis that dystocia occurred in equal proportions among heifers having above and below mean pelvic areas, calf birth weights, and prebreeding weights.

Data were also analyzed using stepwise discriminant analysis to compute linear classification functions in a forward selection procedure. The jackknifed classification matrix was used as a validation procedure to reduce bias. Heifers were classified into two dystocia groups: assisted (dystocia scores 2-4), unassisted (dystocia score 1).

RESULTS AND DISCUSSION

Dystocia occurred in 34% of the heifers observed, and ranged from 19 to 69% among cooperating ranches. Among heifers suffering dystocia, 49% experienced slight difficulty, 41% considerable

difficulty, and 5% required caesarean sections. The remaining 5% experienced malpresentation of their calves and were excluded from analyses involving severity of dystocia. When examined prior to breeding, heifers averaged 13 months of age, and ranged from 11 to 15 months.

Variables correlated ($P<0.05$) with severity of dystocia were heifer birth weight, heifer age at calving, calf birth weight, calf sex, and PA/Bwt ratio (Table 1). Meijering found birth weight of calf and pelvic area of dam had the greatest influence on ease of calving in heifers. However, this study demonstrated little correlation between pelvic area and dystocia. Natural and managerial selection pressure may alleviate some problem lines of females with small pelvic openings and subsequent dystocia in some herds. Correlations between pelvic size and dystocia may also be reduced by low repeatability of pelvic measurements. Heritability estimates of pelvic size appear to be quite high in 2-year-old heifers with reported values of 40 to 50% (3, 8), which indicates that if pelvic area were highly correlated to dystocia fairly rapid progress could be made through selection and culling.

Pelvic area ranged from 100 to 271 cm^2 yet did not have an effect ($P>0.05$) on dystocia scores (Table 2). Mean pelvic area of heifers calving unassisted was 177 cm^2, well below the 200 cm^2 suggested by Makarechian and Berg as observed incidence of dystocia did not differ from that expected for heifers with above or below mean pelvic areas (Table 3, Case 1). Data in Table 3 (Case 4) also indicate that when a heifer with a larger than average pelvic area gave birth to a calf below the mean birth weight, the incidence of dystocia was 19%. However, when the pelvic area was below the average, and birth weight above (Case 5), the incidence of dystocia roughly tripled to 60%; significantly higher than expected.

Increasing calf birth weight had an effect on the severity of dystocia (Table 2). Unassisted calves averaged 31 kg, and those experiencing dystocia averaged 37 kg. Calves with above average birth weight experienced 52% dystocia, while those below average had only 20% (Table 3, Case 2). Increasing birth weight has frequently been associated with dystocia. Factors directly correlated with calf birth weight were heifer birth weight, heifer prebreeding weight, sire birth weight, and gestation length (Table 1). The values in this table also indicate a negative correlation between calf sex and birth weight. Calf sex was negatively correlated with dystocia, indicating males experienced dystocia more frequently than females.

The effect of pelvic area and calf birth weight was expressed in PA/Bwt ratio. The ratio had a higher correlation to dystocia than pelvic area, but not as high as calf birth weight (Table 1). The PA/Bwt ratio averaged 2.6 for unassisted birth, but decreased with increasing severity of dystocia (Table 2). In a study conducted by Deutscher and Zerfoss, major calving difficulty was experienced when the ratio approached 3.0. In this study, the same severity of dystocia was reached when the ratio approached 2.0.

Condition scores of dams did not differ among dystocia scores, but were negatively correlated with gestation length. Assuming palpable subcutaneous fat reflects a heifer's level of nutrition, this correlation indicates the importance of adequately feeding gravid heifers. Under-conditioned or over-conditioned heifers have been reported to experience increased dystocia. Condition scores ranged from 3 to 6, with no emaciated or fat animals observed. In this study, gestation length did not differ among levels of dystocia severity. Gestation length was, however, negatively correlated with heifer prebreeding weight.

Prebreeding weight did not have an effect on dystocia, but was significantly correlated with pelvic area. Sire birth weight was significantly correlated with calf birth weight, but was not correlated with dystocia. Heifer age was correlated with pelvic area and a significant factor in severe dystocia represented by a score of 4.

The stepwise discriminant analysis procedure was conducted utilizing 333 observations to classify heifers into dystocia and non-dystocia groups. These were the animals with data complete in all factors included in the analysis. Calf birth weight was by far the most important factor and was required to properly classify heifers into the appropriate dystocia groups. Heifer age at calving was the only other variable which significantly improved classification. None of the other factors including heifer birthweight, internal pelvic area, condition score or weight at breeding improved the classification and were eliminated by the discriminant analysis procedure. The approximate F-statistics for the discriminant function model and standardized coefficients for canonical variables are shown in Table 4.

The model correctly classified 69.1% of the heifers into the appropriate group. The jackknifed classification gave 68.5% correct classification percentage. Using the proportional choice criterion described by Morrison, the number of correct classifications exceeded proportional choice by 15.7%, indicating acceptable classification accuracy. Priority type measurements did not appear to be significant predictors of dystocia, because birth weight of the calf was always needed to give acceptable classification accuracy.

SUMMARY

Data on 1178 first-calf heifers and their calves indicate calf birth weight was the primary factor influencing dystocia. The ratio of pelvic area divided by calf birth weight also was a highly significant factor in dystocia, however, pelvic area alone was not a significant factor. Discriminate analysis results show heifer age was the only factor after birth weight that improved the predictive equation for dystocia. Results indicate breeding for lighter birth weights will dramatically reduce incidence and severity of dystocia and selecting older heifers will also have some effect. Factors associated with heavy calves at birth were heavy parents, sex of calf, and prolonged gestation.

Table 1. Correlation coefficients (r) among variables.

Variable	Hfr birth wt.	Pelvic area	Hfr cond. score	Hfr prebrd wt.	Hfr age at calv	Calf brth wt	Calf sex	Dysto-cia score	Gest leng	Sire brth wt
Hfr brth wt.	1.0									
Pelv. area	-0.25	1.0								
Hfr BCS	0.11	0.21	1.0							
Hfr prebrd wt.	0.27	0.31	0.41	1.0						
Hfr age clvng	0.04	0.32	0.05	0.06	1.0					
Calf BW	0.37	0.15	0.09	0.38	0.01	1.0				
Calf sex	0.07	0.02	0.00	0.00	0.16	-0.22	1.0			
Dysto. score	0.14	-0.01	0.02	-0.08	-0.23	0.35	-.22	1.0		
Gest. lgth.	-0.09	0.10	-0.34	-0.30	-0.03	0.17	-.07	-.03	1.0	
Sire BW	0.36	-0.38	-0.01	0.39	-0.40	0.25	0.26	.06	--	1.0
PA/BW ratio[b]	-0.13	0.52	0.13	0.03	0.22	-0.65	0.16	-.17	-.40	

Table 2. Variable means by dystocia score groups

	Dystocia Score			
Variable	1	2	3	4
No. heifers	575	147	131	18
	Mean	Mean	Mean	Mean
Pelvic area (cm^2)	177	178	174	173
Heifer condition score	5.0	5.1	5.0	4.8
Heifer prebreeding weight (kg)	288	290	290	279
Heifer age at calving	729	725	722	669
Calf birth weight (kg)	31	34	37	39
Pelvic area/birth weight ratio	2.6	2.3	2.1	2.0
Gestation length (days)	286	287	290	288

Table 3. Results of chi-square analysis testing equal occurrence of dystocia in heifers with above and below mean pelvic area, calf birth weight, and prebreeding weight

Case No.	Variable	n	Percent dystocia Observed	Percent dystocia Expected
1.	Above mean pelvic area	417	31	35
	Below mean pelvic area	455	39	35
2.	Above mean calf birth wt.	399	52	35
	Below mean calf birth wt.	428	20	35
3.	Above mean heifer prebreeding wt.	186	39	39
	Below mean heifer prebreeding wt.	150	40	39
4.	Above mean pelvic area and below mean calf birth wt.	192	19	40
5.	Below mean pelvic area and above mean calf birth wt.	196	60	40

Table 4. Dystocia group summary, showing classification matrix, group centroids, and standardized discriminant function coefficients, determined by stepwise discriminant analysis.

Dystocia group	Cases	Predicted membership Unassisted	Predicted membership Assisted	% Correct	F
Unassisted	210	148	62	71.0	8.47
Assisted	123	43	80	65.9	

Entered Variables	Standard Coefficients
1. Calf Birthweight	-2.65
2. Heifer age at calving	0.36

HANDLING CALVING PROBLEMS

STAGES OF NORMAL CALVING OR PARTURITION

STAGE 1 - Dilation of cervix

a. Visible signs of labor hard to see: isolation, vaginal discharge, mild colic or abdominal pain, restless, frequently get up and down.

b. Duration of Stage 1 is longer in heifers than cows.

STAGE 2 - Expulsion of calf

a. Starts when calf enters birth canal.

b. The first waterbag (chorioallantois) ruptures as calf enters canal.

c. The second waterbag (amnion) often forced through vulva unbroken. Delivery is imminent once the amnion appears.

d. Cow shows labor signs - abdominal presses every one to two minutes.

e. The hardest pressing occurs as head is pushed through the vulva. Cow may rest, then push hard to get calf's chest out. The hips and legs come easier but may occasionally get lodged in pelvis (hip lock).

f. Regular progress to delivery should occur through Stage 2. Giving assistance is okay, for each 10 minute delay in delivery the onset of estrous is delayed by 1 day.

STAGE 3 - Expulsion of placenta

Membranes usually are expelled within hours after birth. Manual removal is not recommended. Give the cow antibiotic injections to prevent illness from retention.

STEPS IN THE CALVING PROCESS

1. Be able to recognize a closed cervix and a partially dilated cervix.

2. **WATCH FOR PROGRESS**, the cow may look like she is going to begin labor then quits.
   a. false labor
   b. uterine inertia - uterus stops contracting
   c. too large of a calf to enter birth canal
   d. breech birth (tail first)

3. The quicker the calf is born (with or without assistance) the easier it is on the calf and heifer.

4. Make sure calf is in correct position.

5. When any of the following conditions exist, the cow needs assistance:
   a. Only the calf's tail is visible.
   b. Only the calf's head is visible.
   c. Front feet protrude past the knees, but the calf's nose cannot be located.
   d. Feet are upside down.
   e. The head and one foot are visible.
   f. More than two feet are visible.
   g. There is no progress after 15-20 minutes in delivery.

6. If it is necessary to go inside the cow, be sure to wash gloves, chains, etc. with disinfectant. Use a lubricant; soaps and mineral oil tends to irritate.

7. Attach smooth O.B. chains above and below fetlock area. Excess force should never be used. When pulling, don't keep both front legs exactly together.

8. Give straight backward and then downward pulls after the calf is in the pelvic cavity. Pull only when the cow strains (keep steady pressure between uterine contractions).

9. Do not rush if calf is being delivered frontwards.

10. Watch out for hip lock - rotate the calf 45 degrees to release hip lock.

11. Remove mucus and membrane from nose and mouth - dry, clean straw is suitable if nothing else is available.

12. If the calf is coming backwards, move rapidly once the calf's hips enter the cows pelvic canal. Experiments have shown that four minutes is the maximum time that a calf fetus can survive without oxygen.

13. Apply artificial respiration if needed; respirators are available - can stimulate sneezing by tickling inside of nose with grass.

14. Treat inside of navel with iodine solution.

15. The cow should be left alone with calf in a clean, small stall until she accepts the calf.

16. See that calf starts nursing. It needs the colostrum for nutrition and disease preventing antibodies.

17. Calves that have had a difficult delivery often have swollen tongues and experience difficulty in swallowing. They need to be carefully watched to see that they get colostrum.

18. Heifers may have poor milk supply and not have as much colostrum as cows, or they may not let calf nurse early.

19. The first colostrum is the richest in antibodies. Save and freeze this whenever it is available. Freeze in single dose units (1-2 qts.). Ziplock freezer bags work great.

20. Identify calves with ear tags or tattoos.

HANDLING CALVING DIFFICULTIES

Calf death at or shortly after calving results in losses of over 3.5 million calves in the USA. Approximately 45% of these losses are caused by dystocia (delayed and/or difficult parturition). The two principle factors involved in dystocia are size of calf and age of cow. Less than 2% of all calving problems occurring in mature cows, it is apparent that the greatest concern is in younger cows, especially two-year-old heifers. Size of calf is largely controlled via genetics.

A review of the stages of parturition and the calving process will help ranchers make wise decisions on how to handle calving problems.

Recognize Normal Calving

As long as the calf is normally presented (Figure 1), the vast majority of animals will give birth without assistance. Recognition of normal calving is just as important as knowing when calving is abnormal.

The first sign that calving may be near is development of the cows udder. This may occur as early as 6 weeks before the calf is born. During the last 4 to 6 days of pregnancy the vulva becomes enlarged, congested and flabby. The pelvic ligaments relax and the area between the tailhead and pin bones is loose and sunken.

Three Stages of Normal Birth

The First Stage - The cow will show signs of uneasiness and slight pain. Occasionally she may kick at her belly. These first spasms of uneasiness occur every 4 to 5 minutes and last only for 3 to 5 seconds. Throughout this first phase the animal is bright and fully aware of her surroundings. She may eat, drink and behave perfectly normal.

Each time the muscular wall of the uterus contracts, the cow feels a slight, sharp pain which produces her uneasiness. The wave of contraction extends from the tip, or bottom of the uterine muscles and causes the water-bag, surrounding the calf, to press against and open up the cervix.

As the first stage progresses, the contractions become strong enough to cause the cow to arch her back and strain slightly. The first strains usually occur at regular intervals and the actual strain lasts for only a second, though the back may remain arched and the tail cocked. The contractions are now becoming more frequent. The cervix continues to dilate.

The cervical dilation is now almost $^{3}/_{4}$ completed and the water-bag is starting to protrude through the cervix. Up to this time, the opening of the cervix is entirely dependent on the water-bag pressure from contractions.

The contractions continue to get more frequent. Near the end of the first stage, the last few efforts will tend to empty the lower gastrointestinal tract and urinary bladder.
This first stage of labor is usually longer in a heifer than for older cows.

Second Stage - This stage of labor is more intense. It begins when the calf's legs enter the vagina. Oxytocin is released and very strong contractions begin. The character of the cow changes markedly. Instead of being alert, she appears to become oblivious of her surroundings and concentrates intensely on uterine contractions. At this stage of labor, uterine contractions usually cause the cow to lie down, although some do not.

Each strain causes the top of the calf's head to press on the inside of the cervix, and this renewed stop-and-start pressure causes the cervix to open up fully.

It is at this point, with the water bag protruding and/or ruptured that birth is imminent. The cow or heifer should continue to push and a steady progress should be observed.

After the appearance of the feet, the number of strains is now greater and each one increases in intensity. At this point progress may slow for a minute or two as the vulva stretches. With a succession of pushes one can see the nose,

head, and shoulders in progression. Labor contractions will be very intense with few if any rest periods.

After the head appears, final delivery usually follows - half a dozen intense strains and the calf is out. With each strain, as the chest comes through, copious quantities of mucus may pour from the mouth and nostrils. This is important, since it clears the respiratory passages for normal breathing. Three or four more contractions and the calf is born - alive and unharmed.

Within 2 or 3 minutes after the calf is born, the mother usually stands and starts to lick the calf. It usually staggers onto its legs within 10 to 15 minutes. Within half an hour, it has found the teats and is sucking colostrum.

Third Stage - The final stage of labor is the passing of the afterbirth. Normally this is passed within 1 or 2 hours but occasionally can be retained for several hours. In such cases the retention is usually due to fatigue. Where the afterbirth is retained for longer periods, special precautions may have to be taken.

Recognizing the normal process will help a rancher provide assistance in a timely fashion. During the initial stage of calf birth, cervical enlargement is entirely dependent on water-bag pressure, especially the pressure exerted on the top part of the cervix. Intervention at this stage is inappropriate. Forcing the process before the tissues are ready can cause damage to the cervix and/or other tissues. Also, cervical dilation is retarded and the birth process is setback. The continuation of cervical dilation now depends largely on the off-and-on pressure of the calf's head on the top part of the cervix.

However, once the calf is in the proper position and dilation is complete, it is actually beneficial to assist in the process. An operator needs to realize that their role is to assist not to rush, rip, and tear. Recent research indicates that correct intervention at birth can reduce calf death loss and decrease days to first estrus in the cow. Calf and cow vitality is increased by prompt completion of birth. For each 10 minutes that the calf is delayed in delivery adds one day to the postpartum anestrous period.

When and How to Examine the Cow

Obviously it is important to know, with complete confidence, exactly when and how long to leave the cow and when to seek help.

If nothing is showing after a period of intense straining, then examine her to determine if presentation is normal. First, take time to scrub the hands and arms thoroughly with non-detergent soap, warm water and antiseptic or use pre-sanitized plastic OB sleeves. Now wash the vulva and anus area.

Insert your hand slowly, and don't rupture the water-bag. Since you may have to insert your arm to the shoulder, use a sleeveless shirt or plastic OB sleeve. If the calf's presentation is not a normal anterior (Figure 1) or posterior (Figure 2), you may want to seek help.

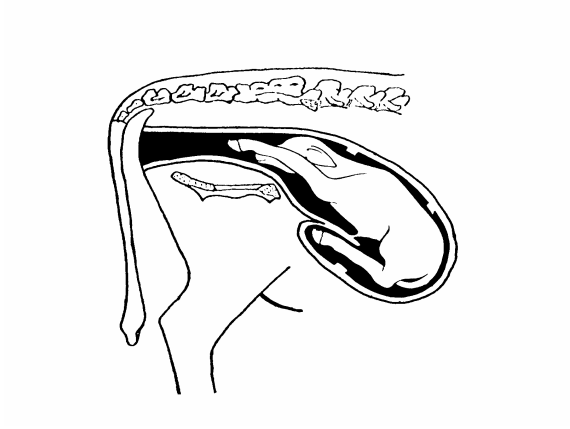


Figure 1. A normal anterior presentation.

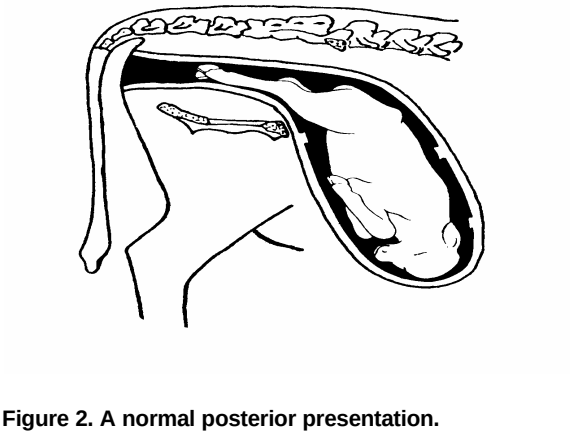


Figure 2. A normal posterior presentation.

Preparation for Calving

Having the proper equipment available at calving time can mean the difference between a dead or a live healthy calf. Consideration should be given to having the following equipment available at calving time:

- OB chains, 30 or 60 inch
- OB handles
- Calf puller
- Plastic sleeves
- Commercial brand lubricants
- Calf tube-feeder

In addition to the standard calving equipment, the stockman should also consider the following pharmaceuticals. Some will require a veterinarian's prescription.

- Dopram® - breathing stimulant - 2cc for newborn calf
- Oxytocin® - 5-10cc after calving - contract uterus
- Long-acting Tetracycline
- Tincture of iodine 7% - calf navel
- Nolvasan® (chlorhexidine) disinfectant

Assisting the process

Pulling a calf should only be done when the presentation and posture of the calf are normal. This applies both to a normal anterior position (Figure 1) and a normal posterior position (Figure 2).

Excess force should never be used in pulling a calf. In most cases, no more than one man should be allowed to pull and then only when the cow strains. Lubricant and patience will often solve the tightest case.

It is generally easier to correct any abnormal presentation if the cow is standing. If a cow or heifer won't get up, she should be so placed that she is not lying directly on the part of the calf which has to be adjusted. Thus, if the calf's head is turned back toward the cow's right flank, the cow should be made to lie on her left flank so that the calf's head is upper-most. This provides more room in the uterus for manipulation.

Once the calf is in a normal position, delivery will be easier if the cow is lying down.

Miscellaneous Points

When the calf's limbs are located, find out whether they are forelimbs or hindlimbs. This is done by starting to feel at the fetlock and moving the hand up the limb. All four legs have two joints that bend. In front legs both joints will bend in the same direction, i.e. fetlock joint bends downward and knee joint bends downward. In the hind limbs, leg joints/fetlock and hock bend in opposite directions.

The calf may be living or dead. Movements can be detected in a live calf by placing the fingers in the mouth, seizing the tongue, pinching the toes or touching the eyelids.

If the genital passage of the cow is dry or if the calf itself is dry, plenty of lubricant should be used.

