MONTANA STATE UNIVERSITY

Incidence and cause of neonatal and postnatal bovine mortality and effects of peripartum complication on subsequent reproductive performance

by David James Patterson

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Animal Science
Montana State University
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Abstract:
Data collected at the Livestock and Range Research Station, Miles City, Montana for the years 1963 through 1977 were used to study: incidence and cause of neonatal and postnatal mortality to weaning in range cattle, effects of calf loss on subsequent reproductive performance of the dam, incidence of backward and breech presentation and effects of cesarean deliveries, retained placentae and prolapses on subsequent fertility. A total of 893 calves died during the 15 year period from 13,296 calvings for a mortality rate of 6.7%. Losses reported within dam age group were: first calf 2-year-olds, 10.9%; first calf 3-year-olds, 8.7%; second calf 3-year-olds, 4.1%; second calf 4-year-olds, 8.3%; third calf 4-year-olds, 4.8%, dams 5 years of age and older, 5.3% ($P < .01$). Losses to first calf heifers accounted for 41.0% of the 893 deaths. Within the first 24 hours postpartum (57.6%) of the losses were incurred, with 75% of the total occurring by day 7 postpartum. Male calves lost totaled 510 (57.1%) ($P < .01$) of the 893 calves. Of the 893 calves lost, 799 were subjectd to detailed postmortem examinations; 65.5% were found to have functional lungs.

Of calves autopsied, (77.6%) were antomically normal. Death due to dystocia was the single largest source of calf loss, accounting for 410 or 51.3% of the dead calves autopsied, and 374 (60.3%) of the 620 anatomically normal calves lost. Of the 178 abnormal calves, 60.8% died as a result of congenital malformation. Musculoskeletal and visceral anomalies accounted for 41.8% and 58.2% of the total defect incidence, respectively. Fall pregnancy rate of dams that lost calves was 72.4% compared to an overall herd pregnancy rate of 79.4% ($P << .01$).

A 1.6% incidence of backward and breech presentation was noted during the 15 year period. Backward presentation occurred more frequently than breech and was observed more often in primiparous dams ($P < .01$) and in births involving male calves ($P < .01$). Backward presentations occurred in 2.3, 5.6 and .8% of all calvings among first calf 2-year-old, first calf 3-year-old and multiparous dams, respectively. Survival rates of calves presented backward or breech were 70.7 and 32.9%, respectively. During the years studied, 121 cesareans were performed; 74.4% involved first calf 2-year-old dams, 4.0% of all 2-year-olds • calving. Pregnancy status of dams experiencing cesareans, exposed for breeding was 52.4%. Retained placentae occurred in 166 calvings,67 (57.8%) of which resulted from induced calving with adrenal steroids. Subsequent pregnancy rates of dams experiencing retained placentae were 82.2% and 50.7% for the non-induced and induced cows, respectively.

A total of 124 vaginal and 29 uterine prolapses were reported, with incidence among primiparous dams comprising 40.3% and 82.8% of that incidence, respectively. Pregnancy rates of cows having vaginal or uterine prolapses were 44.0% and 43.8%, respectively.

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INCIDENCE AND CAUSE OF NEONATAL AND POSTNATAL BOVINE MORTALITY AND EFFECTS OF PERIPARTUM COMPLICATION ON SUBSEQUENT REPRODUCTIVE PERFORMANCE

by

DAVID JAMES PATTERSON

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

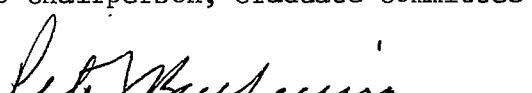
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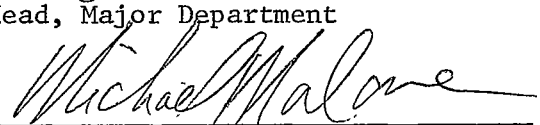
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ABSTRACT

Data collected at the Livestock and Range Research Station, Miles City, Montana for the years 1963 through 1977 were used to study: incidence and cause of neonatal and postnatal mortality to weaning in range cattle, effects of calf loss on subsequent reproductive performance of the dam, incidence of backward and breech presentation and effects of cesarean deliveries, retained placentae and prolapses on subsequent fertility. A total of 893 calves died during the 15 year period from 13,296 calvings for a mortality rate of 6.7%. Losses reported within dam age group were: first calf 2-year-olds, 10.9%; first calf 3-year-olds, 8.7%; second calf 3-year-olds, 4.1%; second calf 4-year-olds, 8.3%; third calf 4-year-olds, 4.8%, dams 5 years of age and older, 5.3% ($P < .01$). Losses to first calf heifers accounted for 41.0% of the 893 deaths. Within the first 24 hours postpartum (57.6%) of the losses were incurred, with 75% of the total occurring by day 7 postpartum. Male calves lost totaled 510 (57.1%) ($P < .01$) of the 893 calves. Of the 893 calves lost, 799 were subjectd to detailed postmortem examinations; 65.5% were found to have functional lungs. Of calves autopsied, (77.6%) were antomically normal. Death due to dystocia was the single largest source of calf loss, accounting for 410 or 51.3% of the dead calves autopsied, and 374 (60.3%) of the 620 anatomically normal calves lost. Of the 178 abnormal calves, 60.8% died as a result of congenital malformation. Musculoskeletal and visceral anomalies accounted for 41.8% and 58.2% of the total defect incidence, respectively. Fall pregnancy rate of dams that lost calves was 72.4% compared to an overall herd pregnancy rate of 79.4% ($P << .01$). A 1.6% incidence of backward and breech presentation was noted during the 15 year period. Backward presentation occurred more frequently than breech and was observed more often in primiparous dams ($P < .01$) and in births involving male calves ($P < .01$). Backward presentations occurred in 2.3, 5.6 and .8% of all calvings among first calf 2-year-old, first calf 3-year-old and multiparous dams, respectively. Survival rates of calves presented backward or breech were 70.7 and 32.9%, respectively. During the years studied, 121 cesareans were performed; 74.4% involved first calf 2-year-old dams, 4.0% of all 2-year-olds calving. Pregnancy status of dams experiencing cesareans, exposed for breeding was 52.4%. Retained placentae occurred in 166 calvings, 67 (57.8%) of which resulted from induced calving with adrenal steroids. Subsequent pregnancy rates of dams experiencing retained placentae were 82.2% and 50.7% for the non-induced and induced cows, respectively. A total of 124 vaginal and 29 uterine prolapses were reported, with incidence among primiparous dams comprising 40.3% and 82.8% of that incidence, respectively. Pregnancy rates of cows having vaginal or uterine prolapses were 44.0% and 43.8%, respectively.

INTRODUCTION

Improved efficiency of production and optimum utilization of available resources, in light of current world population growth trends, warrant attention within the agricultural community. Development of new technology within the agricultural realm must keep pace with needs unique to the production segment; while research efforts must at the same time be directed toward identification and resolution of existing and possible future problem areas.

The interdependence of science upon industry highlights a need for exchange of information necessary for accomplishment of respective goals. The intent of this thesis, based upon consideration of these needs, will be to focus upon identification of specific problems encountered within animal agriculture, pertinent to the beef cattle industry.

Beef cattle production constitutes a major portion of our nation's total agricultural scope, with the sale of cattle and calves accounting for the largest single source of agricultural cash receipt. Problems unique to the beef cattle industry are, however, numerous and in many instances costly. Reproductive failure and resulting consequences are of noted importance, accounting for an estimated annual loss of 760 million dollars.

Calf loss accounts for a substantial portion of the reproductive inefficiency observed in beef cattle and exerts a profound impact upon

associated economic ramifications stemming from such failure. Large scale review of cause and effect relationships regarding calf mortality (from time of birth to weaning), and effects upon subsequent fertility of involved females are notably deficient. Research efforts have in addition neglected to evaluate effects of peripartal complication on reproductive performance.

Producer need, regarding data of this nature, accompanied with the opportunity to pinpoint areas in need of further research were used as the major criteria upon which this investigation was based. The primary objectives of the study were to evaluate (1) incidence and cause of neonatal and postnatal mortality in range cattle, (2) incidence of backward or breech presentation, (3) subsequent reproductive performance of cows losing calves and (4) subsequent reproductive performance of cows experiencing cesarean section, retained placenta, or vaginal or uterine prolapse.

REVIEW OF LITERATURE

Reproductive failure in beef cattle results in substantial economic loss to producers. Three factors affecting reproductive performance, in order of importance, include: (1) number of cows in heat during the first 21 days of the breeding season (2) number of conceptions at first service and (3) number of calves dying at or near the time of parturition (Wiltbank et al., 1973). Studies by Wiltbank et al. (1961) and Dearborn et al. (1973) point to conception failure and early embryonic mortality as added causative factors. Economic loss associated with reproductive failure or calf mortality is incurred through forced culling or death of involved dams, production loss brought about via death of young calves and expenses incurred through veterinary services and drugs (McClure and Dowell, 1968).

Calf crop is generally expressed in percentage terms and is determined by comparing the number of calves weaned to the number of cows eligible for natural service or artificial insemination (National Academy of Sciences, 1968). Average percentage calf crop, under range conditions, may vary from 63-86% (Baker and Quesenberry, 1944; Burke, 1954; Wiltbank, 1973; Bailey et al., 1977; Kress et al., 1979). Work by Bellows (1972) and Wiltbank et al. (1961) imply that reductions in net calf crop may arise from (a) cows failing to become pregnant (b) calf losses during gestation (c) perinatal losses at or shortly after birth or (d) calves dying from birth to weaning.

Calf losses may vary for given time periods. Studies in dairy cattle by Hawk et al. (1955) indicate that 6.6% of all pregnancy loss

(from early pregnancy diagnosis, 35-42 days post breeding) is attributable to death of the developing fetus up to day 150 of gestation. In cows carrying fetuses to term, Reynolds (1973) found that most death losses occur in calves during the first week of life following parturition. Previous death loss studies suggest that 6 to 18% of all conceptions result in nonviable abortions or full term stillbirths, while of all dairy calves alive at birth, 8 to 24% die before one year of age (Dickinson and Touchberry, 1961).