Attempts to repel (push back) the calf should be made between labor pains. Similarly, attempts to deliver the calf by traction will be a lot easier if they are made to coincide with the contractions of the cow.

Normal Anterior Presentation

The normal anterior presentation position is: forefeet first, head resting on the limbs, the eyes level with the knees. In attaching the stainless steel OB chains it is important that there is proper placement on the calf's legs to reduce the chance of a broken leg or injured foot. The best arrangement is a double half-hitch where the first loop is placed above the fetlock and the second half-hitch is placed below the dewclaws.

If the calf is dead, tie a chain around the head behind the ears and pass it through the mouth. This will prevent the head from twisting around when the limbs are being pulled. With a live calf you can do this by placing a hand on the head and ensuring that the head is kept straight. Traction should now be exerted simultaneously on the head and limbs until the head enters the pelvis (Figure 3).

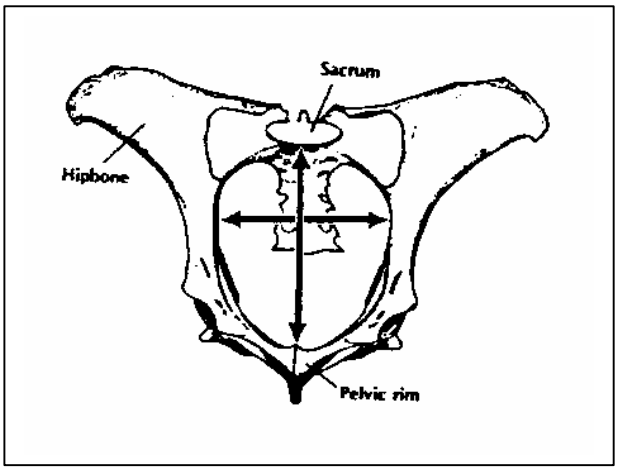


Figure 3. A typical pelvic opening of the beef female

A large calf, with wide shoulders is sometimes held up at this stage. If so, pull only one limb so that the elbow and shoulder of that limb enter the pelvis first. Then, while the pull on this limb is continued, the other limb is treated the same way, until both feet project equally from the genital passage. Now apply traction on both limbs and guide the head until it protrudes from the vulva.

Traction on both limbs at the same time will result in both shoulders entering the pelvis at once. If the shoulders of a large calf can be made to enter on a slant and can be pulled through in that position, delivery will be much easier.

IMPORTANT: Traction on the calf in the early stages should be exerted upward (in the direction of the tailhead) and not downward. Once the calf is in the pelvic cavity, traction should be straight backward until the shoulders clear the vulva and then traction should be directed downward toward the cow's hocks. The calf, thus, passes through the birth canal in the form of an arc.

If the passage of the hind end of the calf presents any difficulty, the body of the calf should be grasped and twisted to an angle of about 45 degrees. Delivery is then made with the calf half-turned on its side. This allows for easier passage of a calf with well developed stifle joints.

Sometimes a calf gets stuck at the hip (Hip lock). Don't just pull, rotate the calf as described above or try turning the cow onto her back, then over onto the side opposite to the one you found her on and try some gentle assistance.

Normal Posterior Presentation

In a normal posterior presentation, both the hindfeet are presented with the calf lying right side up (Figure 2). The hooves face upward. In a normal anterior presentation (head and forelimbs first) the hooves are downward. If the calf is on its back, however, the position of the hooves is reversed in each of these presentations.

In the posterior presentation, the head is the last part to be expelled and there is a risk of suffocation. Delivery should be as quick as possible by traction on the hindlegs. Traction should be exerted on one limb until the corresponding stifle joint has been drawn over the pelvic brim. It may be necessary to push the other limb partly back into the uterus. Thus, the two stifle joints will enter separately into the pelvis and assist easier delivery.

After the first limb has been drawn back sufficiently, traction should be applied to both limbs simultaneously. If this does not succeed, cross one limb over the other and pull on the lower limb. This will make the calf rotate slightly to one side and delivery will proceed more smoothly.

The calf's tail may have a tendency to protrude upward and damage the top of the vagina. Be sure the tail is down between the legs by placing your hand on the tail head while the calf is entering the pelvic cavity.

Posterior presentation is usually more easily dealt with than anterior presentation. Therefore, if a calf is coming hindfeet first, no attempt should be made to turn the calf around.

After delivery of a posterior presentation, more careful attention should be given to the removal of mucus from the mouth and nose because of the greater danger of suffocation than in an anterior presentation.

Other Ideas on Pulling Calves

Some people pull on the jaw or neck. Too much pressure could break the jaw. Pulling on the neck is risky on a live animal since it could damage the spinal cord. The best is a head snare or chain behind the poll, under the ears and through the mouth--this causes the mouth to gape so be

careful that the sharp incisors don't cut the birth canal. After the head and legs have passed through the cervix, traction can be applied to the legs only.

Traction should be applied in a steady, even manner. Jerky, irregular pulls are painful and dangerous. Try to pull when the cow is straining. If you are pulling and a sudden obstruction occurs, stop and examine the birth canal and calf to find out what is wrong before proceeding. To avoid lacerations to the soft birth canal, time should be allowed for enlargement of the birth canal as the calf comes through.

Using the calf jack

A calf puller can easily exert enough force on a calf to cause injury and/or death. In addition a forced extraction can cause serious injury or death to the cow or heifer.
To minimize this danger:

(1) tighten the pressure on the chain(s),
(2) gently pull down on the puller handle (matching the animals contractions), and
(3) slowly lift jack handle and reel the slack as if fishing.

Repeat this cycle several times as the head and chest move through the vulva. As this happens, it is important to exert downward pressure on the calf to ease the hips through the pelvis. Keep the handle pulled down toward the cow's hocks as you continue gentle pressure on the chains. This procedure will help lift the hips up into the wider part of the pelvis.

Abnormal Presentations

One of the most common calving problems and the easiest to correct occurs when one or both of the forefeet are back and the head is presented in a normal position (Figure 4). To correct this problem, push your arm into the point of the shoulder and elbow of the calf. Push the calf backwards a little and lift the foreleg up a little at a time. You may need both arms for this maneuver. You should try to cover the hoof of the calf with your hand to prevent injury to the uterine lining of the cow.

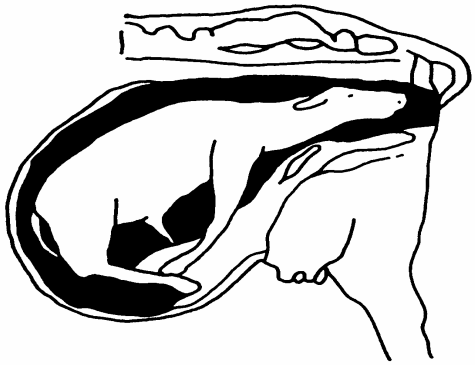


Figure 4. Calf presented with its head in the birth canal but one or both forelegs retained.

Some presentations are more difficult to solve. For example, a calf that has his nose down and the bridge of the nose is butting up against the brim of the pelvis may be harder to correct (Figure 5). If this position is not corrected the calf's head can fall down between the forelegs and not allow the delivery to continue. This is generally easy to correct early in delivery by grasping the calf's mouth or nostrils and pulling the head up into the normal position in the pelvis. If the calf's head is to one side the same procedure is used to correct it. If excessive force is used to pull the head into the canal there is a good chance of breaking the jaw of the calf. Once the head is in position, a person should proceed with a gentle assisted delivery.

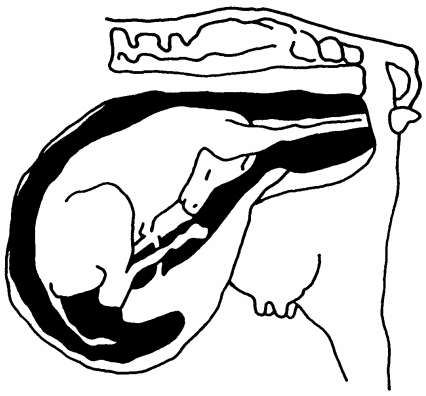


Figure 5. Two legs presented with calf's head down between legs.

Another problem is a backwards presentation (Figure 2). The first step in attempting to solve this problem is to make sure that what you think is going on is in fact the case. Put your arm inside and along the top of the legs until you find the tail. The tail should be next to the top of the pelvis. After locating the tail bring your arm out to the hock joint. If it is the hock, the joint should bend downwards toward the cow's feet and the fetlock should bend upwards.

After determining that indeed the calf is backwards, apply plenty of lubricant and deliver the calf, as presented, backwards. Be gentle and work as rapidly as possible. Never try to turn a backwards calf around. There is not enough room or time, and you can cause tremendous damage to the uterine tissue in attempting this maneuver.

When pulling the calf backwards remember that the umbilical cord of the calf is going to impact on the rim of the pelvis when the head is still inside. This will cut off the circulation of blood to the calf for a short time and may be life threatening. Once the backwards delivery is started, speed is of the essence so a live calf can be delivered.

In a backward pull as in a forward pull it is advisable to alternate the tension from one leg to the other to walk the hips through the pelvic opening. Remember to use plenty of lubricant, be gentle, and be quick. Do **NOT** try to turn the calf around.

A similar presentation is that of a breech calf. This differs from a backwards calf in that the calf is backwards but the legs are down (Figure 6). In other words the calf's back is being presented at the entrance to the birth canal with no feet visible. The only method of assistance is to raise both rear legs up and deliver the calf backwards.

Discussed earlier hip lock can sometimes be avoided by arching the calf through the pelvis with a downward pull. If the hip lock is severe, rotating the calf 1/4 turn will place the hips in the widest dimension of the pelvis. This can be easily accomplished by grasping the calf's legs and pulling them around. Use plenty of lubricant. Sometimes you may need to push the calf back a little ways to correct the problem. This is not always possible.

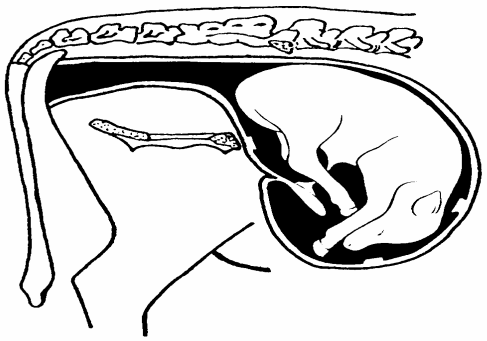


Figure 6. Calf presented in a breech position.

Sometimes a very abnormal presentation is seen, such as a calf being upside down, forward or backward. An upside down calf (forward) will, of course, have a knee joint there and it will bend upward only. A producer can either elect to do a C-section, or try to rotate the calf to an upright position, then deliver the calf. This may mean rolling the cow over to get the calf moving so you can bring the legs of the calf to a position where it can be turned over. Always use plenty of lubricant whenever you work with a delivery.

There may be times when the only solution is a Caesarean section. A C-section may be the means of saving the life of the cow and therefore protect the dollar investment in the cow or heifer. This choice is major surgery and means that the cow will probably be sold. Often the calf is lost, but the cow is still alive.

Twins can cause calving difficulties if they try to enter at the same time. When twins enter the vagina one at a time, there is no problem. However, occasionally twins are presented together and block the birth canal. In most of these cases one comes head first and the other tail first. Make sure both limbs you are working with belong to the same calf. To do this, feel along each limb to where it joins the body and feel along the body the opposite limb. Chain each limb separately and identify the chains, for each twin. If one or both twins are abnormally presented, correct as in a single birth before attempting delivery. Extract the closest twin. If in doubt, first extract the twin presenting hindlegs, after first repelling the other twin forward into the uterus.

It is very important at all times to exert pressure only when the animal strains and to relax completely when the patient relaxes. The old idea of maintaining a steady pressure during assistance is wrong, unless the cow has already given up and no assistance is coming from her.

Many calving difficulties could be eliminated by proper development of replacement heifers and/or breeding first calf heifers to bulls which will sire calves with below average birth weights.

Post-Partum Care - The Calf

Helping the calf after it is on the ground is important, especially if the cow does not get up to clean the calf. Make sure the calf can breathe and that its mouth and nose are free of mucus and phlegm. By tickling the inside of a nostril, a reflex action (sneeze) helps to clear out the mucus. Sometimes if one is strong enough and tall enough, it helps to clear the air passageway by holding the calf upside down and allowing the mucus to drain from the airways. This may result in the loss of fluids from the stomach which some believe are vital to survival. Often you will need a dry rag or glove to keep a tight gripe since the legs may be very slippery. Grasp the hind legs at the hock joints and raise the calf. Be sure the head is off the ground. If this does not work respiration may be needed.

There are several types of respirators available commercially. The least expensive method of reviving a calf is to place your hand around the mouth, close off one nostril, and blow into the other nostril at about six or seven second intervals. This is very effective in getting the calf to breathe after a difficult birth. As this attempt is continuing, someone else should be drying the calf or rubbing its body vigorously to stimulate circulation.

Treat the navel with an iodine solution, especially calves born in a muddy or wet environment.

Make sure the calf gets colostrum milk within the first two to three hours after birth. Colostrum is the calf's only source of protection from many infectious agents. Research indicates that newborn calves are only able to absorb the immunoglobulin in colostrum within the first 24 hours. A rapid decrease of the immunoglobulin in colostrum is also noted within the first 12 hours after calving. The antibody concentration in the first milking is twice that present in the second, five times that in the third milking, and ten times that in the fourth milking.

A calf should receive 10% of its body weight in colostrum in the first 24 hours of life. This is about a gallon of colostrum for an 85 lb. calf. Colostrum may be frozen and stored when none is available. To insure a high quality and concentration of immunoglobulin beef producers should consider using a colostrometer to test colostrum obtained from other sources. Superior rated colostrum will contain greater than 150 mg/ml of total immunoglobulin.

Post-Partum Care - The Cow

Many times problems associated with birth can create additional challenges to the stockman. As a precaution against infection, any cow that has needed assistance at birth should be given an antiseptic bolus, especially when assistance was prolonged or you were required to place your hands inside the vagina or uterus. Recommended treatments are chlorhexidine or betadine boluses placed in the uterus after calf delivery.

ASSISTING AT BIRTH

Results of research at Miles City indicate over 50% of the perinatal calf deaths could be prevented by improved management. The improved management would consist of: (1) giving timely, correct obstetrical assistance when needed; (2) prevention and effective treatment of disease in the newborn.

A study has been conducted at Miles City that has shown interesting effects of obstetrical assistance on postpartum reproduction in beef females (Doornbos et al., 1984). Pregnant dams were divided into two groups, an early assisted group and a late assisted group. Dams in the early assistance group had the calf delivered with obstetrical assistance as soon as the cervix was fully dilated regardless of real or potential dystocia. Full cervical dilation was defined as having occurred when the dam was in labor as evidenced by the abdominal press and when membranes and (or) calf feet extended from the vulva. When these had occurred, labor was interrupted, the dam was taken to an obstetrical stall and the calf was delivered regardless of whether the dam could have delivered the calf unassisted. In the late assistance group, the calf was born unassisted unless emergency assistance was needed to save the life of the calf. We assisted 82% of the calvings in the early assisted group and 15% in the late assisted group. The object was to create a difference in duration of labor between the two groups.

There is an important fact that must be emphasized. This study was conducted by trained, experienced herdsmen that had experience in recognizing when the cervix was dilated and when and how to give obstetrical assistance. Results are summarized in Table 1.

Time of assistance had no effect on calf birth weight, but the calving difficulty scores were greater in the early assisted dams. These differences were to be expected. Each calf received a vigor score ranging from 1 = a live, vigorous calf to 3 = a dead calf, and no difference was found between the two treatment groups. This finding would tend to support the definition used for determining when the cervix was fully dilated. If the birth canal had not been fully dilated, more problems would have been encountered during the assisted delivery resulting in reduced vigor in the calf.

There was no significant effect on postpartum interval, 52 vs. 54 days. There was a sizable, but nonsignificant, difference in first-service conception rate between the early (75%) and late (60%) assisted groups. Pregnancy percentage after a 45-day AI period was 14% greater ($P<.05$) in the early than late assisted group. Additional study of pregnancy rate indicated pregnancy rate was 88% in the early assisted heifers and 69% in late assisted heifers. They also noted improved pregnancy rate in early assisted cows -- 91% in early and 82% in the late assisted. These cows were from 4 to 7 years of age. Thus, early obstetrical assistance had an effect on the pregnancy rate of these dams that was traceable to an improvement in fertility per breeding in both the heifers and cows. In this study, the second stage of labor lasted 55 minutes in heifers and 25 minutes in the 4- to 7-year-old cows.

Results of these studies now indicate early obstetrical assistance can: (1) reduce perinatal calf losses; (2) minimize the poor reproductive performance that is encountered in dams that experience dystocia.

TABLE 1. EFFECTS OF EARLY AND LATE OBSTETRICAL ASSISTANCE

Time of assistance	No.	Calf birth weight (lb.)	CD score	Calf* Vigor	Postpar. interval (days)	%Heat begin breed. season	First serv. conc. (%)	Pregnancy
Early	67	74	2.1	1.1	52	91.3	75	90+
Late	60	74	1.3	1.1	54	81.8	60	76

* Score: 1 = live, vigorous calf to 3 = dead.

CALVING FACILITIES

Every ranch needs to design a functional calving assistance area to increase profits by decreasing calf death losses, animal injuries, and increase subsequent conception rates. Proper and timely assisted births can increase cow and calf vitality, which in turn positively affects growth and reproduction resulting in higher dollar returns to the ranch. As with any other job it is much less difficult to assist in the delivery of a calf if proper equipment and facilities are available.

Proper facilities can affect the motivation to bring the cow or heifer in the barn and allow assisting birth without undue stress on the animal or the producer. The animal should move to the area easily, be constrained without fright, and then helped with the birthing process. With inadequate facilities the rancher often delays assistance and has difficulty in corralling and restraining the animal. Frequently, this results in problems with the 'mothering up' or bonding process after birth is completed. A calm, unhurried manner promotes successful results.

The facilities should be designed for easy animal movement and located in an area familiar to the heifers. The OB stall can be outside although inside a barn is often a more pleasant environment on a cold snowy night. Feeding heifers in the general area will allow them to be familiar with the surroundings and move into the area with ease.

A concrete pad is helpful. After several births, the area tends to become muddy and slick. A pad of rough concrete provides sure footing, as well as a drier, cleaner environment. The pad can be swept clean or a floor drain provided to remove liquid and placenta. A flood light above and behind the animal is also helpful. The obvious benefit is to be able to see what is needed. A light may not heat an area, however, it does 'feel' warmer than working in the dark.

Hinged, swing away or interchangeable panels (gates) allow flexibility in design and aid in cattle movement. These are attached on either side of the head catch to 1) facilitate moving the heifer into the catch and 2) aid in holding the heifer quiet as assistance is given. Once assistance is started the gates need to swing away from the animal so that it might lay down in the birth process. These panels can form a small pen to hold the pair after birth.

The natural actions of cattle after an unassisted birth is to stand, pivot 180°, and begin to mother (lick, etc) the calf. This action not only dries the calf but stimulates it to move, breath, and get up and bond with the mother. To simulate this action the heifer should be allowed to back out of the head catch and pivot with her head down. All she can smell at this point is the calf. Bonding (mothering) will generally occur quickly. If an animal is moved to a new location before bonding has taken place, this process is much slower. The design of the facilities should allow the heifer to mimic this natural instinct.

Head Catch

There are several commercially available head gates which are acceptable for a calving stall. It is essential they open all the way to the floor and have straight side bars which constrain the head. These design peculiarities allow the heifer to lay down during the process without the danger of 'choking down.' A curved head catch gate can be modified by welding a straight pipe into the curved section. A wooden head catch may be less expensive (figure 1) but should open to the floor. The gate can be equipped with a rope to lock the head from the rear or side of the animal when desired. The area beyond the head gate should be open and lighted so the animal will readily enter. A dark hole will discourage most cattle from putting their head through the opening to allow head catch closure.

A squeeze chute is not an acceptable alternative. In proper assistance the calf needs to be delivered in an arc with final pressure directed toward the heels of the mother. In many births the heifer will lie down on her side for delivery which she can not do in a squeeze chute. Furthermore, an operator will not have room to maneuver the calf or any mechanical device to direct the appropriate 'downward' pressure. Worse yet is the case when the heifer goes down on her belly. She can not be rolled to her side in the squeeze chute.

Often a producer is tempted to use a board or belts to hold the animal up. This does not allow room for the arched delivery and eliminates the squeeze as an alternative to the simple self catch gates. Further, it is more difficult to release the heifer post partum and mimic the natural instincts as described previously.

Design

The head gate is placed between two posts in a fence line. These posts are also used as hinge holders for 8 ft or 10 ft. panels. The panels can be brought together to move the animal's head into the catch and then fastened with a chain at the back end. Often the gates need to be stabilized to prevent swinging from side to side. This can be as simple as an angled foot brace on both sides of the panels. A second set of gates should be hinged on the opposite side of the pen so that both sets (4 gates) can be swung open as delivery occurs. This allows room to correctly work with assistance equipment. Also with these open there is sufficient area for the post partum bonding process. See Figure 2 for one pen design example which can be modified to match gates and areas on most ranches.

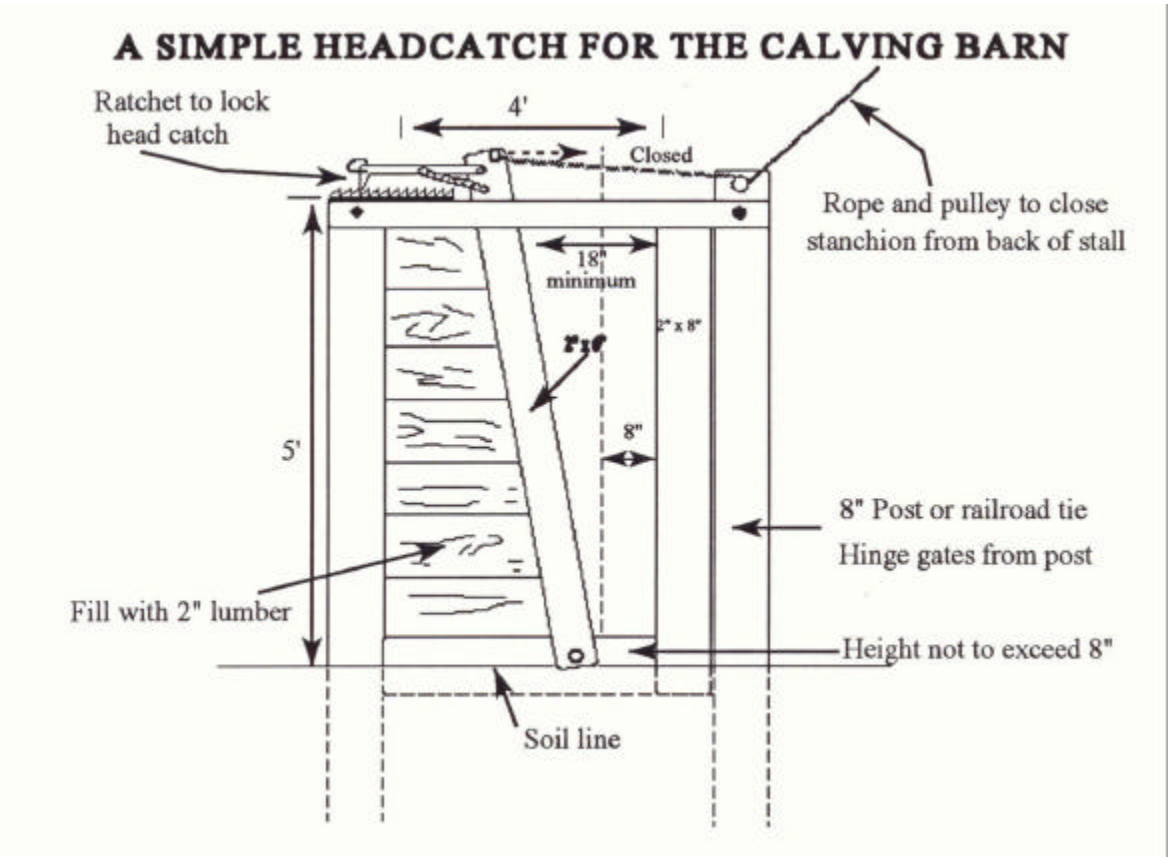
One set of side gates can be closed, the heifer brought to the small pen and manipulated into the head catch by using the second set of gates as leverage. A chain to hold the side panels together will confine the animal and reduce the possibilities of being kicked. Once assistance is started the gates can be swung back out of the way. Once delivery is complete, place the calf in the back corner of the pen near the heifer's hind feet. Make certain that the heifer will not step on the calf. Make certain the calf is breathing and iodine the naval. Also, place the calf on its sternum. Let the heifer back out of the head gate and leave her with the calf.

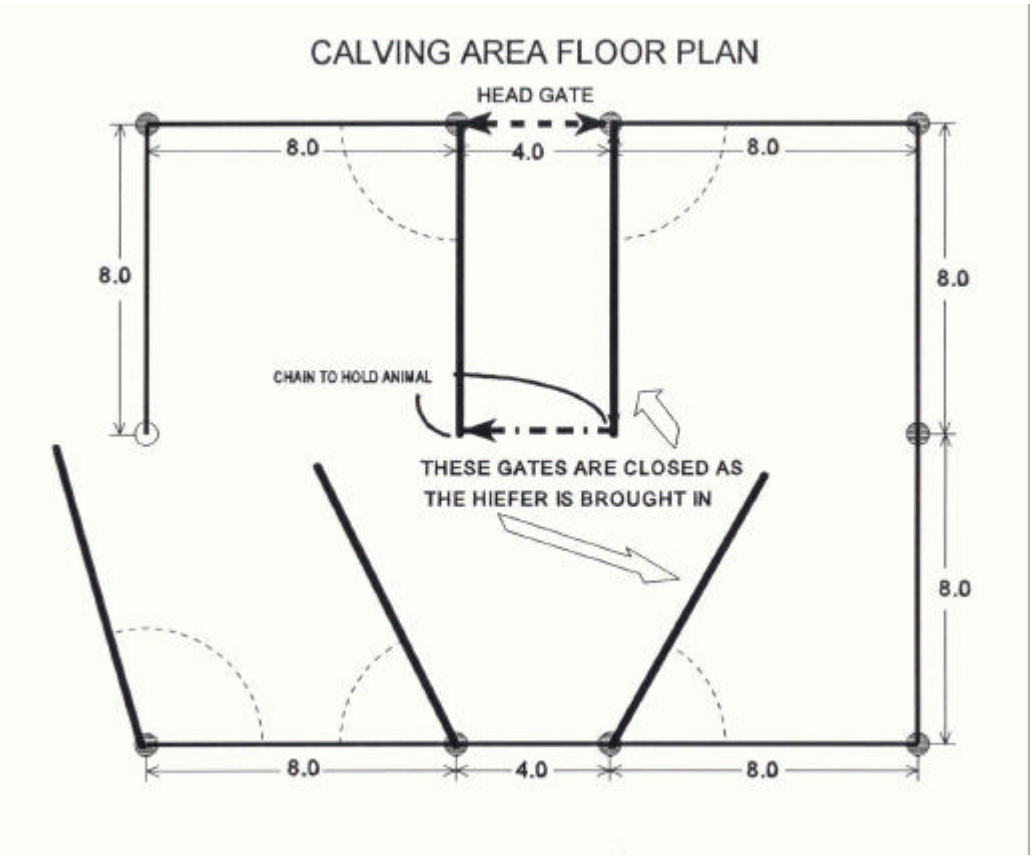
To accommodate the occasional cesarean section the left gate can be modified by being cut in half horizontally, thus allowing the top section to swing out of the way. If a calf needs assistance in nursing (a bad uddered cow, a weak calf, or a graft) the lower portion can be opened while the top restrains the heifer. These procedures should allow both animal and human relative safety.

.

Other items which will get used repeatedly are a few small 10 or 12-foot square pens. These can be used to continue and encourage the bonding process, help graft calves, or doctor sick cows and calves. The design of these pens should allow easy cleaning and sanitation.

Calving facilities should be user-friendly for both the rancher and the heifer. They should provide a safe clean environment for the entire birthing process which should result in more live calves, healthier calves, easier rebreeding cows, and increased profits to the ranch


A SIMPLE HEADCATCH FOR THE CALVING BARN
Ratchet to lock head catch
4'
Closed
Rope and pulley to close stanchion from back of stall
18" minimum
2" x 8"
5'
8"
8" Post or railroad tie
Hinge gates from post
Fill with 2" lumber
Height not to exceed 8"
Soil line


CALVING AREA FLOOR PLAN
HEAD GATE
8.0
4.0
8.0
8.0
8.0
CHAIN TO HOLD ANIMAL
THESE GATES ARE CLOSED AS THE HIEFER IS BROUGHT IN
8.0
8.0
4.0
8.0

DEVELOPING HEIFERS

Breed Differences in Estrus Percentages in 14 to 15-month-old Beef Heifers

Body weights (lb) by breed

BREED	50% IN ESTRUS	65-70% IN ESTRUS	85-90% IN ESTRUS
ANGUS	551	606	675
HEREFORD	606	675	706
CHAROLAIS	706	728	772
AxH	551	606	675
SIMxENGLISH	675	706	772
LIMOxENGLISH	675	706	772
BRAHMANxENGLISH	675	706	772

Weights of Breeds at Various Stages of Development

Sire Breed	Birth	365 d	Maturity	Rate	Height
Angus	75	613	1126	96.4	49.2
Brown Swiss	84	638	1144	98.2	50.4
Brahman	81	715	1210	108.9	52.0
Charolais	81	651	1219	89.0	50.8
Chianina	87	653	1296	83.9	53.5
Gelbvieh	84	649	1185	94.6	50.4
Hereford	73	653	1100	107.1	48.4
Jersey	62	552	935	108.9	48.4
Limousin	75	618	1135	89.3	50.4
Maine Anjou	90	667	1283	87.5	51.2
Pinzgauer	92	719	1155	117.8	50.4
Red Poll	81	592	1124	87.5	49.2
Sahiwal	75	658	1069	110.7	50.0
Simmental	81	661	1131	101.2	50.8
South Devon	77	627	1126	96.4	52.0
Tarentaise	75	701	1142	112.5	49.6

Breed Group Means for Calf Birth Weight and Dystocia of Females Producing Calves.

Breed group	Calf birth weight (lb)	Calving difficulty Score	Calving difficulty (%)	Mature weight	Maturity Ratio
Red Poll	77	2.8	58.7	1124	87.5
Hereford	75	2.7	48.6	1100	107.1
Angus	71	2.3	40.9	1126	96.4
Limousin	78	1.9	29.1	1135	89.3
Braunvieh	93	3.8	68.9	--	--
Pinzgauer	94	3.7	67.9	1155	117.8
Gelbvieh	87	3.4	59.9	1185	94.6
Simmental	86	2.9	52.0	1131	101.2
Charolais	87	2.3	39.0	1219	89.0

PALPATION AT 12 MONTHS OF AGE

It is recommended that all heifers be rectally palpated at one year of age. Heifers bred on the third estrus are twice as likely to conceive as those bred on pubertal estrus. If heifers are to have a high probability of settling by 14 months to calve at 24 months then they need to cycle at about 12 months. Also any heifer with a small or malformed tract can be culled at one year and not see a reduction in sale price as compared to older heifers.

The three items evaluated are:

1) Reproductive tract score
2) Shape of the pelvis
3) Size of the pelvic opening

Colorado scientists have developed a system for evaluating the reproductive potential of yearling heifers. The reproductive tract (uterus and ovaries) are examined through rectal palpation and assigned a score of 1 through 5. A score of 1 would be for a heifer that has a small immature tract and is definitely not cycling and a 5 is a heifer that has a palpable corpus luteum and is cycling (Table 1). Heifers with higher reproductive tract scores had higher pregnancy rates and conceived earlier in the breeding season (Table 2.) Be aware that reproductive tract scoring will require skills gained from much experience in palpation techniques.

Table 1. Description of Reproductive Tract Scores for 13 to 14-month Old Heifers

Reproductive tract score	Uterine Horns	Ovaries Approximate Size Length (mm)	Height (mm)	Width (mm)	Follicle diameter
1	Immature <20 mm diameter - no tone	15	10	8	<8 mm
2	20-25 mm diameter no tone	18	12	10	8 mm
3	25-30 mm diameter good tone	30	16	10	8-10 mm
4	32-35 mm diameter good tone - erect	32	18	12	>10 mm Corpus luteum possible
5	>35mm diameter good tone - erect	>32	20	12	>10 mm Corpus luteum present

Table 2. Effect of Reproductive Tract Scoring on Reproductive Traits

Reproductive Measure	Reproductive Tract Score 1	2	3	4	5
Response to Synchronization %	46.3	76.6	80.4	90.7	89.4
Pregnancy Rate from Synchronized Breeding %	2.6	22.6	39.5	54.6	55.0
Pregnancy Rate at End of Breeding Season %	28.2	74.2	76.8	94.1	85.0
Conception Date (Average # of days into breeding season that conception occurred)	19.0	10.0	2.0	4.3	0.0

EFFECTIVE HEIFER DEVELOPMENT

Optimum reproductive performance from replacement heifers requires (1) the heifer must exhibit estrus and conceive early in the first breeding season; (2) the heifer must have a live calf at side at weaning; (3) the heifer must conceive early in the second breeding season for production of the second calf. These goals depend on the correct management decisions that result in puberty, minimal calf losses and a high reproductive rate in the postpartum first-calf heifer.

Decisions made throughout the early development stages have a major impact on lifetime productivity of beef females, and thus represent one of the most important variables in the long term profitability of a farm or ranch. In any business endeavor, the objective is to produce a quality, profitable product for the least possible cost. The trick in heifer development is knowing where to draw the fine line to keep costs down, yet create a productive cow that will make you more money than those calved the year before. Five key goals in heifer development that will help you accomplish this include:

1) Select heifers that are genetically superior.
2) Manage heifers to reach puberty at 12 to 14 monthsof age.
3) Have a high percentage bred in the first 21 days of the breeding season.
4) Minimize calving difficulty.
5) Breed back early the second year to stay in time with the rest of the herd.
6) Wean a genetically superior calf.

In order to discuss proven management practices and recent research information that help achieve these goals, we will address heifer development in four phases: suckling, weaning to breeding (growing phase), breeding to pregnancy check and pregnancy check to calving. One other critical phase is from calving to rebreeding.

Suckling Phase

Implanting. One important decision that has the potential to impact replacement heifers must be made shortly after birth; whether or not to use growth promoting implants during the suckling and growing phases. Considerable research has been conducted to determine the effects of growth promoting implants on growth, reproduction, and calving difficulty and subsequent milk production. The results can be summarized into the following recommendations:

- There are both advantages (increased weight gains) and disadvantages (reduced fertility) to implanting heifers. Both must be considered and weighed on an economic basis before implanting heifer calves.

- If heifers are to be kept as replacements for the breeding herd and can be identified early, then implanting them as a means of increasing weight, decreasing age at puberty, or increasing pelvic area is a questionable practice and is not recommended.

- Most replacement heifers come from calves born early in the calving period. Consideration should be given to implanting only the late-born heifer calves as a compromise to take advantage of increased weaning weights and market value of heifer calves not intended for replacements.

Creep feeding. Another practice is to creep feed calves. Creep feeding is generally not recommended for potential replacement heifers because of the potential decrease in milk production after they calve. In a Illinois study, Angus and Hereford first calf heifers that had been creep fed as calves produced 2 lbs less milk per day than did control heifers 120 days after calving. This effect may not occur in larger-framed cattle. However, there is no reason to believe that creep feeding heifers will in any way improve reproductive performance. Consequently creep feeding must be evaluated from an economic standpoint because of the tradeoff with weaning weight and milk production. Also, it may be difficult to manage potential replacement females separately from calves that will be sold at weaning.

Growing Phase

Importance of early puberty. It has been well-documented that heifers conceiving early in their first breeding season have more as well as heavier calves throughout their lifetime. In order to calve at 24 months of age heifers must conceive at 14 - 15 months of age. Late bred heifers not only wean lighter calves, they add to the inconsistency of the calf crop and continue to calve late. Before a heifer can conceive, she must first obtain sexual maturity or puberty. A higher percentage of pubertal heifers at the onset of a synchronization program generally results in a greater proportion of heifers synchronized and bred. Montana researchers have reported reduced pregnancy rates of heifers bred at the first (57%) compared to third (78%) estrus. Therefore managers should strive to have heifers in their second or third cycle at breeding, which will result in improved synchronization, increased pregnancy rates and overall lifetime production.

Age and weight are two of the most important factors determining when an animal becomes puberal. If a uniform group of similar aged heifers are selected for replacements, age will not be a problem. Care must be taken not to select heifers that are much younger than 12 months at the beginning of the breeding season, because it is much less likely that they will reach puberty and become pregnant.

Target weights. Texas researchers conducted a study in 1985 that demonstrated the dramatic impact that weight at the beginning of the breeding season has on the productivity of heifers (Table 1.) In this study, heifers were developed to reach either 600 or 700 pounds by the first day of the breeding season. This work has evolved into the "target weight" concept that is now used extensively to optimize for both inputs and productivity when developing heifers.

The target weight concept is based on the recommendation that heifers should weigh 65% of their expected mature weight. Obviously, the best estimation of your heifers' mature weight will be the weight of your cows if they are of similar frame size. Once a target breeding weight has been determined, the optimal daily gain can be calculated by using the following equation.

$$\text{Target ADG} = \frac{\text{Target Weight - Current Weight}}{\text{Number of Days to Breeding}}$$

Formulating rations to achieve this level of gain should both insure a high percentage of heifers cycling before the breeding season, and reduce the possibility of overfeeding which simply costs more money than is necessary. An example of a calculated target weight gain follows:

Average in weight (11/10/92)	=	532 lbs
Average birth date	=	3/18/92
Average age (11/19/92)	=	237 days
Average hip height(11/10/92)	=	43 inches
Days to breeding (11/10/92)	=	172 days
Expected mature weight	=	1150 lbs
Target weight 1150 * .65	=	748 lbs
Gain needed 748 - 532	=	216 lbs
Target ADG 216 / 172	=	1.26 lbs/day

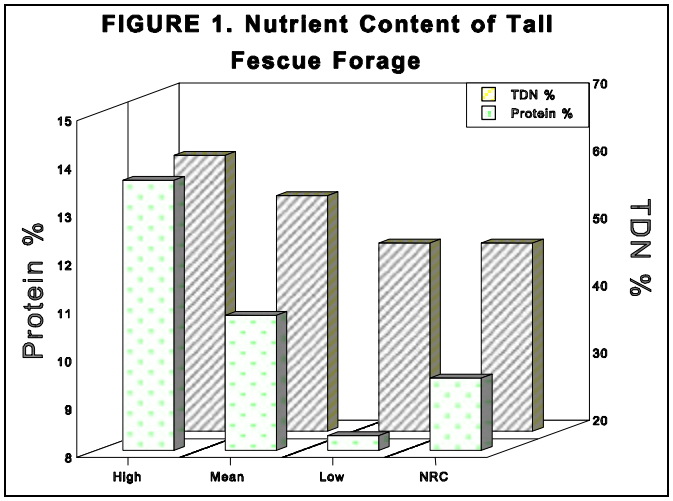
If a scale is available, it is very helpful to weigh the cattle every 30 to 60 days just to insure that you are on target. If you can not weigh all of the heifers, select 10 to 20% that are representative of the group and use them to collect "check" or "spot" weights (the same heifers will need to be weighed every time). These weights will be the most valuable tools you have in order to adjust your supplementation program.

Sorting heifers into groups by weight, then adjusting each groups ration to achieve the same target weight will both increase the percentage of smaller heifers cycling and reduce feed costs for the heavier, older cattle. Obviously this management practice will not be practical unless you have a relatively large group of heifers, the appropriate facilities and feeding system.

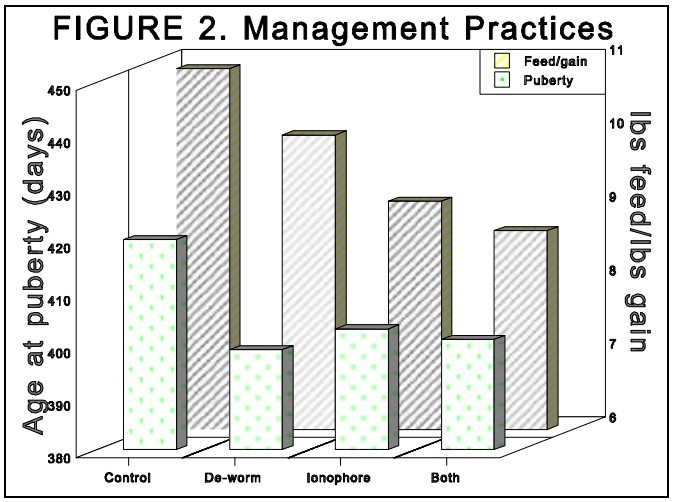
Nebraska research points out that the weight gain does not need to be constant over the entire growing phase as long as the target weight is reached (Goehring, 1990). In this three year study, heifers were fed three different ways: 1) at a constant gain of 1.0 pound per day, 2) zero lbs the first half of the growing phase followed by a 2 lb ADG during the second half, 3) 2 lbs ADG first half followed by 0 lbs ADG second half. Yearling pregnancy rates were not influenced by the timing of weight gain. This information allows producers flexibility in their nutritional program. Feed resources that would not sustain the target ADG could be used in the fall and early winter, followed by a drylot period where heifers were fed a ration to gain at a much faster rate.