The term stillborn or stillbirth, defined by Dorland's Medical Dictionary (1974) refers to the delivery of a dead fetus, hence born dead. Further definition by Woodward and Clark (1959) classifies stillborn calves as those calves exhibiting no movement after birth, while Lindhe (1966) and Philipsson (1976a) associate the term with the occurrence of death at birth or within 24 hours after parturition. An expanded definition of perinatal mortality cites deaths occurring (a) prior to or during parturition (b) within a few hours after parturition or (c) following attended calvings (Donald, 1963).

Stillbirth incidence, as a function of total recorded death, varies. Comprehensive mortality studies allude to occurrence of highest calf death loss at time of parturition or within the first 24 hours of life (Rasbech, 1967; DeRouen et al., 1967; Koger et al., 1967; Pattulo, 1973; Young and Blair, 1974). Independent investigations cite stillbirth ranges from 2 to 11% (Wright, 1958; Woodward

and Clark, 1959; Politiek, 1965; Arthur, 1966; Barriere, 1968; Gaillard, 1969; Auran, 1972; Dufty, 1972), stillbirths accounting for 56.4% of total deaths recorded (Withers, 1952). Neo- or perinatal mortality rates may range from 5 to 10% of all calves born (Hansen, 1965; Rice and Wiltbank, 1970b, 1972), with reported annual calf losses during the first 5 days of life varying from 8 to 25% (Bull et al., 1978a). The highest incidence of calf loss apparently occurs during the first 36 hours of life (Rice and Wiltbank, 1970b, 1972) and exceeds losses between 36 hours postpartum and weaning by 6% (Wiltbank et al., 1973).

Total calf loss percentages recorded for the period from conception to weaning differ. Lovell and Hill (1940) indicate one of every 20 calves born alive dies before the age of 6 months, with one in seven pregnancies failing to produce an adult animal. Prenatal death losses and postnatal losses up to 6 months of age range from 14.3 to 15.1 calves lost per hundred pregnancies (Withers, 1952). Preliminary research efforts of Baker and Quesenberry (1944) note calf death losses of 6% between spring calving date and December 31 of the same year, while more recent works point to overall mortality incidence of 8.6% (Laster and Gregory, 1973). Aggregate losses from birth to weaning effect a 4.1% reduction in net calf crop (Bellows, 1972; Bailey et al., 1977; Kress et al., 1979).

Calf Mortality Causes

Causative components of stillbirth and postnatal mortality are numerous and can best be expressed in factors attributable to the calf, the dam, the sire, pathological agents or climatic factors.

I. Dystocia

Dystocia, defined as delayed and difficult birth, ranks high among factors contributing to perinatal mortality. Calf mortality may be four to eight times higher in dystocia cases than in normal parturition (Wright, 1958; Arthur, 1966; Laster and Gregory, 1973; Smith et al., 1976; Laster, 1976) implicating its occurrence as the principle stillbirth cause (Politiek, 1965; Young 1968a). Dystocia victims number from 40 to 90% of total recorded deaths (Laster and Gregory, 1973; Young and Blair, 1974; Philipsson, 1976a), with the majority of casualties occurring within the first 24 hours of life (Anderson and Bellows, 1967; Pattulo, 1973; Laster, 1976). Reported incidence of dystocia in beef and dairy cattle varies from 2 to 7% of total births (Withers, 1953; Dreyer and Leiphitz, 1971; Joandet et al., 1973) resulting in an assisted birth rate of 6 to 14% (Hansen, 1965).

Means of measurement, regarding severity of dystocia or calving ease, are expressed in modified form. Type of parturition has been divided into discernible classifications of (1) no assistance rendered, (2) delivery assisted with hand pull, (3) required use of mechanical calf puller, (4) extreme traction with mechanical puller and/or

surgical extraction via cesarean section or (5) abnormal presentation (Bellows, 1972; Laster and Gregory, 1973). The time interval from appearance of the allanto-chorion to fetal expulsion has been examined (O'Mary and Hillers, 1976) and suggests possible onset of dystocia within 2 hours following appearance of the allanto-chorion (Young, 1970).

Functional versus nonfunctional status of the lungs of the calf may be used to determine time of death relative to parturition. Available information indicates that lungs in 70 to 80% of the calves lost at birth were classified nonfunctional, while in 20 to 30% of the animals lung status was deemed functional (Anderson and Bellows, 1967; Laster and Gregory, 1973). Lungs that floated when placed in a container of water were classified as functional, those that did not float were classified as nonfunctional.

Visible lesions and post mortem findings indicative of dystocia include: subcutaneous edema of the head, protrusion and swelling of the tongue and presence of blood stained mucous in the nasal cavity and sinuses, larynx and trachea (Dufty, 1973). Petecheal hemorrhages of the thymus, thoracic pleura and pericardium, localized edema of the limbs and perineum, and contusions and/or bone fractures serve as additional evidence of dystocia (Anderson and Bellows, 1967; Young and Blair, 1974; Haughey, 1975; Gopal, 1977).

Contemplating the effects of dystocia on fetal survival, it is interesting to note that an estimated 70% of the identified variation in calving difficulty is due to factors existing or determined at the time of conception; principle effects exerted genetically via the calf's sire and dam (Bellows, 1976). Existence of identifiable variation therefore warrants discussion of individual components contributing to increased dystocia.

Birth weight. Birth weight of the calf has been implicated as one of the leading effectors of calving difficulty. Fetal oversize and/or extremes in birth weight account for the single largest dystocia source (Veterinary Clinical Observation Unit, 1963; Sloss et al., 1967; Bogner et al., 1970; Rice and Wiltbank, 1970a, 1970b; Bellows et al., 1971b; Nelson and Huber, 1971; Ward, 1973; Bellows, 1976; Foulley et al., 1976), with severity of dystocia dependent upon weight of the calf relative to that of its dam (Monteiro, 1969; Sagebiel et al., 1969). Linear increases in calving complication, corresponding to increasing birth weight of the calf, have been noted among and within breed groups (Smith et al., 1976), with increases in percent assisted birth of 2.3±0.21% for each kilogram increase in birth weight (Laster et al., 1973).

Paralleled increases in dystocia score and calf birth weight result in increased need of obstetrical assistance at time of birth (Nelson and Huber, 1971; Pattulo, 1973; Burfening, 1976; Laster, 1976; Kilkenny and Stollard, 1976), with reported increases in percent of

cows requiring assistance at birth and calving ease score of 4.5% and 0.8 per kilogram increase in birth weight (Burfening et al., 1978a, 1978b). Consideration of the effects of birth weight on degree of calving difficulty make the highly significant correlation between birth weight and calving time logical (O'Mary and Coonrad, 1972; O'Mary and Hillers, 1976).

Effects of birth weight on calf survival are noteworthy. Calves with extremes in birth weight, light or heavy, have higher death rates than do those of intermediate weight (Regan et al., 1947; Koger et al., 1967; Pattulo, 1973). Birth weights of calves dying at parturition are generally heavier than averages for live calves (Politiek, 1965; Arthur, 1966; Kilkenny and Stollard, 1976), except in studies reported by Woodward and Clark (1959) and Anderson and Bellows (1967). Studies by Dickerson et al. (1974) note corresponding decreases in percent calf crop of 1% for each kilogram increase in birth weight.

Research efforts suggest that increased calf birth weight is primarily a function of increased soft tissue, not skeletal size (Laster, 1974). Little relationship has been found between calving difficulty and body length, chest depth, wither height and width of the shoulders and hips. Calf shape measurements, independent of birth weight do not relate significantly to dystocia score; however, correlations among body measurements and birth weight are significant (Boyd and Hafs, 1965).

Factors influencing birth weight indirectly affect calving performance (Philipsson, 1976c). Weight of the calf at birth is related to its genotype and sex, and the age, precalving weight, gestation length and gestation weight gain of the dam (Williams, 1968; Joandet et al., 1973; Bellows, 1976; Laster, 1976). Selection of cattle for faster growth rate results in corresponding increased birth weight of the calf, evidence manifest in the positive genetic correlation between weaning and yearling weights to those recorded at birth (Gregory et al., 1950; Foulley, 1976). A birth weight heritability estimate of .48 (Petty and Cartwright, 1966) indicates that selection for smaller birth weight via the sire is possible.

Correlated responses computed within sex by Pahnish et al. (1964) indicate that birth weight may have promise as an early selection criterion for weaning weight improvement unless emphasis on birth weight leads to dystocia. Selection for 18 month weight appears to be a good single criterion for selection for growth throughout life (Brinks et al., 1964). Recent studies suggest that anticipated increase in birth weight could be reduced an estimated 30% if selection emphasis was on postnatal growth rate rather than weaning or yearling weight (Koch et al., 1974). Selection for smaller birth weight and heavier yearling weight by use of a selection index has been predicted to result in shortened gestation lengths permitting rapid postnatal growth without increasing calving difficulty (Dickerson

et al., 1974).

Sex of calf. Sex of calf effects have been reported as one of the leading causes of variation associated with frequency of difficult calvings and subsequent calf mortality (Lindhe, 1966; Sellers et al., 1968). Male calves elicit increased incidence of dystocia resulting in corresponding differences in percent assisted birth (Anderson and Bellows, 1967; Adler and Meding, 1968; Bellows et al., 1971b; Dreyer and Leiphitz, 1971; Laster and Gregory, 1973; Laster et al., 1973; Brinks et al., 1973; Laster, 1974; Bellows, 1976; Philipsson, 1976b; Wilson and Willis, 1976). Estimates suggest that 70% of all dystocia cases (Bogner et al., 1970) and 60 to 70% of all calvings warranting assistance involve birth of male calves (Young, 1968b; Nelson and Huber, 1971; Pattulo, 1973). Survival differences between sexes for births not requiring assistance are nonsignificant (Laster, 1976).