Other nutritional considerations.

Forage testing is a must if you are to design your nutritional program to achieve a specific level of gain. Forages are extremely variable in terms of nutrient concentrations. The crude protein (CP) and total digestible nutrient (TDN) variability in fescue hay samples are shown in Figure 1. Designing a supplementation program without knowing what is in your forage base is merely a shot in the dark. Today's economic conditions no longer allow serious producers to operate in the dark. Your county extension office can provide you with computer software to assist with ration balancing.



Recent research indicates that deworming heifers at weaning improves feed efficiency and weight gains.



Bull exposure. Nebraska research indicates that exposing heifers to bulls for 70 days prior to the breeding season significantly reduces age at puberty and improves breeding performance (Table 2). In this study heifers were fed to achieve two levels of gain, 1.76 lbs ADG or 1.32 lbs ADG. One half of the heifers in each nutritional group were then exposed to epidedectomized (non-fertile) bulls for 70 days prior to breeding. Management of heifers during sexual development can be optimized by a profitable tradeoff between feed resources and bull exposure. They caution that each situation

must be carefully evaluated because magnitude of response to bull exposure decreases as rate of gain decreases.

Breeding to Pregnancy Check

Heat Synchronization and Artificial Insemination. More and more cattlemen are taking advantage of the improved reproductive efficiency and accelerated genetic improvement of artificial insemination. First calf heifers represent the most advanced genetic pool in your herd (if you have been doing a good job of sire selection) as well as the easiest female on any farm or ranch to get pregnant to artificial insemination. Breeding this group of your cattle to the best possible sire you can find only makes sense.

Artificial insemination allows you to use proven bulls with high accuracy EPD's for the traits most needed in your herd. Bulls with low to moderate birth EPD's should be used to reduce calving difficulty. The most important thing is to obtain a healthy live calf early that first year. If the calf is lost at birth all of your cost and effort to this point are for nothing. Whether you plan to use AI or natural service, start your search for a "heifer" bull by obtaining a sire summary from the breed association that you are interested in. These publications report the average birth weight and average birth EPD for their breed. Based on this information you should establish a range of EPD criteria for birth weight as well as other traits. Follow this exercise by talking to breed representatives and cattlemen to see how progeny of bulls that you are interested in perform in your environment.

Heat synchronization greatly improves the efficiency of the AI program and insures a greater percentage of heifers calving in the first 30 days of the calving season. Most commercial producers consider AI and synchronization too time consuming, expensive and labor intensive. Yet most of this intensive management is concentrated in a 3 - 5 day period. Cattlemen who have committed to making AI an important part of their management program simply budget the time needed as a top priority. One factor to remember when a synchronization program is being considered is that a majority of the heifers will calve in a period of 2 - 3 weeks. If the heifers are bred to calve 3 to 4 weeks ahead of the cows, this allows more time to provide extra TLC during that period. However, additional labor and appropriate facilities during inclement weather will be a must.

Selection. Selecting replacement heifers is a genetic selection decision, just like choosing a herd sire. The more documented information you use to evaluate heifers, the more genetic improvement and reproductive success you are likely to achieve. Many cattlemen will make initial selection decisions at weaning, in order to manage the cull heifers differently. The next opportunity to evaluate heifers is prior to the breeding season. At this time winter performance as well as additional information such as pelvic area and reproductive tract scores can be obtained.

Research indicates the major cause of dystocia is a disproportion between the calf size at birth (birth weight) and the pelvic size of the dam. Pelvic measurements are best used to identify and cull heifers with the smallest pelvic areas. Over time this practice will result in a reduction of the incidence of dystocia. Most yearling heifers range from 140 to 200 square centimeters in pelvic area. Nebraska researchers have suggested a yearling pelvic area to birth weight ratio of at least 2:1 to avoid calving difficulty. In other words a heifer with a pelvic area of 140 cm^2 could only deliver a calf weighing no more than 67 pounds without experiencing dystocia (140 / 2.1 = 67).

Pregnancy Check to Calving

Conception date is an important consideration when selecting heifers. During pregnancy diagnosis, the age of the fetus should be recorded. This information will allow the producer to be selective in terms of keeping the heifers that will calve in a very succinct period of time. This data is also useful to determine AI conceptions and thus the success of the AI program.

Heifers need to continue to grow throughout their first gestation. It is traditionally recommended that heifers weigh approximately 85% of their expected mature weight by the time they calve. To do this they will need to gain between .7 and 1 lbs per day. This is not difficult to achieve for spring calving heifers, and in fact many heifers will come off of summer grass weighing in excess of their targeted calving weight.

Care must be taken to insure that any extra gain realized during the summer is not lost during the fall and winter. Remember that the fetus and other maternal tissue associated with the fetus will make up approximately 100 lbs by calving time. Therefore, it is possible for heifers to be gaining weight, but actually losing body condition.

Heifers should approach the calving season in a moderate to high body condition score (see the following proceedings paper for a description of body condition scores).

Table 1. Performance of heifers fed to weigh 600 or 700 pounds at the start of the first breeding season.

Item	600 lbs	700 lbs	Difference
Age at 1st estrus[a]	205	183	22
		1st year	
Pregnant after 1st service (%)	45	60	15
Pregnant after 60 days (%)	52	78	26
Calf wean wt (lbs)	356	386	30
Calf birth date (day of year)	58	41	17
		Second Breeding	
Pregnant after 40 d breeding (%)	33	57	24
Pregnant after 90 d breeding (%)	68	85	17

Wiltbank, J. 1985.

Table 2. Reproductive performance of heifers grown at different rates and exposed to bulls.

Treatment[a]	Age at puberty Year 1	Age at puberty Year 2	AI preg. % both years	Overall preg. % both years	Avg day of calving
BE - 1.76 ADG	358	391	50	85	3/9
BE - 1.32 ADG	417	427	51	87	3/13
NE - 1.76 ADG	427	428	25	88	3/18
NE - 1.32 ADG	456	441	8	72	3/22

[a] BE = exposed to bulls, NE = not exposed to bulls

PELVIC SIZE DATA AND CONSIDERATIONS

Much has been written about the value of pelvic size and the ability to use it as a predictor of calving difficulty. It is logical to assume that dystocia is the result of the disproportionate size between the size of the calf and the size of the opening it must come through. It does not follow that by increasing the size of the opening we reduce calving problems. Table 1 gives the heritability of traits related to birth as well as the genetic and phenotypic correlations between traits.

Although the trait is heritable (.30) and can be selected, we take with it some other traits not as desirable. The high genetic correlation (.81) between hip height and pelvic size means that we are selecting taller heifers and also heavier heifers (.62). These heifers give birth to larger calves (.55) thus we do not see a direct reduction in dystocia. There is a reduction (-.26) in calving difficulty but it is not as large as expected because the calves are bigger. If we can control calf birth weight and increase the pelvic opening, we will reduce calving problems. However, because of the high genetic correlations we can not do this very effectively.

Table 1. Relationship of Pelvic Area and Calf Birth Weight and Dystocia for Females Producing Calves.

	Pelvic area (cm)	368-d weight (lb)	368-d height (in)	Birth weight (lb)	Calving diff. score	Calving diff. (%)
Pelvic area (cm)	.30	.62	.81	.55	-.26	-.19
368-d weight (lb)	.39	.43	.74	.40	.01	.27
368-d height (in)	.38	.62	.39	.44	.03	.29
Calf birth wt (lb)	.13	.23	.24	.25	.50	.52
Calv. difficulty score	-.09	.00	-.06	.51	.12	.90
Calv. difficulty (%)	-.07	.01	-.03	.40	.85	.07

Heritability on diagonal;
Genetic correlation above;
Phenotypic correlation below.

TIMING OF RATE OF GAIN

Goals in heifer development are set as target weights and rates of daily gain are easily calculated and often difficult to set in motion. Often a producer has high quality feeds that may not last nor is needed for an extended time period. Can the target weight be met with different rates of gain over different time periods? Several studies have been conducted to evaluate this question.

Clanton et al. (1983) fed heifers from 45 days after weaning until breeding to: (1) make no gain the first half of the development period followed by .91 kg daily gain the last half; (2) .45 kg daily gain the entire trial; (3) .91 kg daily gain the first half of the development period and no gain the last half. There were no significant differences in age at puberty, conception rate or calf production due to treatment. These workers conclude that adequate growth and development of replacement heifers is necessary, but latitude exists in the rate and time of growth between weaning and breeding. Results are summarized in Table 1. Results of these studies also indicate the importance of selecting the correct target weight for the replacement heifer to reach by the beginning of the breeding season.

Table 1. Effect of Rate and Time of Gain on Replacement Heifers

	Treatment		
	1	2	3
Number	60	60	60
Weights			
Initial	417	405	417
Final	618	612	627
Puberty age (day)	403	394	392
Estrus begin breed season (%)	85	90	90
Pregnancy (%)	75	82	73
Calf wean wt.	299	304	299

FEED ADDITIVE: IONOPHORES (RUMENSIN® OR BOVATEC®)

An ionophore is a product used to increase feed utilization in beef cattle. Ionophores have been shown to increase feed efficiency, increase rate of gain and, perhaps, decrease feed intake, depending on the particular diet and feeding program.

Ionophore acts by changing the action of the rumen in digesting carbohydrates. The rumen digests carbohydrates by breaking them down into three different fatty acids that are used as sources of energy by the body. One of these, propionic acid, provides more energy with less waste than do the other two acids. An ionophore acts by increasing the proportion of propionic acid produced from carbohydrates.

A study was conducted with 143 replacement heifers to determine if an ionophore would have a beneficial effect on reproductive traits as well as growth traits. One group of heifers, referred to as High Roughage (HR) group, received only the control diet without the ionophore. The control diet was 80% ground crested wheatgrass hay and 20% grain. A second group was fed 200 mg ionophore per head per day but was fed about 10% less of the control diet so the rate of gain would be the same as heifers in the control group. A third group was fed 200 mg of ionophore per head per day in the same amount of the control diet as the control animals and were permitted to gain whatever they would on that ration. The heifers were also divided into light and heavy categories on the basis of average weaning weight; and, they were all fed to reach the same target weight by June 15, the start of the breeding season.

Results of the study are shown in Table 1. Heifers fed the ionophore gained more than heifers fed the control diet even when they were fed 10% less feed. Not only does this represent a savings in dollars and cents, but it extends the producers' feed supply.

It is also worthwhile to look at differences between light and heavy heifers to the extent to which they utilized Rumensin in their diet. Remember, the light heifers were fed more feed than the heavy heifers so they would reach the same weight by the end of the feed period. The heavy heifers fed Rumensin® plus 100% of the high roughage diet actually gained more than the light heifers in the same treatment even though they were fed less feed. This may be a case of animals that have a genetic advantage in terms of natural growth rate also having a genetic advantage in utilizing products which increase feed efficiency.

Reproductive traits were not greatly affected. Age at puberty was decreased slightly in the four groups fed Ionophore when compared with the HR control group; but again, the difference was greater in the heavy heifers. Percent of heifers having reached puberty by the start of the breeding season and percent pregnant in the fall were not affected significantly by feeding an Ionophore. Note, however, that heavy heifers had about a 10% higher fall pregnancy rate than light heifers.

TABLE 1. EFFECT OF RUMENSIN® ON GROWTH AND REPRODUCTIVE TRAITS IN BEEF REPLACEMENT HEIFERS

Trait	Light heifers			Heavy heifers		
	High roughage	Rumensin® + 90% HR	Rumensin® + 100% HR	High roughage	Rumensin® + 90% HR	Rumensin® + 100% HR
ADG (lb.)	1.1	1.2	1.4	1.0	1.1	1.5
Body wt., June 1 (lb.)	677	683	716	711	716	807
Age at puberty (days)	378	370	373	383	369	369
% puberal, June 15	100	100	92	100	100	100
% pregnant in fall	86	83	78	83	96	96

MISCELLANEOUS DATA RELATED TO HEIFER DEVELOPMENT

There are a number of miscellaneous points to make relative to heifer development and its impact on herd fertility. The following is only a few of these comments.

Greer et al. (1980) found that longevity of animals in a range beef herd is not great (Table 1). The average age of cows culled was 5.72 years, and the average age of cows in the herd was 4.78 years. In addition, the replacement rate averaged 21.2%. It is well known that production of replacement heifers is expensive and this cost must be charged against the income from only three or four calves that these probabilities indicate she is likely to produce. The largest reason for culling was low reproductive performance.

Lesmeister et al. (1973) found that there are definite production potential differences in beef females that can be predicted based on the time conception-pregnancy occurs following the first breeding season for the replacement heifer. Heifers that calved early in their first calving season continued to calve early and wean heavier calves throughout their lifetime. Heifers that calved late in their first calving season continued to calve late and wean lighter calves throughout their lifetime. Heifers that fell into the late calving group had a more erratic reproductive performance than did the early calving group. The most common factor in the erratic production was calf production in alternate years. Repeatability estimates for calving group ranged from .092 to .105 which indicates only moderate improvement might be made by culling females that calve late in the normal calving season. But, this work indicates the importance of managing and breeding heifers so they will calve early in their first calving season and, thus, tend to maintain early calving throughout their productive lives.

The effect of early calving of heifers on their future reproductive performance and lbs of calf produced has been studied by Spitzer et al. (1975). Yearling heifers were assigned to a Control (C) or New Management (NM) group.

Breeding of the heifers started 20 days earlier than the mature cows and estrous synchronization was used in the NM group. In addition, 70% more heifers were exposed for breeding than were needed as replacements. Replacement heifers returning to the NM herd were selected on the basis of conception early in the breeding season. The duration of the breeding season was 45 and 90 days for the NM and C groups, respectively. Results are summarized in Table 2 and indicate more females exhibited estrus and became pregnant early in the breeding season in the NM group, which resulted in older and heavier calves at weaning.

Wiltbank (1970) suggested that initiating the breeding season for replacement heifers 20 days earlier than the cow herd would increase the pregnancy rate of the young female when rebred for the second calf. This hypothesis was based on data indicating young dams nursing their first calf had postpartum intervals to first estrus 15 to 25 days greater than noted in older dams. The practice of early breeding would then allow the heifer additional time to return to estrus and be rebred with the older cows. This practice is now common in many beef herds. However, heifers bred before the mature cows will calve early. Often, this is at a time when pastures are not available or are not producing sufficient nutrients to maintain weight or gain in the lactating dam. Provision to meet the nutrient requirements must be planned and provided. Short and Bellows (1971) determined the effects of weight gains on puberty and subsequent reproduction in heifers assigned to gain .50, .99, or .83 lbs daily during the 152-day wintering period following weaning (Table 3). Twenty percent of the heifers fed the low level failed to show estrus during the 60-day breeding season, and only 30% of the heifers from the low level feed conceived during the first 20-day period compared to 62 and 60% for heifers from the moderate and high groups.

These results do not mean, however, that excessive feeding is desirable. In addition to incurring unnecessary cost, Arnett et al. (1971) summarized data indicating overfeeding of heifers had a detrimental effect on fertility and milk production.

Table 1. Probabilities and Expected Herd Life

Cow age, years	Probability of entering at 2 and remaining @ age	Expected herd life, years
2	100	3.8
3	81	3.7
4	68	3.4
5	57	3.1
6	47	2.7
7	40	2.2
8	33	1.7
9	26	1.1
10	19	0.5

Table 2. Effect of Management System on Estrus, Pregnancy, and Weaning Weights

	Group			
	New Management		Control	
Item	Estrus, %	Pregnancy, %	Estrus, %	Pregnancy, %
Heifers (number):	(51)		(32)	
First 25-day breed season	98	68	63	41
First 45-day breed season	100	83	81	63
By 90-day breed season	...	...	94	78
Cows (number):	(195)		(199)	
First 25-day breed season	98	74	81	60
First 45-day breed season	100	87	93	78
By 90-day breed season	...	...	100	92
Calf weaning weight	444		411	

Table 3. Feed Effects on Puberty and Reproduction in Heifers

	Winter Gain Group		
Item	Low	Moderate	High
Number of heifers	30	29	30
Weight gains			
Winter	.59	.99	1.40
Summer	1.30	1.19	.90
Puberty age, days	433	411	388
Percentage bred and conceived:			
First 20-day bred season	30	62	60
Second 20-day breed season	10	21	20
Third 20-day breed season	10	3	7
Not bred	20	3	0
October pregnancy, %	50	86	87

GENERAL NUTRITION

DIETARY ENERGY

Many cattlemen believe reducing dietary energy during late pregnancy will decrease fetal size resulting in improved calving ease, whereas increasing energy will increase fetal size leading to a higher incidence of dystocia. Generally speaking, research shows that lowering the energy allowance will decrease birth weight but will not significantly reduce dystocia. At MARC (Meat Animal Research Center), Hereford and Angus 2-year-old heifers were fed three levels of energy (10.8, 13.7 or 17.0 lb TDN/head/day) for 90 days prior to calving. Increasing the level of dietary energy resulted in increased birth weight but not increased dystocia; in fact, the incidence of calving difficulty was lower in the medium and high energy groups than in the low energy group.

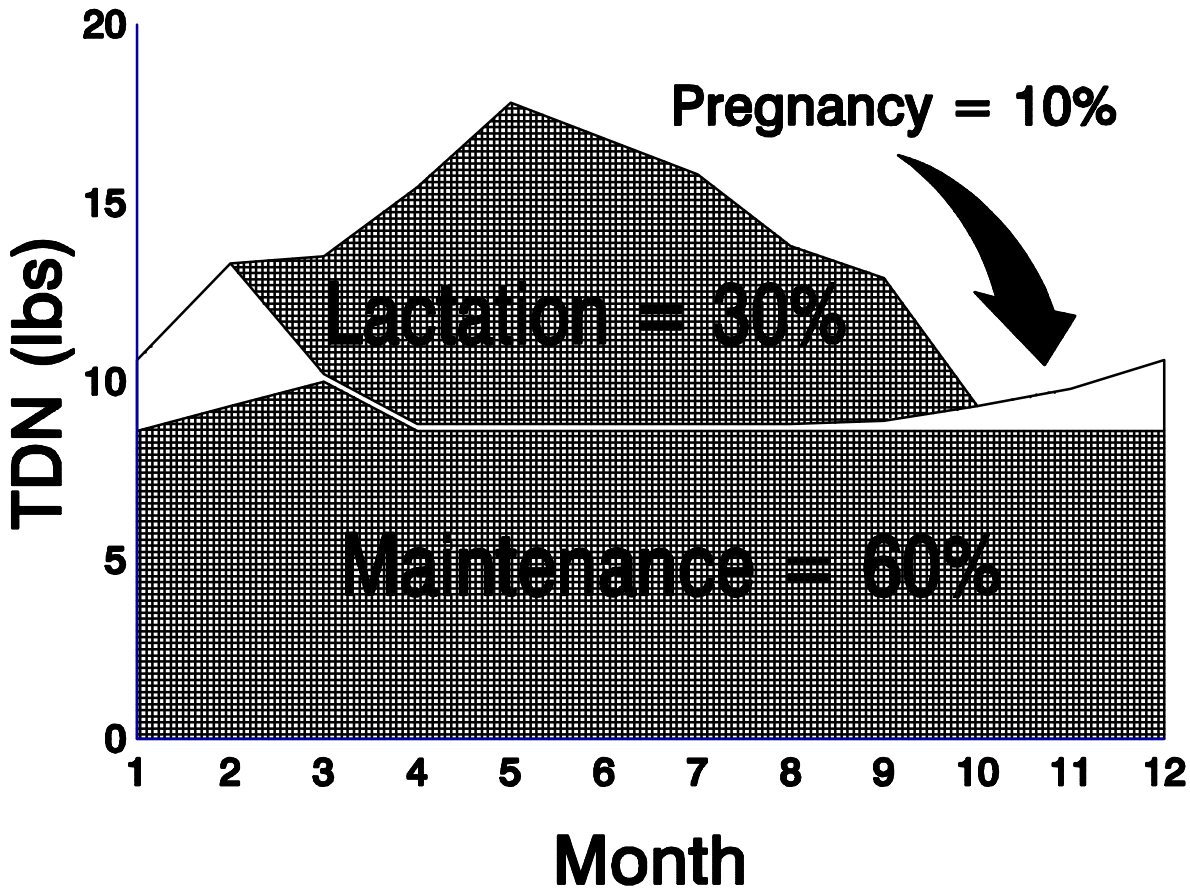
Inadequate nutrition of the young developing heifer can affect her subsequent calving performance. Miles City research showed that restricting the energy of weaned heifer calves during their first winter can have a carry-over effect, resulting in decreased precalving pelvic area and increased dystocia (46 percent vs. 36 percent) compared to adequately fed heifers. From weaning to first breeding as yearlings, heifers should be fed to weigh at least 65 percent of their potential mature cow weight. This translates to a range in average daily gain of approximately 1.25 lb to 1.75 lb for 200 days. Depending upon initial weight, frame size, body condition and environment, this means that daily TDN requirement will range from 8 lb to 13 lb per head.

When they calve as 2-year-olds, heifers should weigh 85 percent of their mature cow weight. This translates to an average daily gain of about 1 lb per day from breeding to calving. Adequate pasture conditions will support this level of performance. During the winter prior to calving, pregnant heifers require from 9 lb to 13 lb of TDN per day. The mature pregnant cow requires from 7.5 lb to 13 lb of TDN.

DIETARY PROTEIN

There is some concern in the cow-calf industry that high levels of protein during the last trimester of pregnancy may lead to a significant increase in birth weight and dystocia. At Miles City, crossbred 2-year-old pregnant heifers were fed diets containing either 86 percent (low) or 145 percent (high) of the NRC crude protein requirement for 82 days prior to calving. Heifers fed the low protein diet had significantly lighter calves at birth and less calving difficulty. Heifers on the high protein diet gained more weight, had higher condition scores at calving, maintained more body weight throughout the study and weaned significantly heavier calves. In a repeat study at Miles City, there were no differences in calf birth weight or calving difficulty. Research at other institutions has shown no consistent effect of protein level on dystocia. It would appear that precalving dietary protein levels should be near the NRC requirement. If it is extremely low, weight and condition of the cows and weight, vigor and post-natal growth rate of the calves may be reduced. If it is unduly high, it represents an economic waste. During the last trimester of pregnancy, crude protein requirement range from 8.2 to 9.8 percent for heifers and 7.6 to 8.2 percent for mature cows.

ANNUAL ENERGY INPUTS FOR A SPRING CALVING COW



NUTRITION OF THE MATURE BEEF COW

Nutritional needs of a mature beef cow vary depending on her production level and her phase of production. The cow's production phases can be divided into four periods: the dry period (middle third of gestation); the prepartum period (the last three months before calving); early lactation (first 3 months of lactation); and late lactation (last 4 to 7 months of lactation).

Estimates of nutritional requirements for the first three periods of production have been developed by the National Research Council's subcommittee for beef cattle nutrition and are included in Table 1. These levels are guidelines to be used in developing feeding levels for the cow herd. These values are estimates developed with research data from selected groups of cattle in confinement under favorable environmental conditions and may not factually reflect the needs of a grazing animal in adverse conditions. The values will need to be adjusted to fit individual environmental and management situations and type of animals.

Dry Period

The cow's nutrient requirements are the lowest during the dry period. Nutrients during this period are needed essentially for maintaining the body. Nutrients are also needed for grazing and other routine activities, including maintaining body temperature during extremely hot or cold temperatures. However, there is little need for nutrients for production. Requirements of energy and crude protein for this period are given in NRC requirements. The recommended levels generally do not include the extra nutrients needed for grazing activity or for cold weather. Under stressed situations, grazing costs may make up as much as 40 percent of the maintenance requirement.

Since nutrient requirements are low during the dry period, which coincides with the mid-third of gestation, from an economic standpoint this period should parallel the time when feed resources are least available. This would optimize the use of nutrients. This period is also the best time to replace weight on thin cows, since nutrients are not being drained off for fetal growth or lactation.

Prepartum Nutrition

The increase in the nutrient requirement during the prepartum period is due to the growth of the fetus. The conceptus (fetus, fetal membranes, and fetal fluids) attains only 25 percent of its final weight during the first 6 months of gestation. The remaining 75 percent is gained during the last third of gestation.

During this period, the fetus starts to place a detectable nutrient demand on the dam. The NRC recommends increasing the energy and protein for females 3 months before calving. Nutrient requirement for fetal maintenance and development increases at a rate proportional to the rate that the fetus grows and develops, however, and 40 percent of conceptus weight gain occurs in the 40 days before parturition. Demands for energy and protein will be higher at this time than before.

Several research trials have shown the importance of prepartum nutrition on reproductive performance of the female as well as the performance of the calf. In a Wyoming study, 60 first-calf heifers were fed either 5.7 or 8.8 pounds of total digestible nutrients (TDN)/head/day during the last 100 days of gestation (Table 1). Both groups received 14.4 pounds of TDN/head/day after calving. Heifers on the high level of energy gained 80 pounds of weight while the heifers on the low energy diet lost 13 pounds during the prepartum period.

A larger percent of heifers fed the high TDN ration prepartum showed estrus by 40 days postpartum--41 vs. 28 percent of heifers fed the low TDN ration. Calves born to the heifers receiving the high level of energy were 4 pounds heavier at birth. There was no difference in the percent of assisted births. A larger number of the calves from the heifers on the high energy diet were alive at birth. These calves also weighed more at weaning. The decrease in birth weight and increase in death loss were again observed when the study was repeated the following year. The lower birth weights had a negative effect on survival of the calf.

Heifers fed a low energy ration (7.5 pounds TDN) in a study at Miles City, Montana, maintained weight but lost condition during the 90-day prepartum feeding period (Bellows, R.A., and R.E. Short. 1978). Heifers receiving a ration containing 13.9 pounds TDN gained both weight and condition score during the period. Heifers fed the low energy diets had a 20-day longer postpartum interval and an 18 percent lower pregnancy rate. Birth weight of calves averaged 4 pounds less in the low-energy group, but no beneficial effects in terms of reduced calving difficulty were observed. In addition, the calves from the heifers fed the low energy ration weighed 11 pounds less at weaning.

Condition score at calving is a direct reflection of prepartum nutrition. Since the development of the fetus requires 100 to 150 pounds of weight gain during the last third of gestation, females on a restricted plan of nutrition may use body stores of energy and protein to support fetal growth. These females will lose condition but may or may not lose weight. They actually break down their bodies to supply the nutrients for growth of the conceptus. While the female is actually losing weight, her weight loss may be offset by a weight gain by the fetus, so the combined weight of the two may change little, if at all. Loss in body condition does indicate that the female has not received the nutrients needed to support the reproductive process.

In a Clemson University study, data from 355 cows indicated that cows calving at a condition score of 4 or less had a 12-day longer interval to first estrus and a 6-day longer interval until pregnancy than cows calving at condition scores of 5 or greater. A Colorado study evaluated the percentage of thin, moderate, and good condition cows in estrus 40, 60, and 80 days postpartum (Table 4). By 80 days postpartum, 98 percent of the cows in good body condition had been detected in estrus while only 62 percent of the cows in thin condition were cycling.

Early Lactation

The nutrient requirement of the mature beef cow is the highest during the early lactation period because of the nutritional needs for milk production and reproduction. To calve every 365 days, the female has to initiate cycling and rebreed within 82 days of calving. Ideally, calving would coincide with a time when there is high feed availability. The requirements NRC listed for a lactating cow are generally felt not to be high enough to prevent weight loss after calving. The condition that a cow is in at the time of calving as well as post-calving nutrition will greatly affect the reproductive performance of the cow.

The period from calving until the cow is bred is the most critical time for the beef cow. During this period, the cow must meet the nutrient requirements for maintaining her body, for milk production, and for reproduction. In many cases, calving takes place in late winter to early spring, when weather conditions are less than ideal. Environmental stress further increases the cow's energy requirement. Shortage of nutrients during this period results in a decrease in the reproductive performance of the cow herd.

Cow condition at calving appears to have an influence on the nutritional requirement of the cow postpartum. Cows with sufficient body fat at parturition appear to be able to use a portion of this energy for lactation without having a negative effect on reproductive performance. The Clemson University study (Table 3) found little difference in the number of cows pregnant 40 days into the breeding season when all cows were fed a high level of energy postpartum. However, only 68 percent of cows that calved in a condition score of 4 or less and were fed a low level of energy postpartum had bred by 60 days into the calving season, compared to 85 percent of those that calved with a condition score of 5 or greater and were fed the same level of energy post calving.

The Clemson study and a Purdue study (Table 4) indicate reproductive performance of cows calving in thin condition can be improved by increased levels of energy. In the Purdue study, cows were given either 7.4 or 10.6 Mcal of NE_m per day starting on the 190th day of gestation. At calving, one half of each group was fed either 10.1 or 16.9 Mcal of NE_m per day. The postpartum interval was shortest for cows that received the low level of energy during gestation and the high level of energy after calving. Only 33 percent of cows fed low energy during both pre- and postpartum were in estrus by 60 days, compared to 56 percent of the cows fed low energy prepartum and high energy postpartum.

Late Lactation

This period corresponds to the last 3 to 4 months of lactation. Nutritional needs during this period are for maintenance and lactation and are closely tied to the individual's production capability. Requirements for average to low milk-producing cows are lower during this period, because they are producing less milk. On the other hand, high-producing cows are still producing enough milk to require additional nutrients during most of this period. Young cows (second and third calf) that haven't reached mature weight require nutrients for growth. This period and the dry period are the time that these types of cows usually complete their growth.

Depending on the time of calving, this period usually corresponds to grazing. Usually, the nutrients in the forage will exceed the nutrient demands, and the cow will replace weight lost during early lactation. During drought or other feed shortages, early weaning is an alternative during this time. This will remove the nutritional needs for lactation. The animal should be bred by this time and early weaning will prematurely move them into the dry period, where nutrient demand is lowest.

Table 1. Effect of prepartum energy level on performance of heifers and their calves.

	Prepartum TDN level	
	5.7 lb	8.8 lb
Weight change, lb	-13	80
Interval to 1st estrus, days	52	51
Exhibiting estrus at 40 days, %	26	41
Birth weight, lb	63	67
Assisted births, %	28	27
Calves alive at birth, %	97	90
Weaning weight, lb	325	354

Corah, L.R. et. al. 1975.

Table 2. Percentage of cows exhibiting estrus as related to condition score at calving.

	Percent exhibiting estrus postpartum		
Condition	40 days	60 days	80 days
Thin	19	46	62
Moderate	21	61	88
Good	31	91	98

Whitman, R.W. 1975.

Table 3. Effect of condition score at calving on rebreeding.

	Condition score[1]	
	<4	>5
Feeding level	% pregnant after day 40 of the breeding season	
	(%)	(%)
High	83	75
Moderate	69	81
Low	48	73

[1] Scored on a 1 to 9 scale (1=extremely thin; 9=extremely fat).
Richards, M.W. et. al. 1986.

Table 4. Effects of increasing flushing on reproductive performance.

	Pre- and postpartum energy levels			
	Low/Low	Low/High	High/Low	High/High
Postpartum interval, day	73	54	66	68
In estrus by 60 days, %	33	56	53	54

Houghton, P.L. et. al. 1990.

CONSIDERATION FOR UREA SUPPLEMENTS FOR COW HERDS

Protein blocks or supplements with Non Protein Supplements (NPN) are effective but do not stimulate intake and digestibility of low quality roughage as effectively as natural protein supplements. Performance will be less in animals that are fed low quality roughage and high levels of NPN supplements.

NPN is best utilized where it is less that 3% of the total supplement composition or a crude protein equivalent of 8.4% (3 x 2.8 (280% CP in Urea.))

Figure NPN utilization from supplements as follows:

Ranch FORAGE TYPE	% UTILIZATION of NPN	
	DRY SUPPLEMENT	LIQUID OR BLOCK
Crop Residues Poor quality hay Weathered Grass	0 - 25	50
Med quality hay silages summer pasture	40 - 60	80
High Energy Diets	90-100	90 - 100

Example: from the feed tag to the right calculate the percent protein from NPN:
17 / 2.81 = 6.05%

twice the 3 % recommended

MJ FEED BLOCK

FEED TAG

CP Not less than 27%
(This includes not more than 17% equivalent C P from NPN not less than 10% from natural proteins)

_____

etc....

MYTH - REDUCED FEED IN LATE PREGNANCY REDUCES DYSTOCIA

Many ranchers have tried to decrease birth weight by reducing either energy or protein in the late stages of pregnancy. Price and Wiltbank (1978a) and Bellows (1984) reviewed literature describing effects of nutrition on dystocia. They concluded that gestation feed level of the dam can affect birth weight. However, the effect on dystocia is not consistent and cannot be considered predictable. The exceptions to these conclusions are in instances of very low or very high feed levels.

Calving patterns and behavior are affected in these animals, seemingly, because dams and calves on very low levels of feed are weak and less active during and after calving. High levels of feed result in a fat-filled birth canal, which effectively reduces the size of the opening with the same effect as a small pelvic area. The effects of gestation feed level are shown in Table 1.

In addition to the effects shown in the table, there was a trend for more dystocia to occur in dams on low feed levels, and low feed levels increased the incidence of scours and depressed calf survival at weaning. Another dramatic effect of low gestation feed levels is the depression of postpartum reproduction of the dam with both estrus and pregnancy rates being affected.

One must conclude that even though gestation feed levels can alter birth weights, low feed levels are not recommended because: (1) a lack of significant and predictable effects on incidence of dystocia; (2) the consistent depressing effects on calf survival and subsequent reproduction in the dam. Likewise, very high feed levels must be avoided because (1) they result in increased calving problems because fat deposits in the birth canal reduce the size of calf that can be accommodated, and (2) excess feed levels are an unnecessary expense to the livestock operation.

Some studies have implicated dietary protein level during gestation as having effects on incidence and severity of dystocia. The literature is not consistent in this regard. Three recent studies are summarized in Table 2. The 1978 Montana work showed an effect, but this was not confirmed by additional work (Anthony *et al*., 1986 or by Bolze and Corah, 1988). The only differences between the two studies at Miles City were higher body condition scores in the pregnant dams and higher environmental temperatures in the study reported by Anthony (1986). What effects these differences caused are unknown. Inconsistent birth weight effects of maternal dietary protein during gestation have also been reported by Elmers *et al*. (1983). Thus, the conclusion reached is that the effects of gestation dietary protein are not consistent and the effects are not predictable.

Table 1. Effects of Gestation Feed Level on Birth Weight and Dystocia

Data Source	Precalve Feed Level	Calf Birth Wt.	Dystocia (%)
Laster, 1974	Low, 4.9 kg TDN	57.2	26
(90 d prepartum)	Med., 6.2 kg TDN	61.6	17
	High, 7.7 kg TDN	63.8	18
Corah *et al*., 1975			
Heifers	Low, 11.4 Mcal ME	61.6	28
(100 d prepartum)	High, 17.6 Mcal ME	66.0	27
Cows	Low, 8.4 Mcal DE	59.4	same
(100 or 30 d prepartum)	High, 19.4 Mcal DE	77.0	same
Dunn *et al*., 1969	Low, 7.3 Mcal ME	63.8	16
(140 d prepartum)	High, 13.3 Mcal ME	70.4	33
Wiltbank & Remmenga, 1982	Low, 7.3 Mcal ME	66.0	34
(115 d prepartum)	High, 13.3 Mcal ME	72.6	36
Kroker & Cummins, 1979	Low, lost .5 kg/d	52.8	25
(90 d prepartum)	Med., maintain wt.	63.8	5
	High, gain .75 kg/d	72.6	15
Bellows & Short, 1978	Low, 3.3 kg TDN	61.6	50
(90 d prepartum)	High 6.3 kg TDN	66.0	47
Bellows *et al*., 1982	Low, 3.6 kg TDN	79.2	64
	High, 6.8 kg TDN	79.2	58

Table 2. Effect of Gestation Protein Diet on Birth Weight and Dystocia

	Protein content	
	Low (80% NRC)	High (145% NRC)
Bellows *et al*. (1978)		
Calf birth weight	72.6	83.6
CD score	1.6	2.2
% assisted	42	58
Anthony *et al.* (1986		
Calf birth weight (kg)	77	79.2
CD score	1.6	1.6
% assisted	36	36
Bolze & Corah (1988)		
Calf birth weight (kg)	90.2	90.2
CD score	2.2	1.7
% assisted	48	37

EFFECT OF P.M. FEEDING ON DAYTIME CALVING

Calving season is the most labor-intensive time for cow-calf producers. It often involves long days and sleepless nights. University studies and observations by ranchers have shown that by changing time of feeding there can be an increase in the percent of calves born during daylight hours. Feeding late in the day, at 5 p.m. or later versus before noon, resulted in more calves born during daylight hours.

Gus Konefal, a purebred breeder from Manitoba, Canada, was one of the first individuals to investigate the possibility of changing calving time by manipulating feeding time. He established two different feeding programs for his cows. One group was fed at 11 a.m. to noon and at 9 to 10 p.m. The second group was fed at 8 and 9 a.m. and again at 3 to 4 p.m. He continued these feeding regimes from about 1 month prior to the start of calving. He recorded the time of day when each calf was born. The results are shown in Table 1. Cows fed later in the day had 80% of their calves born during the daylight hours compared with 38% for those fed earlier in the day.

Iowa State University conducted a survey of 15 cattle producers that fed either early in the day (before noon) or late in the day (5 to 10 PM). Cows fed late had 85% of their calves born during the day while only 15% were born at night (Table 1). Only 49.8% of the cows in the morning feed group calved during daylight hours.

In a three-year study conducted at the Livestock and Range Research Station (LARRS) at Miles City, Montana, the effect of time of feeding on calving time was likewise recorded (Table 1). Approximately 67% of the cows fed early (7 to 9 AM), calved from 6 AM to 10 PM, and 33% calved at night. In the cows fed late 78.1% calved during the day and early evening hours and 22.8% calved at night. In the Konefal study and Iowa survey, feeding occurred as late as 9 to 10 PM, whereas cows in the LARRS study were mostly fed at 5 to 6 PM in the late feeding group. This 3 to 4 hour difference may account for more cows calving during the daylight hours in the earlier studies.

There are several advantages to calving during the day:

- »Easier to observe the herd
- »Assist with calving
- »Fewer cows struggling through the night to calve on their own
- »Fewer calves are lost
- »Newborn calves get sunshine to warm them
- »Possibility of hypothermia is reduced.

A drawback to getting daylight calves is you will probably be feeding hay in the dark. Feeding cows in the evening has shown to increase the number of cows calving during daylight hours; however, this has not eliminated nighttime calving. Therefore, beef cattle producers still need to observe their cows during the late night and early morning hours.

Table 1. Influence of Feeding Time on Calving Time

Time of Feeding	No. of Calvings	Calving Time	
		Daylight	Nighttime
GUS KONEFAL			
Fed 8 to 9 AM & 3 to 4 PM	39	38%	62%
Fed 11 AM to Noon & 9 to 10 PM	44	80%	20%
IOWA STATE			
Before Noon	695	49.8%	50.2%
5 to 10 PM	1331	85.1%	14.9%
LAARS			
Early-fed (7 - 9 AM)	334	66.9%	33.3%
Late-fed (5 - 6 PM)	347	78.1%	22.8%

TEMPERATURE

In monitoring the nutritional needs of cattle, keeping an eye on the weather is important. This is not only during the critical winter months when severe cold is a problem, but also when wet, damp, spring weather affects the nutritional requirements of the cattle.

For cows carrying a winter hair coat, the critical winter temperature is around 30° F. When the temperature dips below that (this is not the actual temperature but the wind chill index) there is an increase in the energy requirement of that animal. For each one degree drop in Fahrenheit, there is approximately a 1% increase in the TDN or energy required.

For sake of a simple example, Table 1 illustrates the increase in TDN and the amount of hay or grain it would take to maintain weight on the cows.

Another critical period that many cow-calf producers overlook is the effect of weather in the spring on the nutrient requirements of the cows. For the past couple of years, we have had wet, cold, spring weather. Cows that have come through the winter, particularly those that have lost weight and are in thin condition, are very susceptible to environmental effects of this weather. When cattle even with a winter hair coat are wet, the critical winter temperature increases to around 50°F. Thus, during wet spring weather when the temperature is around 30-35°F, there is often a weight loss at a very critical period of time in that beef cattle year. In most cases, these are cows that are immediately pre- or post-calving and a weight loss at this time can have a very detrimental effect on not only milk production and calf performance, but also in how soon she will cycle and rebreed.