Available information indicates that nearly 70% of all abortions (Luktuke and Choudhury, 1965) and the majority of all stillbirths involve male fetuses (Woodward and Clark, 1959). Reports imply that one of every five male calves are associated with dystocia, while one in seven is stillborn or later dies (Veterinary Clinical Observation Unit, 1963). A higher incidence of male mortality has been reported (Withers, 1952; Dreyer and Leiphitz, 1971; Laster and Gregory, 1973); however, higher female calf mortality rates are cited by Lovell and Hill (1940) and Donald (1963).

Philipsson (1976d) found significantly larger body measurement in males with respect only to chest width. Most works indicate that increases in dystocia and stillbirth levels related to the male are primarily functions of higher mean birth weight and possible increased gestation length (Gregory et al., 1950; Burris and Blunn, 1952; Koch and Clark, 1955; Flower et al., 1963; Crowley, 1965; Franke et al., 1965; Milk Marketing Board, 1965; Philipsson, 1976b; Smith et al., 1976).

Gestation length. Stillbirth occurs more frequently following abnormally short or long gestation periods (Friedli, 1965). High birth weights resulting from extended gestation, may serve as partial explanation of such occurrence, when considering effects of birth weight on dystocia (Jafer et al., 1950; Davis et al., 1954; Dreyer and Smidt, 1966; Bellows et al., 1971b; Granola et al., 1972). Evidence from Laster (1976) and Burfening et al. (1978c) indicates that increases in birth weight of .25 kg/day for each additional day of gestation may be anticipated, accompanied with increases in percent assisted birth of .70% per day increase in gestation length. A highly significant correlation of .35 between length of gestation and birth weight has been reported (Bogner et al., 1970; Bellows et al., 1971b; Burfening et al., 1978c), while estimates of the heritability of gestation length are near 40% (Politiek, 1965). Consideration of these findings suggests that the influence of gestation length on calving

ease is apparently expressed through effects on birth weight (Burfening et al., 1978c).

Genetic correlations and predicted correlated response to selection, reported by Burfening et al. (1978c), indicate that selection for calving ease would subsequently reduce the severity of calving difficulty and decrease gestation length with little affect on birth weight or 205-day weight. Direct selection against large birth weight was shown to be less effective in increasing calving ease with corresponding effects of shortened gestation length and decreased birth weight and 205-day weight.

Significant effects on gestation length for breed, sire, parity of the dam, type of birth (single or multiple) and sex of calf have been observed (Burris and Blunn, 1952; Everett and Magee, 1965; Boyd and Hafs, 1965; Crockett and Kidder, 1967; Koonce and Dillard, 1967; Bellows, 1976; Wilson and Willis, 1976). Data suggest male calves are carried an average 1.5 days longer than females, with the gestation length of a mature or multiparous dam averaging 1 to 1.6 days longer than that of a primiparous heifer (Anderson and Plum, 1965; Arthur, 1966; Philipsson, 1976b). Forced or restricted activity of the dam during pregnancy was shown to have little or no effect on gestation length or calf birth weight (Bellows, 1976).

Presentation, posture and position. Fetal presentation, posture and position are important considerations when discussing factors affecting dystocia. Presentation includes the relation of the spinal axis of the fetus to that of the dam (longitudinal or transverse) and the portion of the fetus that is approaching or entering the birth canal (anterior or posterior in the longitudinal presentation or dorsal or ventral in the transverse presentation; Roberts, 1971).

Position includes the relation of the dorsum of the fetus in longitudinal presentation, or the head in transverse presentation, to the quadrants of the maternal pelvis. These include the sacrum, the right ilium, the left ilium and the pubis (Roberts, 1971). Posture denotes the relation of the extremities or head, neck and limbs to the body of the fetus. Extremities may be flexed or extended or retained beneath, on the right or left side, or above the fetus (Roberts, 1971). Roberts (1971) defines normal presentation in the bovine as the anterior longitudinal presentation, dorso-sacral position with the head resting on the metacarpal bones and knees of the extended forelegs.

Observed frequencies of abnormal presentation range from 3.5 to 6% of total births; with two-thirds of the births experiencing abnormal presentation subsequently resulting in calving difficulty and one-third in stillborn calves (Philipsson, 1976a). Estimates indicate that 95% of all calves are born in an anterior presentation (Williams, 1948),

while ranges from 3 to 12% have been noted for calves delivered backward or breech (Wiltbank, 1971; Smith et al., 1976). Fetal displacement has been shown to account for 34 to 50% of all difficult calvings (Sloss et al., 1967; Rice and Wiltbank, 1970b), with data from some researchers implicating abnormal presentation as the number one contributing factor to dystocia in beef cattle (Morten, 1968). Studies of calves assisted at birth observed 60% of those assisted presented normally, 21% in a posterior presentation and 19% with some other form of postural abnormality (Pattulo, 1973).

Death loss percentages generally rise with increased occurrence of malpresentation (Wright, 1958; Donald, 1963), with backward delivery being the presentation abnormality of highest incidence. Dystocia and stillbirth are anticipated to be four times as likely to occur if the calf is presented posteriorly (Arthur, 1966). An estimated two-thirds of all births experiencing difficulty are ones in which a normal anterior delivery was observed, while in one-third of the dystocias a posterior presentation was seen (Philipsson, 1976a). Studies report that up to 43% of total calf deaths may be attributable to posterior presentation (Sloss et al., 1967). Unassisted live births are known to occur less frequently in posteriorly presented calves (Woodward and Clark, 1959) due primarily to anoxia and lack of prompt fetal removal, necessary to prevent asphyxiation following pressure exerted on or rupture of the umbilical cord (Roberts, 1971).

Examinations of bovine pregnancy and parturition found the majority of all fetuses in a posterior presentation during months four, five and six of gestation (Arthur, 1966). By the end of the 6th month, half of the fetuses were in anterior position and half posterior. Observation one month later established that the majority of all calves were in normal anterior presentation. Arthur (1966) noted by palpation that beyond the 7th month of gestation one of every 17 fetuses was situated backward. Investigation by Rice and Wiltbank (1970b) found some calves in a dorsopubic position 2 to 5 hours before birth, yet these calves turned to the normal dorsosacral position and were unassisted at parturition.

Study indicates that presentation at birth is determined no later than the 7th month of gestation (Rice and Wilbank, 1972). Changes in presentation during the last month of gestation are unlikely, however changes in position and posture have been found to occur up to one day prepartum (Rice and Wiltbank, 1972). Fetal movement throughout gestation is believed to be due to intrauterine pressure exerted by myometrial contractions (Arthur, 1966). Postural changes by the fetus are said to occur frequently but do not appear to be related to changes in position of the fetus or parturition onset (Dufty, 1973).

Philipsson's data (1976a) indicate abnormal presentation relates to heavier fetal birth weight, which in turn results in less available movement space during late stages of pregnancy. A higher incidence of

malpresentation generally occurs in first calf hiefers (Donald, 1963), with increased occurrence noted in one study in heifers with pelvic areas smaller than 230 sq. cm. (Wiltbank, 1971). Occurrence of backward delivery appears more frequently in cases of twin birth, possibly accounted for by lack of adequate uterine space (Arthur, 1966; Morten, 1968).

Type of birth. Significant differences in calf survival have been reported between twin and single births. Twinning results in a higher than average percentage of stillbirths (Woodward and Clark, 1959; Rasbech, 1967). Roughly one-fifth of all twins born die at birth or within the first 48 hours of life (Morten, 1968). Reduced dystocia frequency has been reported in cases of twin birth along with decreased gestation length (Philipsson, 1976a). Twinning rates appear to increase with advancing cow age. Dairy cows having twins before their fourth calving note increased incidence of infertility (Erb and Morrison, 1959).

Parity and age of dam. Evidence presented in the literature points to effects of parity and age of dam on dystocia and calf survival rate (Lindhe, 1966; Sellers et al., 1968). Significant effects on dystocia score are attributed to parity of the dam (Wilson and Willis, 1976), with the percent of total difficult calvings notably higher among primigravid heifers (Lefever and Wiltbank, 1961; Rasbech, 1967; Young, 1968b; Dreyer and Leiphitz, 1971; Dufty, 1972; Laster et al., 1973;

Hafez, 1974; Laster, 1976; Philipsson, 1976b; Tong et al., 1976; Bailey et al., 1977; Kress et al., 1979). Resulting higher incidence of perinatal mortality is reported (Woodward and Clark, 1959; Politiek, 1965; Arthur, 1966; Anderson and Bellows, 1967; Adler and Meding, 1968; Young, 1968b; Pattulo, 1973), with losses in some instances 50% higher in heifers than mature cows (Auran, 1972).

Study of the effects of parity on calving difficulty frequency notes decreases from 20% at first parity to 4% at second parity. Observed decreases have been attributed to enlargement of the birth canal and physiological condition change from first to second calvings (Monteiro, 1969). Early embryonic mortality and abortion rates are higher in first calf heifers (Withers, 1952; Withers, 1953, Donald, 1963; Luktuke and Choudhury, 1965), with reported frequency of stillbirth and abnormal presentation three times higher in first parity dams (Lindhe, 1966). Percentage differences in dystocia and loss due to stillbirth between male and female offspring are greater in primiparous dams (Politiek, 1965; Smith et al., 1976). Increases in dystocia, evidenced by the incidence of localized edema in calves born dead to primiparous dams, have also been noted (Young, 1974).

Uterine inertia, malposture and malposition occur more frequently in mature cows (Williams, 1968), with disproportion between fetal size and pelvic opening appearing more often in heifers. Maternal death loss at time of parturition is said to be highest in first calf heifers

due to increased severity of calving complication (Wythes et al., 1976), with proportionately larger numbers of exposed heifers failing to wean their calves (Dearborn et al., 1973).

Age of dam and calf birth weight represent the two most important variables influencing calving difficulty (Laster, 1976), with up to 50% of the variation in calving score accounted for by birth weight of the calf (Ménissier, 1975). Sire and dam breed, calf sex and age of dam were shown to exert significant effects on dystocia score when holding birth weight constant or deleting it from the statistical model. Age of dam evoked the only significant effect on dystocia score when reconsidering birth weight in the analysis, with other variables expressing their effects indirectly via birth weight (Laster et al., 1973).

Reported calf losses are higher in 2-year-old dams not experiencing dystocia than in cows three and older; cow age however, fails to exert a significant influence on calf mortality in parturitions involving dystocia (Laster and Gregory, 1973). Despite these significant findings, conflicting reports regarding the influence of cow age on dystocia and neonatal survival exist (Politiek, 1965; Young, 1968a; Joandet et al., 1973).

Cows bred to calve first as 2-year-olds produce more calves and more total weaned calf weight, in their lifetime, than cows calving first as 3-year-olds and older (Donaldson, 1968). Studies record a higher incidence of calving difficulty and calf mortality in heifers

calving first at 24 months of age versus those at 36 months, although early calving effects on growth rate, mature body weight and subsequent reproductive performance of the dam were not observed (Pittaluga et al., 1967).

Age of dam effects on birth weight, weaning weight and postweaning daily gain were shown to be highly significant (Koch and Clark, 1955; Flower et al., 1963; Petty and Cartwright, 1966; Kress and Burfening, 1972; Bogart et al., 1975). Cow production, regarding these factors, increased from 3 to 6 years of age with declining production noted in cows beyond 6 years. Contrasting results from prior research efforts indicate birth weight maximums will not be realized until dams reach 9 to 10 years of age (Burris and Blunn, 1952). More recent work suggests optimum productivity ranges from 5 to 10 years of age (Cunha and Warnick, 1973). Percent calf crop increases in cows aged 10 to 11 have been reported (Davenport et al., 1965; Bailey et al., Kress et al., 1979), with intermediate aged mature dams experiencing the least incidence of calving difficulty and perinatal loss (Philipsson, 1976b).

Cow weight and pelvic area. Positive effects of precalving body weight of the dam exert the most important influence on calf birth weight (Bellows et al., 1971a). Correlations of birth weight with cow weight are cited by Gregory et al. (1950) and O'Mary and Hillers (1976). Negative correlations were found to exist between body weight and height at the withers of the dam and level of calving

difficulty (Cadle and Ruttle, 1976), with decreases in dystocia score of .68 for each 45.4 kg increase in dam weight (Singleton et al., 1973). These findings were in contrast to prior studies, which failed to note significant correlations of dam weight to calving difficulty and/or calf survival (Koger et al., 1967; Young, 1968a; Rice and Wiltbank, 1972).

Cow weight provides the largest source of variation associated with pelvic area (Bellows et al., 1971a; Laster, 1976). Larger cows have larger pelvic openings, in terms of height and width, as well as, greater hip width and rump length (Bellows et al., 1965; Ward, 1971; Laster, 1974). Pelvic size, independent of cow weight, affects calving difficulty (Foulley, 1976), with the highest relationship existing in first calf heifers (Rice and Wiltbank, 1970a, 1970b). Heifers of increased skeletal size have larger pelvic openings, but also tend to have larger calves (Bellows, 1976; Laster, 1976). Birth weights tend to increase when the size of the pelvic opening of the dam becomes larger (Menissier, 1975).

Differences in pelvic area are generally due to pelvic height, with discrepancies between the dam and fetus more likely to occur for pelvic height and depth of calf chest than for width measures (Singleton et al., 1973; Philipsson, 1976d). Bellows et al. (1971b) failed to elicit differences regarding pelvic height, but instead reported a negative effect on calving difficulty contributed via

precalving total pelvic area. Pelvic areas in yearling heifers are influenced by breed of sire and dam (Laster, 1974), large increases in pelvic size occurring between ages two to three (Bellows et al., 1971a). Aside from cow weight and pelvic area considerations, subjective dam conditions scores and cow body measurements bear no significant relationship to calving difficulty (Nelson and Huber, 1971; Ward, 1973; Laster, 1974).

Nutrition. Level of nutrition during gestation has little effect on calving difficulty but may influence neonatal survival and subsequent reproduction of the dam (Joandet et al., 1973; Bellows, 1976). Prepartum feed level exerts a marked effect on postpartum reproduction with low feed levels being more detrimental to heifers than cows (Bellows et al., 1979). Increased amounts of energy or crude protein result in higher calf birth weights but do not affect the incidence or severity of dystocia, nor the percent of cows requiring calving assistance (Laster, 1974; Bellows et al., 1978).

Philipsson (1976d) warns that increased calving difficulty may be anticipated in extremely thin or fat heifers. Comparison of moderate conditioned dams to obese dams, by Arnett et al. (1971), noted fewer services per conception and reduced assistance at parturition among the moderate conditioned group, in addition to reduced losses at calving and increase in the proportion of calves weaned. Moderate short term obesity during pregnancy did not result in detri-

mental affects on mature dams. Reduced assistance at parturition was cited in cows considered thinner than average (Nelson and Huber, 1971), while increased losses at birth of 7% have been reported for calves born to cows fed on restricted energy levels (Corah et al., 1975).

Energy restriction during early and mid-gestation failed to reduce fetal size or calving difficulty (Laster, 1974), with higher recorded mortality rates in calves born to heifers fed at elevated energy levels (Wiltbank, 1971). Losses related to high energy levels were due in part to excess fat deposition in and around the pelvic opening of the dam, combined with a higher than normal incidence of backward presentation of the calves. Results of this study refute theories of corresponding increases in birth weight of the calf and dystocia caused by high gestation feed levels. Findings do suggest, however, that cows deprived of adequate energy subsequently give birth to lighter weight calves.

Hughes et al. (1978) summarized the long term effects of level of winter supplement on the productivity of range cows. Dams in the study were fed on low, moderate, high and very high levels of supplement. Very high level females weaned only 66.3% of their calves in calf crop one, while the other 33% were stillborn. Following the first calf crop, very high level dams weaned more kilograms of calf per cow exposed than the other three groups, however when weighted average calving percent

data were calculated through nine calf crops, the low and very high groups ranked lowest of the four.

Breed and sire. Breed differences account for a portion of the variation observed in frequency of dystocia and resulting calf loss (Wiltbank et al., 1961; Lindhe, 1966; Koger et al., 1967; Young and Blair, 1974; Philipsson, 1976a). Breed group significantly affects calf mortality rate in births involving calving difficulty, but fails to exert an influence in unassisted parturitions (Laster and Gregory, 1973; Laster, 1976).

Evidence of survival difference between straight and crossbred calves appears frequently in the literature, with reported death loss in most instances highest in straightbreds (Gains et al., 1966; Laster and Gregory, 1973; Reynolds, 1973; Laster, 1976). Dystocia score comparisons between straight and crossbred calves fail to reveal significant differences between the two (Laster et al., 1973); however, reports of increased calving difficulty in crossbred heifer calves have been cited (Sagebiel et al., 1969). Crossbred calves tolerate higher levels of stress related to dystocia situations (Laster and Gregory, 1973), accompanied with percentage increases in the number of calves born, alive at 2 weeks postcalving and weaning (Gaines et al., 1966; Wiltbank et al., 1967).

Birth weights were higher in crossbreds than averages recorded for straightbreds (Laster et al., 1973). Breed of dam serves as one

of the leading factors affecting variation in birth weight (Franke et al., 1965), but fails to exert an influence on dystocia or calf mortality incidence (Milk Marketing Board, 1965). Findings contrary to these reports note increased frequency of dystocia in heavier dam breeds due to higher mean birth weights of their calves (Monteiro, 1969; Foulley et al., 1976).

Breed of sire and individual sire within breed contribute to observed variation in calving difficulty incidence and severity (Donald, 1963; Lindhe, 1966; Sagebiel et al., 1969; Dreyer and Leiphitz, 1971; Singleton et al., 1973; Laster, 1974; Wilson and Willis, 1976; Burfening et al., 1979). Significant sire effects on embryonic mortality, length of gestation, calving time, birth weight and stillbirth appear in the literature (Gregory et al., 1950; Hawk et al., 1955; Politiek, 1965; Crockett and Kidder, 1967, Adler and Meding, 1968; O'Mary and Coonrad, 1972; Laster, 1976, Philipsson, 1976a; O'Mary and Hiller, 1976), with influence of the dam on gestation length and birth weight outweighed by that of the sire (Everett and Magee, 1965).

Rising rates of dystocia augmented by increasing calf weights at birth are linked to the large European cattle breeds including: Charolais, Simmental, Limousin, South Devon, Maine Anjou, Chianina, Gelbveih, and Brown Swiss (Veterinary Clinic Observation Unit, 1963; Rowden, 1970; Laster et al., 1973; Kilenny and Stollard, 1976; Laster, 1976; Smith et al., 1976). This does not mean that sires of British

or other breed origin are incapable of producing nor responsible for problems encountered at calving time.

Dystocia heritability estimates for sires within breeds of .18, accompanied with calculations independent of birth weight of .12 imply that breed and sire selection within breed can best be used to minimize calving difficulty (Laster, 1976). Selection of a paternal breed for use on heifers should enlist a sire capable of incorporating growth potential of the calf with calving ability of the cow (Menissier, 1975).

Miscellaneous. Year, season of the year, and location effect the nature of the parturition process and resulting calf survival (Wiltbank et al., 1961; Lindhe, 1966; Koger et al., 1967). Fewer cows experience calving difficulty and stillbirth problems during the spring and late summer months, with highest incidence occurring in winter (Withers, 1953; Politiek, 1965; Philipsson, 1976b; Wilson and Willis, 1976). Studies by Laster (1976) point to reduced occurrence of dystocia in the south when compared to reports from the western and midwestern United States.