Table 1. An Example of Diet Composition and Energy Supplied

Temperature	% Increase TDN	Amount of Extra Hay Needed	Amount of Extra Grain Needed
50°	0	0	0
30°	0	0	0
10°	20%	3½-4 lbs/cow	2-2½ lbs/cow
-10°	40%	7-8 lbs/cow	4-5 lbs/cow

DATA SHOWING THE NEGATIVES EFFECT OF OBESITY IN BEEF FEMALES

	Degree of fatness	
	Normal	Obese
Body wt., lb.		
Initial	462	458
At first mating	686	979
At first calving	822	1305
At second calving	1046	1388
At third calving	1096	1369
Cows surviving after 3 calvings, %	100	58
Services/conception	1.43	1.70
Cows requiring calving assistance, %	16	100
Birth wt. of calves, lb.	64	65
Calves lost at calving, %	11	22
Daily milk production, lb.	11.6	9.9
Weaning wt. of calves, %	373	339

BODY CONDITION SCORES

BODY CONDITION SCORING (BCS) SYSTEM FOR BEEF CATTLE

GROUP	BCS	DESCRIPTION
	1	**Emaciated** - Cow is extremely emaciated with no palpable fat detectable over spinous processes (back bone), transverse processes (edge of loin), edge of hip bones or ribs. Tailhead and ribs project quite prominently.
Thin Condition	2	**Poor** - Cow still appears somewhat emaciated but tailhead and ribs are less prominent. Individual spinous processes are still rather sharp to the touch but some tissue cover exists along the spine.
	3	**Thin** - Ribs are still individually identifiable but not quite as sharp to the touch. There is obvious palpable fat along spine and over tailhead with some tissue cover over dorsal portion of ribs.
Borderline Condition	4	**Borderline** - Individual ribs are no longer visually obvious. The spinous processes can be identified individually on palpation but feel rounded rather than sharp, some fat covers ribs, transverse processes and hip bones.
	5	**Moderate** - Cow has good overall appearance. Upon palpation, fat cover over ribs feels spongy and areas on either side of tailhead now have palpable fat cover.
Optimum Moderate Condition	6	**High Moderate** - Firm pressure now needs to be applied to feel spinous processes. A high degree of fat is palpable over ribs and around tailhead.
	7	**Good** - Cow appears fleshy and obviously carries considerable fat. Very spongy fat cover over ribs and around tailhead. "Rounds" or "pones" becoming obvious. Some fat around vulva and in crotch.
	8	**Fat** - Cow very fleshy and over-conditioned. Spinous processes almost impossible to palpate. Cow has large fat deposits over ribs, around tailhead and below vulva. "Rounds" or "pones" are obvious.
Fat Condition	9	**Extremely Fat** - Cow obviously extremely wasty and patchy and looks blocky. Tailhead and hips buried in fatty tissue and "rounds" or "pones" of fat are protruding. Bone structure no longer visible and barely palpable. Animal's mobility may even be impaired by large fatty deposits.

==========

RICHARDS ET AL., Journal of Animal Science, 62:300

There are several systems for Body Condition Scoring (BCS) available but the accompanying chart is probably the most universally accepted system. There are numerous studies that illustrate the value of the BCS and relationship with breeding performance. Cows in moderate to good condition cycle sooner after calving than do thin ones. Fat cows are a financial extravagance as well as having reduced reproductivity. Most studies show a 20% or higher reduction in conception for thin cows compared to cows with adequate condition.

Cow condition at calving effects her vigor as well as calf vigor and disease susceptibility. The BCS can indicate what management (nutritional) programs should be followed for optimum efficiency of production. It does take time to change cow body weight. BCS changes take even longer.

In a recent study at Oklahoma (J. Animal Science 1989. 67:1520-1526) 22 cycling Hereford cows in moderate BCS were randomly assigned to maintenance (M) or restricted (R) diets. The cows were in feedlots where intake could be controlled. The M cows were fed to maintain their initial body weight. The R cows were fed to lose 1% of their body weights weekly until cycling stopped. Weights were significantly reduced ($P<.01$) by 5 weeks and BCS by 15 weeks. Cycling activity stopped after week 20 and 91% were not cycling after week 26 (six months). The R cows had lost 24% of their body weight and dropped to a 3.5 BCS. The cows resumed cycling after nutrient intake was increased for 9 weeks. These cows gained back 1/2 of their lost body weight and increased BCS by 1 point to 4.6.

The important points are that BCS changes take longer to effect than weight changes. Significant time is required to bring animals back from a nutritional deficiency. It is probably better to manage cows so that we maintain condition rather than be forced to change weight on BCS because of periods of deficiencies. In years where grass supplies are short it might be better to wean calves and feed them separately rather than feeding the cow after both cow and calf have lost weight (BCS).

In general, for each condition score change, the cow must gain between 70 and 100 lbs. This is cow gain not fetal calf gain (another 100 lbs). Figure 1 shows the relationship between cow body condition score and the calving interval. Females with a pre-calving BCS of less than four tend to have production cycles greater than one year. For example, cows with a body condition score of three would be expected to have a calving interval of approximately 400 days, while cows with a body condition score of six at calving would have a calving interval of approximately 360 days.

Although a thin cow will generally give birth to a healthy calf, it is the postpartum interval that causes the beef producer the potential loss in profitability. Figure 2 illustrates results from South Dakota, showing that the percentage of thin cows cycling during June was significantly lower than for cows in a more moderate body condition. During July, 55 percent of the BCS-4 cows were still not cycling compared with over 90 percent of the cows in a more moderate body condition. Thin cows may cause a longer breeding season, more open cows in the fall and lighter calves to sell next year because these calves would be born late in the calving season.

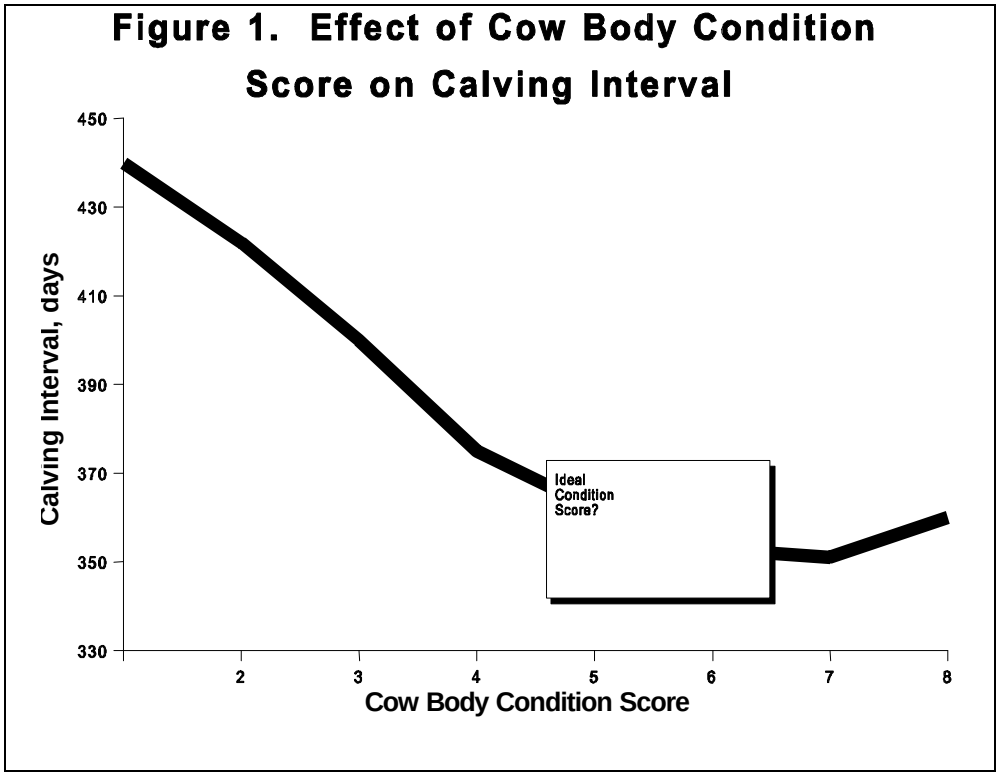


Figure 1. Effect of Cow Body Condition Score on Calving Interval
Calving Interval, days
450
430
410
390
370
350
330
2
3
4
5
6
7
8
Cow Body Condition Score
Ideal Condition Score?

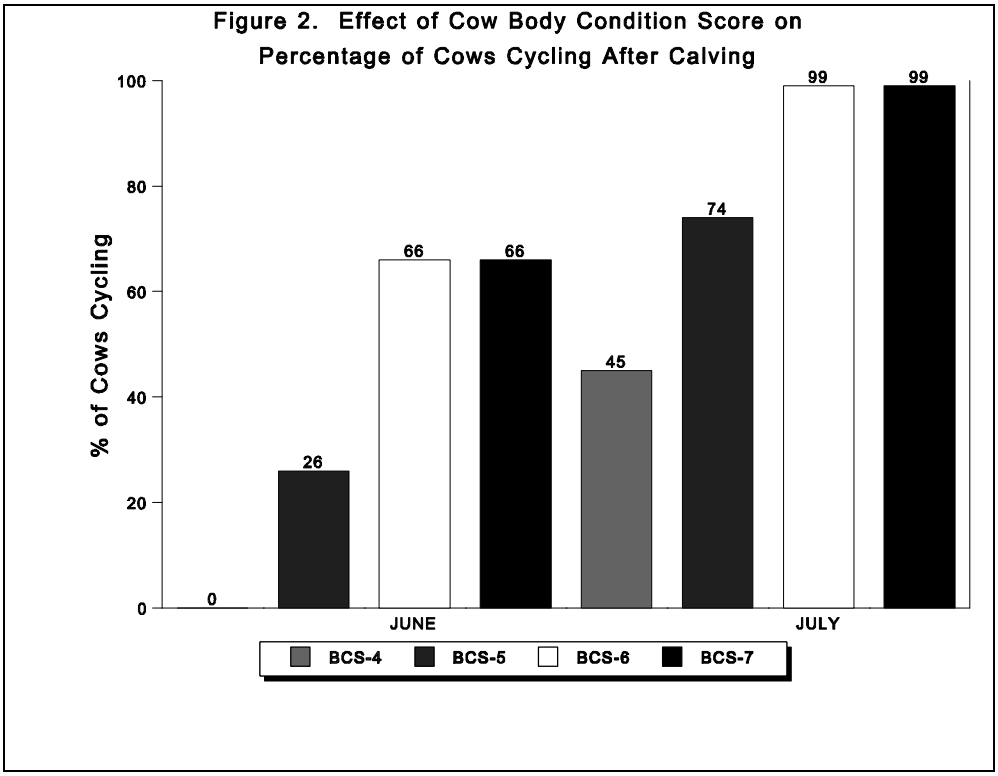


Figure 2. Effect of Cow Body Condition Score on Percentage of Cows Cycling After Calving
% of Cows Cycling
100
80
60
40
20
0
0
26
66
66
45
74
99
99
JUNE
JULY
BCS-4
BCS-5
BCS-6
BCS-7

MALE INFLUENCES ON DYSTOCIA

GENETIC MANAGEMENT

From a genetic standpoint, there are several traits that may be considered in a selection program to keep dystocia under control:
(1) individual birth weight;
(2) Expected Progeny Difference;
(3) the sire's EPD for direct (his own) calving ease on first-calf heifers;
(4) the sire's EPD for maternal (his daughters') calving ease on first calves;
(5) the sire's pelvic area;
(6) the pelvic area of potential replacement heifers.

BIRTH WEIGHT AND EPDs FOR BIRTH WEIGHT

Although individual birth weights can be used as a guide in selecting your unproven bulls, EPDs are better predictors because they combine data from several sources -- the individual, his ancestors and his half-sibs. As a bull becomes older and sires a significant number of progeny, the accuracy of his EPD's improve markedly. By then, his individual birth weight is of little or no significance. A number of studies have shown strong correlations between EPDs of sires and actual birth weights of their progeny, especially among sires with high accuracy (over .80).

In order to minimize dystocia in first-calf heifers, ideally they should be mated to bulls with breed average or lower birth weight EPDs. For maximum precision, a young unproven bull's EPD should be compared against the breed average for bulls in his own birth year group. Breed average information is contained in many of the sire summaries published by breed associations.

As noted before and shown in Table 1 (CSU data), birth weight is a moderately heritable trait and is positively genetically correlated with other growth traits. Therefore, many bulls having average to below average birth weight EPDs will be average or lower for other growth traits. However, there are exceptions, and a search of sire summary lists can be used to identify bulls that have low birth EPDs and high weaning and yearling EPDs.

A calf's birth weight is influenced by both the sire's and the dam's genotype for birth weight. Therefore, selecting heifers from sires with low birth weight EPDs can stack the herd's pedigrees in favor of calving ease.

EPDs FOR CALVING EASE

Direct Calving Ease: Except for Simmentals, the EPD is reported as a ratio; sires with higher ratios will calve easier when mated to first-calf heifers. In general, EPDs for direct calving ease are closely related to EPDs for birth weight. All breed associations publish EPDs for birth weight, but only three associations report calving ease EPDs.

Maternal Calving Ease: This trait is reported and interpreted in a manner similar to direct calving ease. This EPD predicts how easily a sire's daughters will calve, not how easily the sire himself will calve.

Heritability estimates of calving ease have been lower than those reported for birth weight. This suggests that genetic progress made by selecting directly on calving ease EPDs would be slower. An exception would be the Simmental breed in which calving ease EPDs have been shown to be a more accurate indicator of dystocia than birth weight EPDs. This is because Simmental calving ease EPDs incorporate birth weight as well as a score for calving ease. For long-term improvement in the herd, using sires with high maternal calving ease EPDs and retaining their daughters should be beneficial.

SELECTING NATURAL SERVICE BULLS

The producer who is not in a position to artificially inseminate first-calf heifers does not normally have the option of using highly proven sires with high accuracy EPDs for birth weight and/or calving ease. An alternative is to purchase an older bull, known for his calving ease, from another producer in the area.

Transmission of disease is a potential risk when this is done. A more realistic option is to purchase an unproven bull that has a low birth weight EPD, a large pelvic area and a low individual birth weight (adjusted for age of dam). If birth weight EPDs are not available, try to look for sons of highly proven calving ease sires. Even better, look for young bulls whose sire and maternal grandsire are both highly proven calving ease sires. If no information is available except for an individual birth weight, consider the age of the dam when the bull was dropped because younger cows give birth to lighter calves. Ideally, birth weights should be adjusted to a 5-to-year-old dam equivalent by adding the following adjustments: 2-yr.-olds, 8 lb; 3-yr.-olds, 5 lb; 4-yr.-olds, 2 lb; 11-yr.olds and over 3 lb. These are standard adjustments published by the Beef Improvement Federation; some breeds have their own adjustments. However, relying solely on individual birth weight is risky business. A low birth weight bull whose sire may have unknowingly been a high birth weight sire is not likely to be a good candidate for use on virgin heifers.

Table 1. Heritabilities of growth traits and their genetic correlations with birth weight

Trait	Heritability	Genetic correlation with birth weight
Birth Weight	.41	--
Weaning Weight	.32	.36
Yearling Weight	.43	.29
18-Month Weight	.61	.69

SELECTING SIRES

Expected Progeny Differences (EPDs) have become an increasingly common part of the language of beef cattle selection in recent years. Many producers either have not had an opportunity to learn about EPDs, or are confused by what they have read and heard. The purpose of this paper is to describe EPDs and explain how to use them effectively in your breeding program.

Before discussing the ins and outs of EPDs, I think it's important to stop and recognize that genetics is only one aspect of a complete ranch management program. It's easy to get caught up in striving for genetic change without stopping to consider if we are really making genetic improvement. Other aspects of management include but are not limited to nutrition, herd health, and economic analysis. I want to stress that few (if any) of these factors operate independently of the others. This is especially true of genetics.

One interesting side of beef production, especially in the West, is the wide diversity of environments. Cows graze pastures varying from sparse desert ranges to lush mountain meadows - often on the same ranch in the same year. This makes it hard to give genetic recommendations without knowing something about the specific production environment. Nonetheless, I think we can talk about common principles that apply to most situations.

One approach I'd like to suggest is to emphasize the resource management aspect of ranching. By this I don't just mean natural resources, although that is an important consideration. You also manage several other kinds of resources including human and financial. Think of your livestock as a genetic resource. Their job is to turn your other resources into something you can sell - a calf. For some major production traits, the genetic merit of the parents influences the value of this calf. As a manager, your job is to match these genetic resources to the rest of your resources.

With that said, an EPD is simply a tool to predict what an animal can contribute genetically for a specific trait. It comes with a certain set of rules on how to use it and how not to use it. The rest of this paper will look at what information is available, and show some examples of practical applications.

EPDs - What are They?

The real goal in evaluating breeding stock is to decide which replacements will make the best parents. In the strictest sense, we measure the value of a parent by the average value of its progeny. This is exactly what the Expected Progeny Difference (EPD) does. We want to predict how much we expect the progeny of one animal to differ from the progeny of another animal. This difference is expressed in the units of measure we normally use with the trait.

The EPDs give us a numerical value for each animal. We then use these numbers to make a direct comparison between animals. For example, consider two sires with EPDs for yearling weight of +20 lb. and +5 lb. If we subtract the yearling EPD of sire B from that of sire A we get a difference of fifteen lbs.

+20	Yearling EPD - Sire A
+5	Yearling EPD - Sire B
+15	Expected Difference

We would expect the calves from sire A to average fifteen pounds heavier as yearlings than the calves from sire B. The EPDs are listed in pounds but we can't say what the yearling weights will be. Actual performance is heavily influenced by individual ranch management. Although we don't know what the calves will weigh, having a prediction of the difference between the two sire groups gives us the information to make a selection decision. Comparing larger groups of animals is a matter of ranking the EPDs among all the animals in the group and making comparisons among any animals in the list.

This is a good place to talk about what animals we can legitimately put in the list to compare. You should only directly compare EPDs among animals of the same breed. Each breed association produces its own genetic evaluation using just its own data. There is no direct connection between the data used in the analyses for the various breeds. This gives us no means of directly comparing an EPD from one breed to an EPD from another breed. It would technically be possible if those connections existed. It just hasn't been done yet.

Accuracy

Expected progeny differences are calculated based on varying amounts of data on different animals. Animals with the most information will be predicted more accurately. Dams, young sires and non-parents will be evaluated less accurately simply because we have less information about their true genetic value. As we accumulate more information on an animal, we become more confident that the data reflects their genetic potential. The main factor that increases accuracy over time is to have data on more progeny. Other contributors are the number of daughters the sire has in production and the number of herds he is used in. A sire with ten calves in each of ten herds will be ranked more accurately than another sire with 100 calves in one herd.

Breed associations report accuracy two ways. The value that is usually reported along with each EPD estimate is a number which ranges from 0.0 to 1.0. Numbers closer to 1.0 suggest a higher level of confidence in the estimate.

These accuracy values can be used to express the reliability of the EPD by computing the standard error of the prediction. For a given accuracy, this measures the potential error associated with that EPD. This is shown graphically in Figure 1 for Limousin weaning EPD. We expect the 'true' EPD to lie within the plus or minus range of the possible change value about 67% of the time. As the accuracy increases toward 1.0, potential error decreases and we are more confident that the 'true' EPD falls closer to our current estimate.

On average about one third of the animals may have 'true' EPDs outside the possible change limits. However, most animals will be grouped toward the center of the range. Each trait will have its own range of possible change for the different levels of accuracy. This range is expressed in the units of the trait and is published in the introduction of the sire summary.

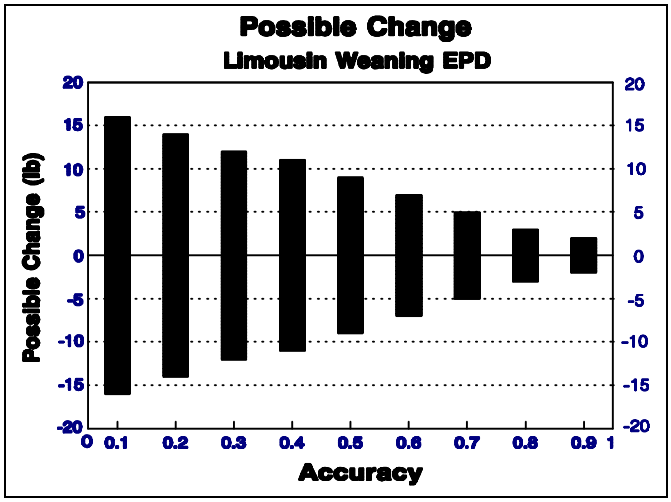


Figure 1. Possible change values.

What role should accuracy play in making selection decisions? This question typically comes up when comparing an older, high accuracy sire to a younger sire with fewer progeny (and lower accuracy). Although an accuracy closer to zero suggests the EPD has a lower level of reliability, selection decisions should still be based primarily on the EPD itself. If a bull meets your standards he should be used. However, there is more risk associated with using lower accuracy sires. You might want to limit this risk, especially in an AI program, by controlling the number of cows bred to a particular sire.

You can also manage the risk of lower accuracy EPDs by selecting groups of young bulls using a consistent standard. The accuracy of the average EPD of a group of bulls is higher than that of the individual bulls.

What Traits are Available?

The traits evaluated for EPDs include the typical weight-based performance traits such as birth weight, weaning weight, milk and yearling weight.

Weaning weight in beef cattle is influenced by the milk production of the calf's dam plus the inherent ability of the calf to grow. In Figure 2, we see that the Milk EPD of the maternal grandsire of the calf is an expression of the extra pounds of calf weaning weight due to the genes for milk passed from the maternal grandsire to the dam. EPDs generally predict the performance of the animal's progeny. In this case, the

Milk EPD for the maternal grandsire predicts the performance of his daughters when kept as replacements.