Percentage increases in perinatal mortaility correspond to low temperature and high precipitation (DeRouen et al., 1967); with weights of calves at birth influenced to a degree by seasonal and yearly variation (Everett and Magee, 1965). Length of previous lactation and calving interval fail to exert a significant influence on the birth process (Dreyer and Smidt, 1966), while contradictory reports of

exercise effects on calf birth weight and calving difficulty are also cited (Bellows, 1972; Philipsson, 1976b).

Review of the literature notes factors, concomitant to those previously outlined, contributing to calving difficulty incidence. Vulval stenosis, uterine inertia and/or torsion, cervical and vaginal dilation failure, intrauterine post mortem fetal changes and premature delivery favor dystocia happening. Added complication may be incited via constriction of the posterior genital tract, cervical prolapse or neoplasm, pelvic fracture or uterine rupture (Wright, 1958; Sloss et al., 1967; Morten, 1968; Rice and Wiltbank, 1970b; Dufty, 1972).

II. Disease

Disease exerts a significant role in its contribution to calf loss incidence; however, in view of the large number of known pathologic agents, comprehensive discussion is not feasible. Based on frequency of occurrence, this review will focus on the following: infectious calf scours, virus pneumonia, weak calf syndrome and miscellaneous disease entities.

Calf scours. Infectious calf scours, otherwise known as the enteritis complex, results in substantial annual loss to the beef industry. Early documented findings name the disease as the major cause of death in young calves (Regan et al., 1947); while more recent works place it second, preceded only by dystocia (Pattulo, 1973). Young and Blair (1974) report the disease as the leading cause of

death in calves 8 days to 3 months postpartum, with 12 to 15% of all recorded deaths a result of the complex (Pattulo, 1973).

Comprehensive summaries list two occurring forms of infectious calf scours, acute and subacute (National Academy of Sciences, 1968). Characteristic symptoms accompanying diarrhea range from sudden prostration and subnormal body temperature in the acute form, to depression, dehydration, emaciation and body temperature elevation in the subacute. Additional consequences may include acidosis, renal failure or shock. Enteropathogenic serotypes of Escherichia coli, salmonellae, chlamydiae or the virus of infectious bovine rhinotracheitis (IBR) act as primary causative agents of the disease, although environmental influences on the calf via exposure, sanitary insufficiency or diet may serve to escalate its epidemicity and severity (The Merk Veterinary Manual, 1973).

Virus pneumonia. Respiratory infections, namely enzootic or virus pneumonia, rank second among disease elements advancing mortality rates in beef calves. Calf losses within the first 30 days postpartum are due largely to pneumonia (Anderson and Bellows, 1967), with noted morbidity and mortality rates in severe outbreaks of 100% and 25%, respectively (National Academy of Sciences, 1968). Pneumonia stems from a combination of viral and bacterial infection often teamed with one or more environmental stress situations. Body temperature ranges of 39 to 40 degrees Centigrade may be observed, accompanied with a

harsh cough and serous nasal discharge. Increased respiratory and heart rates, diarrhea and dehydration may accompany the pneumonia. Post mortem lesions indicative of such ailment include dark red areas of partial alveolar collapse, death occurring 3 to 7 days post onset (The Merk Veterinary Manual, 1973).

Weak calf syndrome. Since its discovery in 1963, death loss attributable to weak calf syndrome has been of major consequence. The disease is characterized by 1 to 2% abortion rates and significant mortality loss during the first 2 weeks postpartum; death loss estimates in the Pacific Northwest range from 5 to 40% with citings of individual ranch loss approaching 75%. Affected calves are weak, unable to rise or may walk stiffly. Excessive heat and edema over the cannon bones and fetlock joints may be noted upon palpation, accompanied with diarrhea, erythema of the muzzle and body temperature elevation (Bull et al., 1978a; Ward, 1978).

Hemorrhages of the third eyelid, sclera and conjunctiva may be exposed post mortem, as well as hemorrhage and edema of subcutaneous tissues around the hock and knee joints. Red discoloration of synovial fluid in affected joints may also be a precursor to diagnosis. Prepartum crude protein consumption by the cow is negatively correlated to weak calf syndrome incidence, with average increases in occurrence of 95% for every .05 kg decrease in intake of crude protein below .91 kg/day. Comparative observation of cold stressed calves noted sub-

cutaneous hemorrhages in the hock joint area similar to those associated with weak calf syndrome, while contiguous reports indicate synovial fluid discoloration relates directly to combined effects of cold stress and protein restriction (Bull et al., 1978a, 1978b; Ward, 1978).

Miscellaneous disease entities. Disease entities of reduced scope and frequency as compared to those previously reviewed include navel ill, hemorrhagic enterotoxemia, and impacted abomasum syndrome.

Navel Ill. Navel ill stems from infection due to a number of microorganisms including: streptococci, staphylococci, Escherichia coli salmonellae, Corynebacterium pyogenes, and Brucella abortus. Clinical findings include omphalitis, purulent arthritis, and possible umbilical hernia. Lesions typical of the condition are manifest in joints, the liver, and umbilical area. Disease pathogenicity is due primarily to improper sanitation. Disease contraction may occur prepartum due to uterine infection, though generally appears post calving (The Merck Veterinary Manual, 1973; National Academy of Sciences, 1968; Young and Blair, 1974).

Enterotoxemia. Hemorrhagic enterotoxemia is an acute disease affecting young calves 2 to 14 days of age. Augmented by indigestion, both beta and alpha toxin may be produced, accompanied with symptoms of abdominal pain. Resulting from an intoxication of Clostridium perfringes type C, the disease is often characterized by diarrhea, hemorrhagic enteritis and death. Disease vulnerability is equated with

the better calves in a herd, generally those from heavier milk producing dams. Adult cattle and sick calves may support disease transmission, although environment may play a role (Griner and Baldwin, 1954; National Academy of Science, 1968; The Merck Veterinary Manual, 1973).

Impacted abomasum syndrome. Starvation of the calf due to abandonment may contribute to neo- or postnatal mortality incidence; however, signs of starvation may be confused with the impacted abomasum syndrome, common in calves 2 to 3 months of age. Arising out of milk curd formation in the abomasum, the condition is accompanied with the presence of hairballs, straw and/or wood acting to block the pylorus and produce effects of impaction. Calves may exhibit signs of anemia, diarrhea and incoordination. Long hair coat, nasal discharge, and a tucked up abdomen yielding an impression of excess fluid, serve as supportive diagnostic symptoms. Excess casein is believed to be responsible for milk curd formation, which in turn accounts for the appetite loss. Stemming from impaired magnesium absorption, hypomagnesemia results, accompanied with eventual appetite depravation (Gray, 1968; Young and Blair, 1974).

III. Inbreeding

Inbreeding, defined by Brinks and Knapp (1975), is the result of mating individuals more closely related than average relationships in

the population to which they belong, thus increasing the probability that two alleles at a particular locus in an individual will be identical. Affects of inbreeding on performance traits in beef cattle generally appear via declines in reproductive performance, survival and growth rate (Brinks and Knapp, 1975).

Marked decreases in percent calf crop born correspond to higher levels of inbreeding (Rice et al., 1961), with increased incidence of embryonic mortality reported in inbred embryos versus outbred (Hawk et al., 1955; Conneally et al., 1963). Little or no effect of inbreeding on abortion rate is cited (Regan et al., 1947). Increased frequency of stillbirth corresponding to increases in inbreeding coefficients of either the dam or the calf are reported, with a relatively large percentage incidence of anatomical abnormality noted among such stillbirths (Regan et al., 1947; Woodward and Clark, 1959; National Academy of Sciences, 1968).

Losses are higher among inbred calves up to 5 months of age than for noninbred contemporaries (Regan et al., 1974; Hawk et al., 1955; Davenport et al., 1965). Respiratory and digestive disturbances account for two of the most frequent causes of death of inbred calves, possibly due to their decreased resistance or increased susceptibility to health complications (Regan et al., 1947; Arthur, 1966). Studies conducted by Stonaker (1954) noted 30% more outbred calves raised to weaning compared to inbred contemporaries; outbred calves were compared

to 30% inbred calves reared on 20% inbred dams.

Increased levels of inbreeding further result in reduced growth rate during the suckling period and throughout early life of the calf (Brinks and Knapp, 1975). Effects of inbreeding, aside from calf loss, are reported for fertility, birth weight and body size (Regan et al., 1947); however, more recent studies fail to note significant effects contributed via the calf or dam on calf birth weight (Alexander and Bogart, 1961).

Review of the affects of inbreeding on calf survival by Brinks and Knapp (1975) cite inbreeding of the calf as the most critical factor affecting inbred calf survival traits. A 10% increase in inbreeding of the calf or the specific mating involved resulted in a 1.3% increase in percent of cows open, .8% more deaths at birth, .8% more deaths from birth to weaning, and 1.6% fewer calves weaned. Data further substantiated detriment to performance in fitness and growth traits associated with increased levels of inbreeding. It should be noted however, that detrimental effects exhibit variability in response among and between lines.

IV. Congenital Defects

Congenital defects enhance occurrence of perinatal calf mortality resulting in increased loss to the producer and reduction in number of calves weaned. Defects may, in addition, be responsible for creating

obstetrical problems and increasing the occurrence of dystocia (Wright, 1958; Sloss et al., 1967; Morten, 1968; Greene et al., 1973b). Congenital defects are defined as abnormalities of structure or function present at birth (Dorland's Medical Dictionary, 1974), caused by genetic or environmental factors and interaction of genetics and environment (Ingalls, 1957; Johansson, 1965; Fechheimer, 1968; Greene et al., 1973b; Dennis et al., 1975).

Leipold et al. (1972) indicate that occurrence of congenital defects results from a disruptive event or process of variable duration at one or more stages in the integrated sequence of embryonic and fetal development. Defects exert their influence either by a specific or total change in body structure and function with frequency varying according to breed, locale, sex, age of parent and nutrition (Leipold et al., 1972).

Estimates indicate that .2 to 3.6% of all calves born are afflicted with varying forms of congenital anomaly (Rasbech, 1967; Barriere, 1968; Roberts, 1971; Dreyer and Leiphitz, 1971; Laster and Gregory, 1973; Greene et al., 1973b; Dennis et al, 1975). Withers (1952) reported a 2.6% abnormality rate among stillborn calves, while Anderson and Bellows (1967) reported a 21% incidence among dead calves autopsied. Of calves affected, 38 to 50% reportedly are born dead, while an additional 10% die within 48 hours of parturition (Rasbech, 1967; Leipold, 1978b).

Genetic defects. Genetic defects are commonly classified as: lethal (cause death of the carrier before attainment of puberty); semi-lethal (defects in which the percentage of survivors is above zero, but less than 50%); and subvital (more than 50%, but less than 100% of the carriers survive) (Johansson, 1965). More than 80 inherent diseases are known to cause congential defects in cattle (Dennis et al., 1975).

Leipold et al. (1972) define congenital hereditary defects as pathogenic or pathophysiologic results determined by mutant genes or chromosomal aberrations. Anomalies may be expressed via overdominant, dominant, incompletely dominant or recessive gene inheritance, as well as by pleitropic patterns of action of specific genes (Hadorn, 1961; Leipold, 1978b). Few reports however, have implicated sex linkage (Leipold, 1978b).

Classification of chromosomal aberration is according to heteroploidy or structural aberration with causative aspects consisting of: parental genotypes, ionizing radiation, chemicals and drugs, viruses, maternal age, age and physiological state, temperature shock or general environmental factors (Fechheimer, 1968). A wide spectrum of expressivity is observed among most hereditary defects, and in some instances the mutant gene may not be expressed in the phenotype making gene penetrance incomplete (Johansson, 1965).

TABLE 1. SIRE TESTING PROCEDURES

Procedure	Offspring needed to reach probability level of: 0.05	0.01	0.001
Homozygous abnormals 1)	5	7	10
Heterozygotes 1)	10	16	24
Father-daughters 2)	22	35	52

1) Checks for one trait only

2) Checks for all undesirable recessive traits

(From Leipold, 1978b)

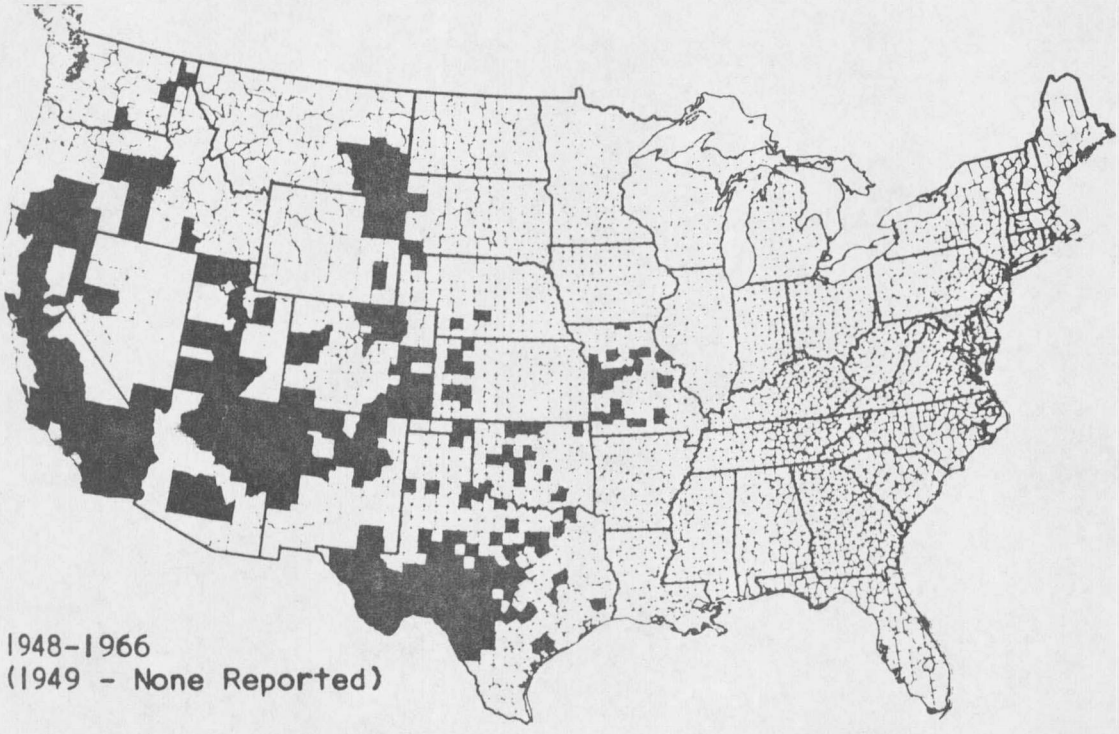
Testing of sires suspected of carrying recessive deleterious genes becomes important when considering the expanded use of artificial insemination of beef cattle. Table 1 summarizes testing procedures recommended for use on sires prior to their inclusion in an A.I. Stud. Sires may be bred to homozygous abnormal females, known heterozygous individuals or their own daughters. The number of offspring in each column represents the number of normal progeny required to reach respective probability levels indicating a sire's likelihood of being a defect carrier.

Environmental agents inciting congenital defect. Congenital defects may be linked to environmental factors. Specific disease entities and ingestion of toxic plants are two factors largely responsible. Review will encompass Bluetongue virus, Bovine virus diarrhea and the effects of lupine and loco ingestion on pregnant cows.

Bluetongue virus. Bluetongue virus, referred to as epizootic fever, is an infectious, non-contagious viral disease transmitted by insect vectors of the genus Culicoides (Bowne et al., 1966; Kennedy, 1968). Disease incidence is seasonal, occurring in late summer and early fall, during years when environmental factors result in large insect vector populations (Hourrigan and Klingsporn, 1975b). The disease is characterized by a 6 to 7 day incubation period with host specificity including: cattle, sheep, species of antelope, goats, bighorn sheep, white-tailed deer and mule deer (Bowne et al., 1966; Kennedy, 1968; Erasmus, 1975; Hourrigan and Klingsporn, 1975a).

The following map of the United States indicates areas in black in which presence of Bluetongue virus has been confirmed in sheep. The map was prepared from data collected during the years 1948 to 1966. Shaded areas, indicating disease presence, include regions of the United states occupied by large sheep populations, (Figure 1).

Symptoms of Bluetongue virus observed in mature cattle include: anorexia, elevated temperature, leukopenia, marked stiffness and lameness, frothing of the mouth, excess salivation, protrusion of the tongue and frequent chewing and teeth grinding (Bekker et al., 1934; Bowne et al., 1966). Affected individuals may also exhibit a rapid loss in condition, reduced milk flow, respiratory distress, blistering and necrosis of oral mucous membranes, swelling of the coronary band and swallowing difficulty (Bekker et al., 1934; Bowne et al., 1966; Bowne et al., 1967).



(From Kennedy, 1968)

Figure 1. Counties in the United States in which Bluetongue has been reported.

The acute clinical disease is characterized by severe inflamation of mucous membranes of the mouth, nasopharynx, esophagus, rumen and lower digestive tract (Hourrigan and Klingsporn, 1975b). Bluetongue virus, in addition, has been isolated from cows showing signs of photosensitization (Barriere et al., 1966). Viral immunity does not develop in the case of Bluetongue virus, cattle may be reinfected year after year (Bowne et al., 1966).

Bluetongue virus in cattle has been shown to be both abortogenic and teratogenic, with the most critical period of infection occurring during the first trimester of gestation (Jochim et al., 1974; Luedke et al., 1977). Anomalies of calves born to dams infected with Bluetongue virus include: excessive gingival tissue, dwarfism, arthrogryposis, hydranencephaly, agnathia, doming of the skull, ataxia and prognathia (McKercher et al., 1970; Barnard and Pienaar, 1976; Luedke et al., 1977). Affected calves may be undersized at birth and exhibit little or no control of the suckling reflex (McKercher et al., 1970; Luedke et al., 1970). Similar findings have been reported in sheep (Griner et al., 1964). Study of aborted fetuses infected with Bluetongue virus, in which hydranencephaly was observed, noted lack of mid-brain structures and replacement of the cerebral hemispheres by straw-colored fluid (Barnard and Pienaar, 1976).

Bovine virus diarrhea. Bovine virus diarrhea is an infectious disease of cattle manifested by diarrhea and dehydration and characterized by erosion and hemorrhage of the digestive tract (The Merck Veterinary Manual, 1973). Disease transmission is not well established, but is assumed to occur via contact with infected animals or contaminated feed (The Merck Veterinary Manual, 1973). Abortion, fetal mummification or teratologic effects upon the eye and cerebellum of the developing fetus may occur as a result of disease infection (Ward et al., 1968; Kendrick, 1971; Scott et al., 1973; Brown and deLahunta, 1975; Brown et al., 1975a, 1975b; Zemjanis and Hurtgen, 1975). Pregnant cattle exposed to the BVD virus will not abort if immune from a previous exposure (Kahrs, 1968).

Effects of the disease on newborn calves vary from complete lack of coordination and normal body posture to slight ataxia (Brown and deLahunta, 1975). Hypoplasia and ataxia were observed in calves born to cows infected with the BVD virus at 102 to 183 days of gestation (Kahrs et al., 1970), which contrasts first trimester anomaly development common to Bluetongue virus infection. Symptomatic evidence of BVD presence in newborn calves is further manifest by observance of opisthotonos, nystagamus, mandibular brachygnathism, musculo-skeletal deformities, alopecia and decreased cerebellum size (Kahrs et al., 1970; Roberts, 1971; Brown et al., 1975a).