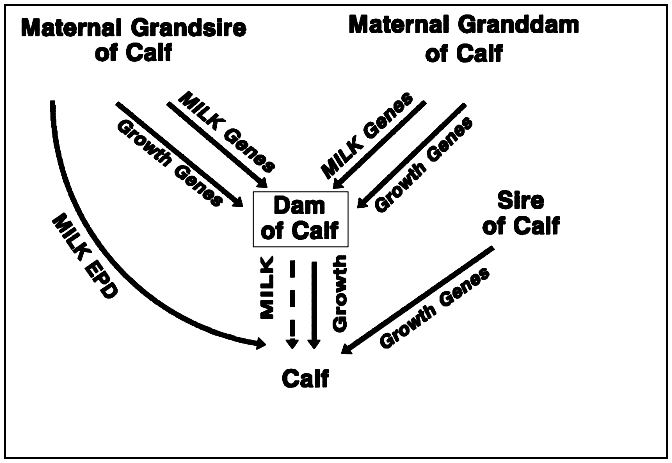


Figure 2. Maternal influences on weaning weight.

Weaning weight will have three EPDs associated with it. The Weaning EPD represents the genes for growth passed from the parent to the calf. The Milk EPD shows the genes for milk that will be expressed if the animal's daughters are kept for herd replacements. We then combine these two values to get an estimate of Total Maternal EPD. This is the total milk and growth contributed by an animal's daughters to their progeny. The Total Maternal EPD is computed as: Total Maternal = ½ Weaning EPD + Milk EPD.

You may also find EPDs for a number of other traits including calving ease, gestation length, scrotal circumference, and hip height. With the move toward value-based marketing, several breeds have or are developing carcass trait EPDs. Mature size EPDs are also under development and should be a valuable tool in the search for efficiency. These EPDs are all measured in the units we normally use for that trait and are used as explained above to compare animals for genetic merit.

Multiple Traits and the Real World

One of the real lessons of the cattle business is that we have to be concerned with production efficiency. I think our grandfathers probably knew this, but it seems like that message got overlooked somewhere in the last twenty or thirty years. In most cases this means some kind of multi-trait selection. An initial criticism of genetic evaluation programs was that they encouraged too much emphasis on single-trait selection for growth and mature size. The good news is that as the EPD programs have matured we now have a powerful set of tools for multiple trait selection.

We have predictions of individual genetic merit for a whole range of traits. More importantly, we also have detailed information on the positive and negative relationships between these traits. Birth weight and yearling weight are positively related. Increased mature size is related to increased weight and increased age at puberty. Milk production tends to be negatively related to growth rate.

Do these antagonistic relationships hold true for every animal? Not necessarily. Researchers at the University of Georgia demonstrated this in a herd of purebred Angus cows. Bulls were selected from the top 1% of all Angus sires for yearling weight EPD. Out of this group of high growth bulls, we then selected high and low birth weight EPD bulls. The birth weight EPDs differed by 6.6 pounds between the two groups. After breeding these bulls to the Angus cows in the Georgia herd, the calves in the low birth weight sire group averaged 8.2 pounds less at birth.

High growth animals do tend to sire calves that are heavier at birth. Other genetic correlations also tend to be true across the population. The exciting change is that now you can accurately identify animals that run contrary to the general trend. The message of this study is that EPDs are an effective tool for multiple trait selection even in the face of antagonistic relationships.

Interactions and the Environment

Producers are commonly told to match their cows to their environment. This usually refers to mature size and milk production. We recognize that increased growth and milk production will increase weaning weights. You have to weigh these possible benefits against the higher maintenance costs and the increased risk that the cow won't rebreed under limited nutrition. I don't have a silver bullet to solve this age-old problem because there are just too many variables of cattle and forage and management. Even with what we know about matching different biological types of cows to the environment, you will often have to rely on your personal experience and judgement.

Without knowing the details of each individual ranch, I can't tell you whether you need more milk or less, bigger cows or smaller ones. A cow that will work well on lush irrigated pasture may not work at all out on the desert. Once you decide what kind of animal you need, we can outline some general strategies for using genetics to help you meet your production goals.

Selection Strategies

Matching genetics to the environment hinges on being able to accurately identify breeding stock that meets your needs. Expected progeny differences can help you do that. But first you have to decide what those needs are. Make your breeding system and performance goals compatible with your environment and overall ranch management. For a crossbreeding program, first choose the breeds with general qualities that make them suited to your program. Then use EPDs to select individuals within those breeds. Remember, there may be as much variation within a breed as between different breeds.

A commercial breeder buying natural service sires will typically be looking at young, unproven bulls. Although the EPD accuracy will be lower for these bulls than for proven AI sires, it is still our best estimate of their genetic potential. You should lower the risk of using low accuracy bulls by looking at groups of bulls that meet your needs. Use the EPDs to sort the bulls based on your performance goals. After identifying a group of bulls that meet your standards, select the ones to buy based on your other selection criteria. This would be things like reproductive soundness, structural correctness, breed character, etc. Using EPDs to group the bulls also helps ensure uniformity in your calf crop.

Use a different approach to select a bull for artificial insemination. The genetic value of AI to a commercial breeder lies mainly in two things: Predictability and Performance. For picking an AI sire, predictability is the more important of the two. I'm not suggesting that performance is unimportant. It's just that there are plenty of high accuracy AI sires that will meet your performance standards. Let the purebred industry take the risk of testing and culling young bulls.

The traits you emphasize will depend on how you plan to use the sire. If the heifer calves will be kept for replacements you will want to ensure that the sire's maternal EPD fits in with your herd. Birth weight EPD should be watched closely if the bull is going to breed first calf heifers. On the other hand, birth weight and maternal traits are less important for a terminal cross sire bred to mature cows where all the calves are to be marketed.

ACROSS BREED EPDs

We all know there are differences between breeds. A number of scientific studies over the years have been designed to evaluate these differences. There is currently an effort to use these breed comparison studies to make an EPD conversion chart. This chart would allow us to indirectly convert EPDs from one breed to a value that can be compared to another breed. It's beyond the scope of this paper to talk about all the pros and cons of this approach but be aware that it does have its limitations.

Whenever a producer is involved in a breeding program that includes more than one breed it is difficult to avoid year to year production shifts. We are frequently ask questions like "how do you avoid calving problems as breeds are changed in a rotation?" In order to avoid radical changes, a producer must carefully outline the crossbreeding program including the breeds involved prior to buying any individual bull. Thus, a producer needs to: 1) study breed differences from data such as the MARC (Clay Center, Nebraska) or 2) have someone else calculate those differences.

There is currently an effort to do the latter - publishing standardized EPDs to reach across breed lines. In this manner a producer who crossbreeds can make breed selection more easily. "This would put all breeds on an equal basis and make selection simpler." This refers to the selection of the breed more so than the selection of the individual.

We need to consider that the breeds are different. Progress and genetic change is based on differences both within and between breeds. Breeds developed because of differences, particularly differences in biological responses within a given environment. The more related (the same) two breeds are, the less response to crossbreeding.

Current conversion charts being developed should allow producers to select breeds that are compatible. Further numeric comparison of breed averages will be simplified. However, the choice of breeds should occur prior to the selection of individuals which can be accomplished within breed.

The tendency to revert to single trait selection using across breed EPDs is a commonly stated stumbling block. A producer will need to continue to select cows that 'fit the environment' and produce progeny that 'fit the box'. We need to use EPDs as a tool to aid in the process not to be the process by itself. Thus, for a multi-breed program, our recommendation is that breeds are selected prior to sires.

COMPOSITE BREEDS

The current trend in the beef breeding industry is the marketing of composite lines of cattle, a new use of an old idea. A composite breed is a breed formed from crossing two or more breeds of cattle. The

obvious advantage is that one can combine the desire traits of the breeds and form a single line of cattle that will perform well in a given situation. The disadvantage is that some of that response is hybrid vigor which decreases as animals become uniform (homozygous) in the breed.

Several breeders are advertizing crossbred bulls as composite lines of cattle. Until there is an identifiable core group of cattle the crosses are not a breed. Brangus, Beefmaster and others are examples of successful composite breeds. The black-baldy is an F_1 created from the crossing of the angus and hereford breeds. If a group of cattle are further bred from this group to form a breed then a composite is developed. If hereford and angus are continually used to produce the breeding cattle then we have a crossbred male or female not a composite breed.

PREVENTION OF CALF SCOURS

The best prevention for calf scours is a management system that ***maximizes*** the opportunity for newborn calves to receive an adequate amount of high-quality colostrum that gives passive protection against scours-causing organisms and ***minimizes*** build up of, and exposure to, these same microbes. For recommendations on ensuring adequate amounts of colostrum to newborn calves, see "Feeding Colostrum to a Calf."

As mentioned above, ensuring that calves receive adequate high-quality colostrum within 2 - 4 hours of birth is key to scours prevention. There are a number of factors that influence the quantity and quality of colostrum that the calf receives from the dam. These include age of dam, precalving nutrition, precalving vaccination, calving difficulty and calf vigor.

Nutritional Management

Studies have shown that precalving nutrition has a measurable impact on calf survival. In 1975, Corah et al. reported that pregnant cows fed 70% of their calculated energy requirements during the last 90 days of pregnancy produced calves which experienced increased sickness and death rates.

Calves born to first-calf heifers that were restricted either in protein or energy had reduced ability to produce body heat soon after birth. This likely results in calves that are more susceptible to cold stress. Also, calves born to two-year-old heifers whose body condition score is below optimum (<4 on a scale of 1 to 9) are less vigorous and have reduced serum immunoglobulin (antibody) levels at 24 hours of age.

It is important to meet the nutrient requirements of the pregnant cow if she is to deliver a healthy calf with maximum opportunity to resist environmental stress and disease. Since first-calf heifers have different nutrient requirements than older cows and tend to get less feed when fed with the herd, it is recommended that two-year-olds be sorted from older cows.

An excellent tool that can be used to ensure nutrient requirements are met is body condition scoring of all cows. Those on the low side could be sorted off for better or more feed before calving. Targeting cows for a medium body condition score of 5 and for first-calf heifers an even higher score of 5.5 to 6.0 at calving is important.

Precalving Vaccination

Ideally, we would like to control or prevent the spread of the infectious agent of every disease case on the ranch. Certainly, this is a goal that we might move towards. However, even in the best of circumstances, that is difficult to achieve. In the case of infectious calf diarrhea, environmental and management factors play more of a causal role in disease expression than the microbes themselves. Environmental conditions such as weather and management choices such as cattle density on a piece of ground many times combine to overwhelm the best passive protection program in calves. Even so, there are a number of vaccines on the market that advertize protecting calves against infectious scours. This is achieved by vaccinating the pregnant cow in a timely manner, thereby boosting the colostral immunity she can provide for her calf. The best time to achieve this is during the last few weeks of pregnancy. At this time the cow begins to make the immune-cell rich colostrum. If antibodies to specific microbes are present in large volumes, as could be the case in a recently vaccinated animal, the immune quality of her colostrum is greatly enhanced.

Recommendations for vaccination against scours are based on the herd management, disease history, current risks of disease, cost of vaccine and accessibility of the cattle. **We know that vaccination alone is seldom enough, weather, management and cow nutrition are equally important.** In many large, extensively managed cow herds, there is less opportunity to vaccinate cows just before the calving season (with the exception of first-calf heifers). These herds are also more likely to be calving in larger areas, where exposure to infectious organisms may not be as great as in more confined areas.

Specific programs of cow vaccination should be developed for your own calves. Such a program should take into account risk of disease from management and environmental factors, as well as the nutritional needs of the cow herd. In these types of programs, vaccines are only one of several tools used to prevent and control scours.

Clean Calving Environment

The incidence of infectious disease is a function of not only level of immunity, but also the level of exposure to infectious agents. Exposure to infectious organisms is highest in confined environments and also for calves that need assistance at birth. Some recommendations that may help reduce the level of exposure to organisms include:

1. Keep maternity pens or areas as clean and dry as possible.

2. Move pairs out to "clean" pasture after calving.

3. Use a clean area when assisting calf delivery.

4. Wash teats of the cow after an assisted delivery.

5. Clean esophageal feeder between uses on calves, especially when treating calves for scours.

Note: First-calf heifers are frequently maintained in confined environments because they require more assistance at calving. Remember, these calves may be more susceptible to disease to start with, so for them, increasing the level of exposure by confinement increases the risk of disease.

Calving Difficulty

Whenever calving is prolonged, the added stress and physical pressure experienced by the dam and her calf serve to depress natural immune protection and important energy reserves required for survival after birth. This may be critical for the calf. Many times, calves born after difficult or prolonged labor are weak and have very little vigor.

If environmental temperatures are cold, and/or the dam also being in a weakened condition, does not clean and mother the calf, cold stress can render the calf unable to stand or nurse in a very short time. Also calves that lack vigor at birth may continue to fail because they are unable to get the nutrition and protection they need. Extra care of the calf after assistance, such as giving it a quart of colostrum and drying it off can many times make all the difference in the calf's survival.

FEEDING COLOSTRUM TO A CALF

When a calf is born it is virtually unprotected against infectious diseases until it absorbs an adequate supply of colostrum. Generally, we must rely on good management and a sanitary environment to help protect the calf from immediate infection. Within hours of suckling colostrum from its dam, the calf absorbs protective antibodies into the blood stream and other immune cells into its lymph nodes that immediately help to fight off infection. If the calf fails to suckle or for some reason does not receive an adequate amount of colostrum, it must rely on its naive immune system to develop protective antibodies. If the infectious agent is present in large numbers or is particularly strong (virulent) the calf's immune system is overwhelmed and the calf succumbs to disease.

Colostrum is the primary source of immediate natural protection. Ingestion of this antibody (immunoglobulin) and immune-cell rich milk is critical for newborn calf survival. The dam's serum antibodies (IgGs) and some important immune stimulating cells are concentrated in the udder as colostrum during the last month of pregnancy. The concentration of antibodies is lower in heifers as compared to mature cows. For maximum protection, an adequate amount must be delivered within 4-12 hours of birth.

Colostrum in the beef cow tends to be more concentrated than in the dairy cow. **Generally speaking, a 75 lb. calf ingesting 2 to 3 quarts of colostrum in the first 4-6 hours of birth will receive adequate colostrum.** But, what can be done for the calf whose dam has no milk or is otherwise deprived of colostrum?

Even though a calf may need its own dam's colostrum for the immune stimulating cells that seem to energize its immune system, the next best substitute for the natural dam's colostrum is colostrum from another cow. This should be collected and used fresh for optimum results. Colostrum may be frozen in quart containers, however, many modern freezers which have an automatic defrosting system may cause the frozen colostrum to lose a percentage of its protective antibodies and all of the immune-stimulating cells during storage.

Some care must be taken when thawing frozen colostrum. Studies have shown that rapid defrosting using boiling temperatures destroys a portion of the colostrum by destroying the protein antibodies. These same studies have shown that defrosting in a microwave at settings above 60% power has the same result.

Two methods that can be recommended are: a warm water thaw whereby the container (1 or 2 quarts) of colostrum is immersed in 110? F water and stirred every five minutes to assure even thawing and warming. Continue process until colostrum reaches 104? F. A second method is to use a microwave oven set at no more than 60% power. Again, agitate frequently to assure even warming and thawing. Stop when the colostrum reaches 104? F. Either process will take approximately 40 minutes.

We can not assume that the antibody concentration in the colostrum of all cows or heifers is equal. In fact, studies have shown that the antibody concentration varies considerably from cow to cow, breed to breed and heifer to heifer. There is no practical way to measure with certainty the antibody concentration of colostrum before delivery. Colostrometer measurements are helpful but may vary also. However, fresh or fresh frozen and properly thawed colostrum is still the best source of natural protection for a newborn calf.

During the past several years, many colostrum substitutes have been promoted for use in calves. These products are not adequate substitutes for cow colostrum. They are meant to be supplements for calves that have already received some natural colostrum. Below is a list of some of the colostrum supplements commercially available.

Colostrix® (Protein Technology Inc., Minneapolis, Minnesota) a powder product derived from ultrafiltration of cheese whey. Each bag of colostrix is stated to contain 24 grams of immunoglobulin. If a calf requires 150 grams, it must consume 6 or more bags of the product. This product is reconstituted at about 1 quart/bag. In order to receive adequate amounts of antibody mass a calf would need to be given 6 quarts or more within 12 hours. This volume is not recommended.

Colostrum Bolus II® (Smarte Int. Inc., Alberta, Canada). These boluses have been reported to contain 0.3 grams of immunoglobulin in each 6 gram bolus. One may easily calculate the number of boluses required to deliver even a minimum of 80 grams of immunoglobulin (antibodies) to a newborn calf.

ID-1® (Cuprem, Kenesaw, Nebraska). This ultrafiltrate powder product is derived from first colostral whey and is available as a nutritional supplement. The product is recommended by the manufacturer to be given in 10cc oral doses for three days. If the calf shows evidence of scours, 15 to 25 cc doses can be given. Manufacturer recommended dosages, less than 5 grams of total antibody mass, would be given to the newborn calf.

Dried Colostrum Whey (Smarte Int. Inc., Canada), a colostral whey powder, is given orally. Recommendations are to give 1 to 3 ounces of whey powder per quart of reconstituted milk replacer. Again, as with other products mentioned here, a dosage of 2 ounces/quart would deliver approximately 8 grams of antibody mass.

Nurse-Mate First Milk® (Sterling Tech., South Dakota) is a paste product containing less than 5 grams of immunoglobulin in a 30 ml tube.

There are many other products on the market that are promoted for colostrum supplementation of the newborn calf. We have given just a few as examples.

THE CALVING PROCESS AND CALF SURVIVAL

There are several things a calf and its mother must accomplish in the first 24-hours to assure survival. The calf must begin breathing. The mother should clean off the excess fluid that soaked the calf while in the womb. The calf must stand and find a teat and nurse. The mother must stand still to allow nursing to take place and the bonding process which makes them a pair needs to be completed. Finally, the mother must have an adequate supply of quality feed to make enough milk for the calf. In most cases, these events take place smoothly and almost unnoticed. This paper addresses these events and when and how to assist in their completion, if necessary.

We begin with the 2nd stage of labor, calf delivery. When the birth is normal or assisted correctly, the calf will arrive on the ground and take its first breath in a few seconds and then continue breathing. Normal breathing is an automatic reflex and it begins as soon as the calf fills its lungs with the first full breath of air. If calving assistance is too forceful or labor too prolonged the oxygen supply to the calf may be cut off as the umbilical cord, which supplies oxygen to the unborn calf, is pinched off against the pelvic bone. Within a few seconds the calf will be automatically stimulated to take a breath. If the calf is still inside the womb when this happens, it will suffocate. Calves that are delivered in a normal but backward position are especially at risk of suffocating while inside the womb. After delivery, you need to help the calf that is not breathing right away. First, clear away any obvious obstruction over the nostrils. Second, using a piece of straw as a probe, place it into one nostril moving it in and out in an attempt to stimulate a "sneeze" reflex in the calf. In order to sneeze the calf inhales air then blows it out in the reflex. This should only take a few seconds to get a response if the air passage is clear and the calf not too depressed. Third, if you think the air passageway is blocked lift the calf by its hind legs (around the hocks) to let the placental fluid drain out through the nose and then repeat the second step. If the calf is still not trying to breathe by this time you may try mouth to nose resuscitation. However, this method may not be successful because the air you blow in may go into the stomach not the lungs. For more advanced techniques and medications which may be used in these extreme circumstances, we advise consulting with your veterinarian.

The next event in survival is for the mother to clean the excess fluid off the calf's body. This becomes important when the outside temperature and windchill factor combine to make the calf's environment too cold. A newborn loses heat to the environment very rapidly.

It is possible for a newborn calf to become so weakened from body-heat loss that it is unable to stand and/or nurse. An attentive mother may save her calf's life by cleaning it immediately after birth. The cleaning action of the mother's tongue does two things. It removes the fluid soaking the calf which in turn helps to dry the calf off, and it stimulates the calf's blood circulation. In combination these actions help prevent excess loss of body-heat from the calf allowing conservation of its energy which then is available for use in standing and finding a teat to nurse from. Drying and warming are two primary actions you can perform to assist a weak newborn calf in recovering its strength. All cows and heifers, but particularly pairs, need to be in an area where they can find shelter from the wind and moisture.