Toxic plants. Lupine, ingested by pregnant cows from days 40 to 70 of gestation, may produce Crooked Calf Disease among developing fetuses, accompanied with deformities including torticollis, scoliosis, and palatoschisis (Wagnon, 1960; Shupe et al., 1967a; Binns, et al., 1968). Two species of lupine, Lupinus caudatus and Lupinus sericeus, have been found to cause crooked calf syndrome, with toxicity related to the alkaloid content possessed by the plant (Shupe et al., 1967a). Maternal signs of toxicosis include: lethargy, nervousness, lack of coordination, muscle twitch and convulsions (Wagnon, 1960; Shupe et al., 1967a).

Varieties of loco, including Astragalis lentiginosis, Astragalis pubentisimus and Oxytropis sericea, caused abortions and congenital malformations in offspring of sheep and cattle when ingested during pregnancy. Congenital malformation in lambs and calves consisted of lateral rotation of forelimbs, anterior flexure and hypermobility of hock joints, and contracted tendons. Ingestion of loco produced effects similar to those resulting from deficiency of selenium (James et al., 1967).

Other range plants suspected of causing deformities in calves include Senecio and related plants (common name - Groundsel; Leipold, 1978b).

Congenital abnormality characterization. Review of specific congenital defects regarding appearance of the defect, incidence and

mode of inheritance will be reviewed. Information of this nature is limited, hence discussion will be restricted to those defects (1) of greatest economic importance and (2) most often encountered.

Relative frequency of various body systems affected by congenital defect were summarized by Leipold (1978b) and include: central nervous system (21.6%), musculature (13.7%), anomalous twins (10.0%), congenital systemic disturbances such as hydrops (9.5%), defects of large body cavities such as schistosomum reflexum (9.3%), facial skeleton (8.8%), bones of the leg including joints (6.9%), digestive (4.3%) urogenital (4.3%), bone and cartilage (2.8%), heart and vessels (2.7%), skin (2.0%), and others (1.7%). These findings are similar to those reported by Greene et al. (1973b).

Deformities of the jaw include: campylognathia (lateral deviation of the face), superior or inferior prognathia (abnormal length of the upper and lower jaw) and superior or inferior brachygnathia (short upper or lower jaw). Inheritance has not been satisfactorily explained (Leipold et al., 1972).

Polymelia is defined as limb duplication, with extremity absence referred to as amelia. Abrachia refers to missing front legs and apodia to missing hind legs. Tibial hemimelia is a lack of tibial development of the hind legs of the affected animal (Dorland's Medical Dictionary, 1974). Associated defects include brain hernia, ventral

abdominal hernia, cryptorchidism in males and nonunion of the Mullerian ducts in females (Leipold et al., 1972; Leipold and Dickenson, 1978a).

Crooked Calf Disease occurs predominantly in range cattle in the western United States and Alaska (Shupe et al., 1967b). The disease has been seen in calves born to cows fed lupines between days 40 and 70 of gestation (Shupe et al., 1967a). Similar deformities, including arthrogryposis, kyphosis, torticollis, scoliosis, and palatoschisis, may be due to homozygous recessive genes (Palotay, 1959; Crooked Calf Symposium, 1960; Hoffsis, 1977). Pregnant dams fed on manganese deficient diets produce calves with similar skeletal deformities (Shupe et al., 1967b; Leipold et al., 1972).

Acroteriasis congenita is due to a simple recessive autosomal gene that results in low birth weight, amputation of the four legs, defects of the facial skeleton, palatoschisis, brachygnathia inferior, microtia, hydrocephalus, kyphosis or scoliosis and eye defects (Leipold et al., 1972).

Arthrogryposis is one of the most frequently observed congenital defects in calves (Gopal, 1977), characterized by persistent flexure or contracture of a joint (Dorland's Medical Dictionary, 1974). Kyphosis, lordosis, scoliosis and palatoschisis may be associated with arthrogryposis (Greene et al., 1973a). Arthrogryposis generally affects hind limbs, but may affect forelimbs as well (Leipold et al., 1970). Prenatal viral infection with Akabane virus may cause arthrogryposis

(Hartley et al., 1975). Spina bifida may cause bilateral arthrogryposis of the hind legs (Leipold, 1978b). Arthrogryposis and associated defects in Charolais calves, referred to as the Syndrome of Arthrogryposis and Palatoschisis, constitutes a syndrome of Mendelian etiology due to a recessive autosomal gene (Faucon and Lauvergne, 1976).

Hydrocephalus, in most instances, is produced by a recessive autosomal gene (Cole, 1942; Gilmore, 1949; Baker et al., 1961; Greene et al., 1974). Hydrocephalus is characterized by accumulation of excessive fluid within the ventricular system (Leipold, 1978b). Symptoms include small body size, bulging forehead and incomplete teeth development (Blackwell et al., 1959). Hydrocephalic calves were reported to have had lower birth weights and reduced wither height, body length, chest circumference and cannon bone length when compared to normal non-hydrocephalic contemporaries (Blackwell et al., 1959). Affected calves are usually born alive, are weak and make little attempt to stand. Calves will usually die shortly after birth but may live 24 to 48 hours postpartum. The eyes of hydrocephalic calves are often small and the lower jaw is frequently light tapering to a narrow muzzle and poorly developed teeth (Baker et al., 1961).

Calves affected with cerebellar hypoplasia exhibit severe ataxia, consistent head movement and abduction of the forelimbs (O'Sullivan

and McPhee, 1975). The condition is believed to be of familial origin and appears in calves via an autosomal recessive mode of inheritance (Finnie and Leaver, 1965).

A high proportion of the congenital cardiac anomalies in cattle have involved the ventricular septum (Fisher and Pirie, 1964). Ventricular septal defects may be single isolated defects or may be combined with abnormalities of the large vessels (Leipold, 1978b). Deficiency of vitamin A has been shown to result in the development of cardiac deformities in experimental animals while genetic factors were suspected of causing cardiac abnormalities in one herd of Hereford cattle (Fisher and Pirie, 1964). Reported congenital heart abnormalities among inbred progeny consisted largely of patent foramen ovale and intraventricular septum (Regan, 1947).

Fertility Effects on Dams Maintained for Breeding

Reproductive efficiency in the bovine is influenced to a large extent by the fertility of dams maintained within a particular breeding herd. Aside from the economic loss associated with the death of a calf, it is worthwhile to note effects of such loss on subsequent fertility of involved dams. In addition, dystocia and possible resultant peripartum complications including cesarean section, retained placentae and vaginal or uterine prolapse warrant further consideration when evaluating factors related to or detracting from a dam's reproductive

potential. Although incidence of peripartum complications has been reported, information regarding subsequent fertility of affected females is limited. Discussion of factors contributing to reproductive efficiency in the bovine will precede review of effects exerted via lactation status and peripartum complication. Interaction that may occur between respective complications and factors concerning age, nutrition, and breed justify such review.

Failure of cows to become pregnant accounts for the single largest contributing factor to reduction in net calf crop (Bellows, 1972). Age of dam effects upon percent of cows pregnant is evidenced by reports indicating higher pregnancy rates among mature dams (Burke, 1954; Dearborn et al., 1973; Doornbos, 1978), with contrary findings reported by Baker and Quesenberry (1944). Cows pregnant to calve first at 2 years of age produce more calves in their lifetime than cows calving first at 3 years and older (Pittaluga et al., 1967; Donaldson, 1968); however, reproductive failure rate among 2-year-old dams is generally higher the year following production of their first calf than failure rates recorded for mature dams (Dearborn et al., 1973).

Feed levels throughout gestation have been shown to affect first estrus and subsequent pregnancy rate in beef cattle (Bellows, 1976); however, effects of ration protein level on postpartum interval, services per conception and final pregnancy rate percentages are reportedly nonsignificant (Bellows et al., 1978). Study of the effects

of heterosis on reproductive performance note increased pregnancy rates of 2% in cows bred to produce crossbred calves (Wiltbank et al., 1967).

I. Lactation. Calf loss and/or lactation status may influence subsequent reproductive performance of dams, however, data pertaining to the effects of such factors are notably deficient. Rasbech (1967) noted a 13 to 14% reduction in number of cows conceiving at first, second and third inseminations after giving birth to a nonviable fetus, while previous year's lactation status was shown by Wiltbank et al. (1961) to influence the following year's calving performance in mature dams. Comparison of mature lactating and non-lactating dams at time of breeding, subsequently noted fewer calves lost within the first 36 hours postpartum, in addition to a greater proportion of calves weaned, among dams bred to calve while lactating. Notable exception to this finding was with respect to lactating 3-year-old dams bred to calve as 4-year-olds (Wiltbank et al., 1961).

II. Dystocia. Numerous reports of decreased pregnancy rates in cows experiencing dystocia appear in the literature (Dreyer and Smidt, 1966; Konerman et al., 1969; Brinks et al., 1973; Laster et al., 1973; Dickerson et al., 1974; Foulley et al., 1976; Laster, 1976), with pregnancy rates 5 to 16% below contemporaries not experiencing calving difficulty (Konerman et al., 1969; Laster et al., 1973; Foulley et al., 1976; Laster, 1976).

Laster et al. (1973) noted significant effects of dystocia on percent of cows detected in estrus during a 45 day AI breeding period, conception rate to AI, and total conception rate. Study of heifers experiencing dystocia as 2-year-olds noted 11% fewer calves weaned from cows involved the first year and 14% fewer calves weaned per cow exposed the second year, than contemporaries not experiencing calving difficulty at first calving (Brinks et al., 1973).

Early obstetrical assistance at the time of parturition was shown, from studies conducted at the Livestock and Range Research Station, to increase the percent of females exhibiting estrus the first 21 days of breeding by 10%, and first service pregnancy rate by 15.1%. Total pregnancy rates were 12.8% higher in females provided obstetrical assistance early in stage two of parturition as compared to females receiving only emergency assistance. A one minute increase in labor duration lengthened the postpartum interval .2 days, lowered the percent of dams exhibiting estrus the first 21 days of breeding .7% and decreased total pregnancy percent following a 45 day AI period .6% (Doornbos, 1978).