Standing and getting its first meal is the next step for the calf. This also requires cooperation from the cow. She must stand relatively quiet while the calf figures things out. For the best chance of survival, the calf should suckle its first meal of colostrum shortly after birth. It needs the antibody protection and just as importantly, it needs the energy digested from the colostrum to maintain body heat. The calf loses 50% of its ability to absorb antibodies from the colostrum within 12 hours and nearly all ability by 24 hours, so the sooner the calf gets colostrum for immune protection the better. To assist the calf in achieving this step, you may need to control the movement of the mother by putting her in a stanchion head gate or, in the case of a willing mother but a weak calf, give 1 or 2 quarts of colostrum to the calf for extra energy and strength to stand and\or nurse. This amount will be enough to last the calf a only few hours but, that may be long enough for it to get more meals on its own. Anytime you assist a birth of a calf you should consider giving the calf some colostrum

before you leave the mother and calf to be on their own. Feeding the calf with an esophageal-tube feeder is the recommended method for giving all fluids to a newborn calf. It is safe, when done correctly, and imposes little interference and stress on the calf and dam. Safe use of an esophageal feeder can be explained by an Extension livestock agent.

The final step for survival is the bonding process between dam and calf. This process takes place during the first days of the calf's life. The calf learns who its mother is and the cow or heifer learns to identify its own calf. The actions of the mother help to stimulate the calf to get up and aid in its survival. A heifer has no experience in what this "mother business" is all about. The first few moments after delivering the calf can be important for a heifer to discover and begin to mother her calf. Interference from us can distract her and delay this process. We recommend that after an assisted delivery, the calf be placed on the ground somewhat behind and to one side of the heifer before you release her from the head catch. Release her quietly and in a way that she is inclined to take a step back and turn toward her calf on the ground. Provided there is no object except her calf to distract her attention, most heifers will step to the calf and begin the investigation that leads to "mothering". However, heifers will always remain unpredictable and some will need more encouragement to accept their calf.

It is important to provide some additional pair time for this mothering process to develop particularly with heifers. If possible leave the new pair by themselves for 24 hours. Group with 3 or 4 other "new pairs" for about 24 hours. Then if all are mothered up, turn out with the other pairs.

Since nutritional needs increase dramatically for the cow at calving, it is a good idea to have pairs separate from heavy cows. Cows that lack feed prior to calving have a longer post-partum anestrus period. Cows shorted on feed after calving do not settle as easily as those on proper levels of nutrition.

Although the cow's intake will increase because she has more room with the calf gone, she may also need a higher quality of feed. Actually her dry matter requirement is only about 1/2 lb. per day but, her rumen acceptance may increase by as much as 10 pounds.

Energy requirements increase about 10% to 13 to 14 lbs. of energy (TDN) per day. In terms of energy, a cow needs to eat 23 lbs of hay at 53% TDN per day before calving and 29 lbs. after calving. Both are reasonable amounts if good quality forages are used and the cows are mature. Heifers cannot eat this much because they are smaller. Also, the lower the forage quality, the slower the rate of passage and the less even a cow will consume. It is not unusual for mature cows fed grass residues to consume less that 18 or 20 lbs. per day. Good quality grass hay or alfalfa hay should fulfill their requirements.

In terms of protein, a cow needs 1.6 lbs. of usable protein prior to calving and 2.3 lbs. after calving. This is a 30% increase in requirement and is needed for milk production in addition to the normal body functions. If we are feeding grass hay at 8% protein, a cow will need 22 lbs. of material to meet the pre-calving demand. After calving, she will need to eat 32 lbs. of material. The problem is that grass hay is not this high in protein and a cow will not eat this amount. We need to supplement post-calving to meet her requirement. Alfalfa hay is an excellent protein source in this situation as well as some other feeds.

LITERATURE CITED

Anderson, H. and M. Plum. 1965. Gestation length and birth weight in cattle and buffaloes: a review. J. Dairy Sci. 48:1224.

Anthony, R.V., R.A. Bellows, R.E. Short, R.B. Staigmiller, C.C. Kaltenbach and T.G. Dunn. 1986. Fetal growth of beef calves. I. Effect of prepartum dietary crude protein on birth weight, blood metabolites and steroid hormone concentrations. J. Anim. Sci. 62:1363.

Arnett, D.W., G.L. Holland and R. Totusek. 1971. Some effects of obesity in beef females. J. Anim. Sci. 33:1129.

Bellows, R.A. 1984. Calving management. Proc. Annu. Mtg. Soc. for Theriogenology. Denver, Co. p. 145.

Bellows, R.A., J.B. Carr, D.J. Patterson, O.O. Thomas, J.H. Killen and W.L. Milmine. 1978. Effects of ration protein content on dystocia and reproduction in beef heifers. J. Anim. Sci. 29:263.

Bellows, R.A. and R.E. Short. 1978. Effects of precalving feed level on birth weight, calving difficulty and subsequent fertility. J. Anim. Sci. 46:1522.

Bellows, R.A. R.E. Short, D.C. Anderson, B.W. Knapp and O.F. Pahnish. 1971. Cause and effect relationships associated with calving difficulty and calf birth weight. J. Anim. Sci. 33:407.

Bellows, R.A., R.E. Short, R.B. Staigmiller and W.L. Milmine. 1988. Effects of induced parturition and early obstetrical assistance in beef cattle. J. Anim. Sci. 66:1073.

Bellows, R. A., R. E. Short and G.V. Richardson. 1982. Effects of sire, age of dam, and gestation feed level on dystocia and postpartum reproduction. J. Anim. Sci. 55:18.

Bohlender, B. 1989. Pelvic evaluation and Synovex-C influence. Proc., Beef Seminar. Moose Jaw, Saskatchewan, Canada. Feb. 8-10. Handout. 4 pp.

Bolze, R.P. and L.R. Corah. 1988a. Effects of a single zeranol implant on conception rates and dystocia in primiparous beef heifers. Prof. Anim. Sci. 4:19.

Bolze, R.P. and L.R. Corah. 1988. Effect of prepartum protein level on calf birth weight, dystocia and reproductive performance of primiparous and multiparous beef females. Prof. Anim. Sci. 4:25.

Boyd, G.W. 1991. Exploring mating loads for modern beef bulls. Proceed. Range Beef Cow Symposium XII. p. 161.

Britt, J.H. 1991. What's new in reproductive physiology and endocrinology. (reference unknown)

Brinks, J.N. 1987. Genetic aspects of calving ease. Proc. Range Beef Cow Symp. X. Cheyenne, WY. Coop. Ext. Serv. and Anim. Sci. Depts. WY, SD, CO and NE (handout), 7 pp.

Brinks, J.S., J.M. Mcinerney and P.J. Chenoweth. 1978. Relationships of age at puberty in heifers to reproductive traits in young bulls. Proc. West. Sec. Amer. Soc. of Anim. Sci. 29:28.

Brinks, J.S. 1982. Genetic aspects of reproduction in beef cattle. Proc. West. Sec. Amer. Soc. of Anim. Sci. :28.

Buchmich, S.L., R.D. Randel, M.M. McCartor, and L.H. Carroll. 1980. Effect of dietary monensin on ovarian response following gonadotropin treatment in prepuberal heifers. J. Anim. Sci. 51:692.

Burfening, P.J. 1979. Induction of puberty and subsequent reproductive performance. Theriogenology 12:215.

Byerley, D.J., R.B. Staigmiller, J.G. Bernardinelli and R.E. Short. 1987. Pregnancy rates of beef heifers bred either on puberal of third estrus. J. Anim. Sci. 65:645.

Carstens, G.E., D.E. Jonson, M.D. Holland and K.G. Odde. 1987. Effects of prepartum protein nutrition and birthweight on basal metabolism in bovine neonates. J. Anim. Sci. 65:745.

Clanton, D.C., L.E. Jones, and M.E. England. 1983. Effect of rate and time of gain after weaning on the development of replacement beef heifers. J. Anim. Sci. 56:280.

Corah, L.R., T.G. Dunn, and C.C. Kaltenbach. 1975. Influence of prepartum nutrition on the reproductive performance of beef females and the performance of their progeny. J. Anim. Sci. 41:819-824.

Cundiff, L.V. 1986. The effect of future demand on production programs biological vs. product antagonisms. Proc. Beef Imp. Fed., Lexington, KY. p. 110.

Deutscher, G.H. 1988. Pelvic measurements for reducing calving difficulty. NE Guide 688-895.

Deutscher, G.H. 1989. Pelvic measurements of heifers and bulls for reducing dystocia. Proc., Beef Imp. Fed., Nashville, TN (In Press).

Deutscher, G.H., L.L. Zenfoss and D.C. Clanton. 1986. Time of zeranol implantation growth, reproduction and calving of beef heifers. J. Anim. Sci. 62:875.

Doornbos, E.E., R.A. Bellows, P.J. Burfening, and B.W. Knapp. 1984. Effects of dam age, prepartum nutrition and duration of labor on productivity and postpartum reproduction in beef females. J. Anim. Sci. (in press).

Dow, J.S. Jr., J.D. Moore, C.M. Bailey, and W.D. Foote. 1982. Onset of puberty in heifers of diverse beef breeds and crosses. J. Anim. Sci. 55:1041.

Dufty, J.H. J.B. Bingley and L.Y. Cove. 1977. The plasma zinc concentration of nonpregnant, pregnant and parturient Hereford cattle. Aust. Vet. J. 53:519.

Dunn, T.G., J.E. Ingalls, D.R. Zimmerman, and J.N. Wiltbank. 1969. Reproductive performance of 2-year-old Hereford and Angus heifers as influenced by pre- and post-calving energy intake. J. Anim. Sci. 29:719.

Dzuik, P.J. and R.A. Bellows. 1983. Management of reproduction of beef cattle, sheep, and pigs. J. Anim. Sci. 57(Suppl. 2):355.

Eimers, J.P., R.C. Bull, D.G. Falk and L.C. Anderson. 1983. Postnatal growth and nitrogen metabolism in calves from protein restricted beef cows. J. Anim. Sci. 34:291.

Ferrell, C.L. 1991. Maternal and fetal influences on uterine and conceptus development in the cow: II. Blood flow and nutrient flux. J. Anim. Sci. 69:1954.

Foote, W.D., W.J. Tyler and L.E. Casida. 1959. Effect of some genetic and maternal environmental variations on birth weight and gestation length in Holstein cattle. J. Dairy Sci. 42:305.

Foote, W.D., W.J. Tyler and L.E. Casida. 1959. Effect of uterine horn pregnant, parity of dam and sex of calf on birth weight and gestation length in Angus and Shorthorn cattle. J. Dairy Sci. 19:470.

Gonzales-Padilla, E., R. Ruiz, D. LeFever, A. Denham, and J.N. Wiltbank. 1975. Puberty in beef heifers. III. Induction of fertile estrus. J. Anim. Sci. 40:1110.

Gosey, J. 1987. Breeding specification cattle for the future. Proc. Range Beef Cow Symp. X. Cheyenne, WY. Coop. Ext. Serv. and Anim. Sci. Depts. of WY, SD, CO and NE. p. 218.

Greer, R.C., R.W. Whitman, and R.R. Woodward. 1980. Estimation of probability of beef cows being culled and calculation of expected herd life. J. Anim. Sci. 51:10.

Hahn, J., R.H. Foote and G.E. Seidel, Jr. 1969. Testicular growth and related sperm output in dairy bulls. J. Anim. Sci. 29:41.

Holland, M.D. and K.G. Odde. 1992. Factors affecting birth weight: a review. Submitted for publication in Theriogenology.

Houghton, P.L., R.P. Lemenager, L.A. Horstman, K.S. Hendrix, and G.E. Moss. 1990. Effects of body composition, pre- and postpartum energy level, and early weaning on reproductive performance of beef cows and preweaning calf gain. J. Anim. Sci. 68:1, 438-1,446.

Kiracofe G.H. 1980. Uterine involution: Its role in regulating postpartum intervals. J. Anim. Sci. 51(Suppl. II):16.

Lamond, D.R. 1970. The influence of undernutrition of reproduction in the cow. Anim. Breed. Abstr. 38:359.

Laster, D.B., H.A. Glimp, and K.E. Gregory. 1972. Age and weight at puberty and conception in different breeds and breed-crosses of beef heifers. J. Anim. Sci. 34:1031.

Lemenager, R.P., W.H. Smith, T.G. Martin, W.L. Singleton, and J.R. Hodges. 1980. Effects of winter and summer energy levels on heifer growth and reproductive performance. J. Anim. Sci. 51:837.

Lesmeister, J.L., P.J. Burfening, and R.L. Blackwell. 1973. Date of first calving in beef cows and subsequent calf production. J. Anim. Sci. 36:1.

Lunstra, D.D., J.J. Ford, and S.E. Echternkamp. 1978. Puberty in beef bulls: Hormone concentrations, growth, testicular development, sperm production and sexual aggressiveness in bulls of different breeds. J. Anim. Sci. 46:1054.

McCartor, M.M., R.D. Randel, and L.H. Carroll. 1979. Effect of dietary alteration of ruminal fermentation on efficiency of growth and onset of puberty in Brangus heifers. J. Anim. Sci. 48:488.

Meijering, A. 1984. Dystocia and stillbirth in cattle--a review of causes, relations and implications. Livestock Prod. Sci. 11:143.

Moseley, W.M., M.M. McCartor, and R.D. Randel. 1977. Effects of monensin on growth and reproductive performance of beef heifers. J. Anim. Sci. 45:961.

Moseley, W.M., T.G. Dunn, C.C. Kaltenbach, R.E. Short, and R.B. Staigmiller. 1982. Relationship of growth and puberty in beef heifers fed monensin. J. Anim. Sci. 55:357.

NRC. 1976. Nutrient Requirements of Domestic Animals, No. 4. Nutrient Requirements of Beef Cattle. Fifth Revised Ed. National Academy of Sciences-National Research Council, Washington, D.C.

Neville, W.E., Jr. and D.J. Williams III. 1973. Estrus, ovulation and conception in hormone treated prepuberal Hereford heifers. J. Anim. Sci. 36:540.

Odde, K.G. 1988. Survival of the neonatal calf. Vet. Clinics of N. America: Food Animal Practice 4:501-508.

Pond, W.G., C.L. Farrell and L.G. Beerwinkle. 1983. Zinc supplementation to corn silage-alfalfa haylage diets for pregnant beef heifers may improve zinc status. Feedstuffs Aug. 1:23.

Price, T.D. and J.N. Wiltbank. 1978a. Dystocia in cattle. A review and implications. Theriogenology 9:195.

Price, T.D. and J.N. Wiltbank. 1978b. Predicting dystocia in heifers. Theriogenology 9:221.

Pryor, W.J. 1976. Plasma zinc status of dairy cattle in the parturient period. New Zealand Vet. J. 24:57.

Richards, M.W., J.C. Spitzer, and M.B. Warner. 1986. Effect of varying levels of postpartum nutrition and body condition at calving on subsequent reproductive performance in beef cattle. J. Anim. Sci. 62:300-306.

Ridder, T.A., J.W. Young, K.A. Anderson, D.W. Lodman, M.D. Holland, D.E. Johnson and K.G. Odde. 1991. Effects of prepartum energy nutrition and body contion on birth weight and basal metabolism in bovine neonates. CSU Beef Program Report, p. 119.

Roberts, S.J. 1986. Veterinarian obstetrics and genital diseases. Ithaca, N.Y. Distributed by Edwards Brothers Inc., Ann Arbor, Michigan.

Short, R.E. and R.A. Bellows. 1971. Relationships among weight gains, age at puberty, and reproductive performance in heifers. J. Anim. Sci. 32:127.

Short, R.E. and R.A. Bellows, J.B. Carr, R.B. Staigmiller, and R.D. Randel. 1976. Induced or synchronized puberty in heifers. J. Anim. Sci. 43:1354.

Short, R.E., R.A. Bellows, R.B. Staigmiller and J.B. Carr. 1979. Multiple linear and nonlinear regression analyses of factors causing calving difficulty. Theriogenology 12:121.

Short, R.E., R.A. Bellows, R.B. Staigmiller, J.G. Bernardinelli and E.E. Custer. 1990. Physiological mechanisms controlling anestrus and infertility in postpartum beef cattle. J. Anim. Sci. 68:799.

Smith, M.F., W.C. Burrell, L.D. Shipp, L.R. Sprott, W.N. Songster and J.N. Wiltbank. 1979. Hormone treatments and use of calf removal in postpartum beef cows. J. Anim. Sci. 48:1285.

Spitzer, J.C., J.N. Wiltbank, and D.C. LeFever. 1975. Increasing beef cow productivity by increasing reproductive performance. Colorado State Univ. Exp. Sta., Fort Collins, Gen. Series 949.

Staigmiller, R.B., R.A. Bellows, and R.E. Short. 1983. Growth and reproductive traits in beef heifers implanted with zeranol. J. Anim. Sci. 57:527.

Stewart, T.S., C.R. Long, and T.C. Cartwright. 1980. Characterization of cattle of a five breed diallel. III. Puberty in bulls and heifers. J. Anim. Sci. 50:808.

Toelle, V.D. and O.W. Robinson. 1985. Estimates of genetic correlations between testicular measurements and female reproductive traits in cattle. J. Anim. Sci. 60:89.

Varner, L.W., R.A. Bellows, and D.S. Christensen. 1977. A management system for wintering replacement heifers. J. Anim. Sci. 44:165.

Whitman, R.W. 1975. Weight change, body condition, and beef-cow reproduction. Ph.D. Dissertation. Colorado State Univ., Fort Collins.

Willham, R.L. 1974. In: Commercial Beef Cattle Production. Ed. C.C. O'Mary and I.A. Dyer. pp. 120.

Wiltbank, J.N. 1970. Research needs in beef cattle reproduction. J. Anim. Sci. 31:755.

Wiltbank, J.N. 1983. Developing replacement heifers. In: F.H. Baker (ed.), Beef Cattle Science Handbook 19:473.

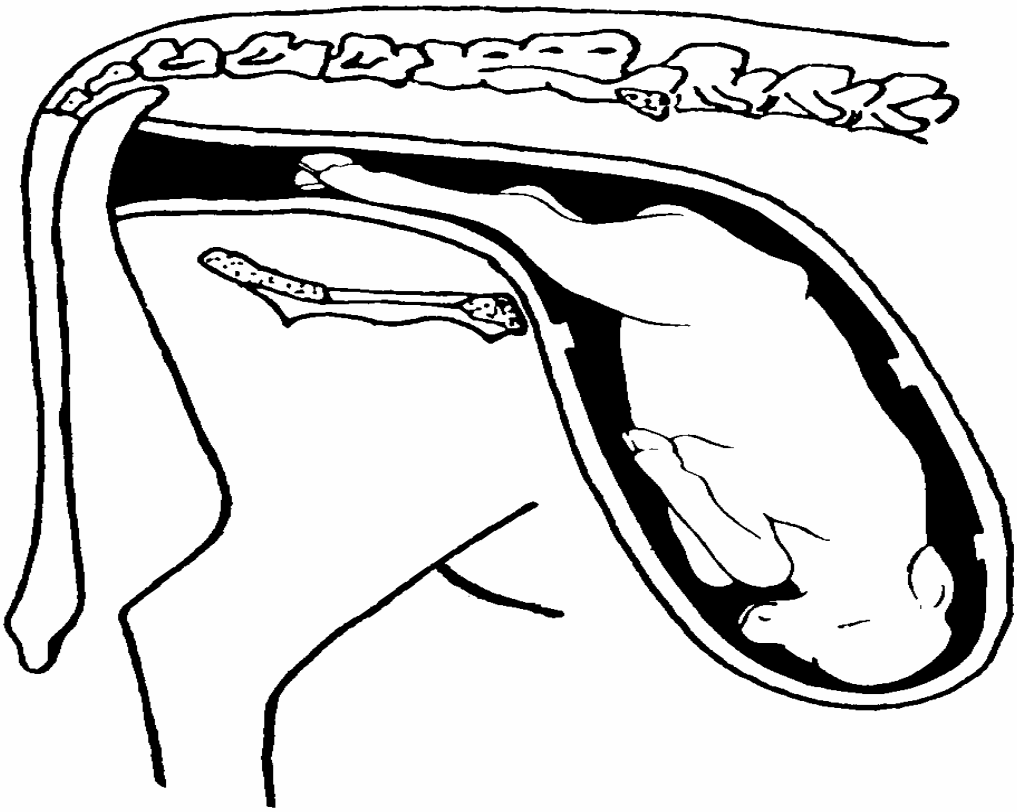
Wiltbank, J.J., W.W. Rowden, J.E. Ingalls, K.E. Gregory, and R.M. Koch. 1962. Effect of energy level on reproductive phenomena of mature Hereford cows. J. Anim. Sci. 21:219.

Yaves, Y. and J.J. Reeves. 1992. Stress at breeding does no lower conception rates of heifers. J. Anim. Sci. 70 (Suppl. 1):254.

Zalesky, D.D., M.L. Day, M. Garcia-Winder. K. Imakawa, R.J. Kittok, J.E. Kinder. 1984. Influence of exposure to bulls on resumption of estrous cycles following parturition in beef cows. J. Anim. Sci. 59:1135.

NOTES

Normal Posterior Presentation



Normal Anterior Presentation