III. Cesarean section. Parturitions completed by cesarean section (C-section) generally occur as a result of disproportion in fetal size relative to pelvic area of the dam and inability to correct an abnormal presentation (Morten, 1968; Rowden, 1970; Roberts, 1971). Twenty-two percent of the cesareans performed in one study involved

delivery of fetal monsters (Wright, 1958).

Wright (1958) and Sloss (1974a) reported a 3 to 4.7% incidence of cesarean delivery in beef cattle, with the number of cesareans performed decreasing with advancing age of the dam. Reported percentage incidence ranges from 10 to 30% in first calf dams to 2.8% in mature cows (Sloss, 1974a; Menissier, 1975; Foulley et al., 1976). Maternal survival rate following cesarean delivery ranges from 80 to 90% (Wright, 1958), accompanied with calf mortality incidence of 5 to 30% (Roberts, 1971; Sloss, 1974).

Foulley et al. (1976) reported a 31% reduction in pregnancy rate among heifers experiencing cesarean section, while Wright (1958) cites a 50% fertility rate for C-sectioned cows.

IV. Retained placenta. Retained placentae, interchangeably referred to as retained fetal membranes, are defined as retained if not shed within 24 hours after parturition. Retained fetal membranes reduced pregnancy rate 40% in dairy cows (Erb et al., 1959), but comparable information in beef cattle is lacking. Incidence of retained placenta in beef cattle ranges from 1.9 to 11.7%, with frequency rates two to three times higher in cases involving calving difficulty or stillbirth (Palmer, 1937; Kennedy, 1947; Withers, 1953; Morrison and Erb, 1957; Hansen, 1965; Wetherill, 1965; Sloss, 1974b; Philipsson, 1976e). Incidence of retained placenta is suggested to be two times more frequent following stillbirth than in parturitions producing viable

offspring (Rasbech, 1967).

Higher rates of retained fetal membranes are reported to occur following twin or abortive births (Erb, 1958). Relationship between length of gestation and retention of fetal membranes is also reported, with highest incidence occurring in gestation periods less than 273 days or greater than 285 days (Wetherill, 1965; Carroll, 1974). One study noted a higher incidence of retained placenta in first calf heifers and older dams than in cows delivering their second, third or fourth calf (Wetherill, 1965). A higher percentage of retained fetal membranes is associated with birth of male than female calves (Erb et al., 1958). The onset of endometritis or pyometra are complications stemming from retained fetal membranes (Mutiga and Kimberling, 1977).

Induced parturition with adrenal steroids increases the incidence of retained placenta (Willham and Evans, 1971; Carroll, 1974; Grunert et al., 1975) and subsequently reduces pregnancy rates (Moody and Han, 1976). Willham and Evans (1971) however, observed no affect on subsequent fertility in cows retaining fetal membranes following induced parturition.

V. Vaginal and uterine prolapse. Reported incidence of prolapse of the reproductive tract in beef cattle ranges from 1 to 2% (Woodward and Quesenberry, 1956), while published data regarding subsequent fertility of cows that experience prolapse are not available.

Differences among age groups experiencing prolapse have not been cited. A trend does exist however, toward reduced prolapse incidence following the first parturition and increased occurrence in cows 7 years of age and older (Woodward and Quesenberry, 1956).

Prolapse of the vagina, including a portion of the uterus and/or the bladder, occurs both during pregnancy and following parturition, with the majority of cases seen during the last 2 months of gestation (Woodward and Quesenberry, 1956; Arthur, 1975). Uterine prolapse occurs most frequently during the third stage of labor, with incidence affected by seasonal and regional factors (Arthur, 1975b). Prognosis depends upon the specific case involved, duration of the condition prior to treatment and injury sustained by the organ. Arthur (1975) indicates that repetition of uterine prolapse in subsequent calvings is generally not a problem.

Actual cause of prolapse of the reproductive tract is undefined, although occurrence is often observed following severe straining in response to vaginal trauma or infection following dystocia (Sloss, 1974b; Arthur, 1975). Anatomical anchorage of the genital tract of cows prone to prolapse is less efficient than for cows in which prolapse is not a problem (Arthur, 1975); however, explanation regarding this phenomenon is lacking.

MATERIALS AND METHODS

Data collected at the Livestock and Range Research Station, Miles City, Montana, from 13,296 calvings for the years 1963 through 1977 were used to evaluate: (1) incidence and cause of neonatal and postnatal mortality through weaning in range cattle, (2) incidence of backward or breech presentation, (3) subsequent reproductive performance of cows losing calves and (4) subsequent reproductive performance of cows experiencing cesarean section, retained placenta or vaginal or uterine prolapse.

Sources from which data were obtained included: field calving reports, autopsy reports of calves that died from parturition to weaning, breeding herd records and fall pregnancy status reports.

Death Loss Study

A total of 893 calves died during the 15 year period studied. Data used to evaluate incidence and cause of neonatal and postnatal mortality included: year of occurrence; numeric identification of the sire, dam, and calf involved; respective breed or inbred line of the calf, dam, and sire; inbreeding coefficients of linebred or crossline progeny; relationships between linebred sires and dams of dead calves; calf birth date, weight and sex (male, female, intersex, sex not recorded); and presentation and posture of the calf at birth.

Presentation and posture descriptions used were similar to those described by Roberts (1971) and were defined accordingly; normal

(anterior longitudinal presentation, dorso sacral position, head resting on the metacarpal bones and knees of the extended forelegs); backward (posterior longitudinal presentation, dorso sacral position); breech (posterior longitudinal presentation, dorso sacral position, hind limbs retained beneath the body); hiplock (failure of the trochanter majors of the fetus to pass between the shafts of the maternal ilia); and deviation from normal of the head, neck, and limbs (flexure or extension deviation of the fetal extremities).

Supplemental information collected pertained to specific types of birth and viablity status at parturition of the calf involved (single born dead, single born alive, twin born dead, twin born alive, multiple born dead, multiple born alive, premature born dead, and premature born alive). Multiple births involved parturitions producing more than two calves. All recorded instances of triplet birth were a result of physiological manipulation and were not included in data relative to this thesis.

The data also included: time of death (expressed in number of days from date of birth) and calving difficulty score (1 = normal delivery, no difficulty or assistance rendered, 2 = delivery assisted with hand pull, 3 = required use of mechanical calf puller, 4 = extreme traction with mechanical puller and/or surgical extraction via cesarean section or, 5 = abnormal presentation, defined as presentation or posture deviation from normal). Recording of calving

difficulty scores began in 1965; scores were not available for the years 1963 and 1964. Postmortem examination findings were recorded and categorized; in addition, functional status of the lungs (functional versus nonfunctional) and gross anatomical normalcy of the calf were noted (normal versus abnormal based upon lack or presence of skeletal and/or visceral anomaly).

Data examined in relation to the dam included: age of dam in years at the time of calf loss; parity and previous year's lactation status (lactating, non-lactating, or first calf heifer); and pregnancy status the fall succeeding calf loss. Parity and age of dam groupings included: first calf 2-year-olds; first calf 3-year-olds; and multiparous dams (second calf cows and older). Dams managed to calve first as 2-year-olds that failed to do so, were not included in the first calf 3-year-old inventory, but rather included in the second calf 3-year-old grouping. Distinction between groups hence eliminates confounding that may have arisen between the two dam groupings. Depending upon the availability of data, condition scores at calving, precalving weights, pelvic area measurements and pasture locale at breeding and calving were obtained for dams losing calves. For the purposes of this thesis, however, summary pertaining to these data will not be made, due to their lack of complete availability.

Breeding herd assignation of dams was made according to the respective station project involved. Animals in genetic projects

represented numerous crossbred, linecross and inbred combinations, while the physiology and nutrition herds were maintained on an outcross crossbreeding program. Breed codes were assigned to designate specific breed or breed crosses and straight line or linecross progeny. Codes were established to represent 248 breed or breed cross combinations and 384 straight line or linecross combinations.

The development of inbred Hereford lines at the Livestock and Range Research Station began in the 1930's, with selection based on performance of cattle relative to traits of greatest economic importance. Fourteen lines were established, with crosslines formed from crosses of two to four of the respective inbred lines. In addition, the Florida Line was obtained from the Beef Cattle Research Station at Brooksville, Florida in 1962, and a Carcass Line was created using high performance grade Hereford dams bred to Line 1 sires (Urick et al., 1966). Data collected pertinent to this thesis represent eight of the inbred lines including Lines 1, 4, 6, 9, 10, 11, 12, and 14. The Carcass Line and Florida Line were also represented in the data.

Management schemes employed breeding periods ranging from 45 to 60 days duration. Fall pregnancy status of cows exposed for breeding was determined by rectal palpation in October. Cows were bred to calve beginning in March continuing through early May.

Calving sites for the majority of the station herds were

representative of a range calving operation. First calf heifers were calved separately from primiparous and multiparous females. Range calving areas contained shelter provided by trees and/or brush cover. Facilties were available at all calving locations to render obstetrical assistance if the need arose. Herdsmen were responsible for 24 hour observation of first calf heifers and daylight observation of mature dams prior to parturition. Herdsmen were trained to provide obstetrical assistance if, in their judgment, the situation deemed it necessary. Complicated parturitions, involving severe fetal malposition, extreme hard pulls or cesarean deliveries, were completed by licensed veterinarians.

Practiced herd health measures were directed toward disease prevention and based upon recommendations of veterinary consultants at Montana State University. Current disease preventive measures include vaccination of animals for: bovine genital vibriosis, leptospirosis, brucellosis, parainfluenza-3 (bovine myxovirus), infectious bovine rhinotracheitis, bovine virus diarrhea, Clostridium perfringens type C and D, and Clostridium chauvoei, septicum and sordelli. Treatment of calf scours and viral pneumonia was based on veterinary consultation and consisted largely of broad spectrum antibiotics and oral or intravenous electrolyte solutions.

Detailed postmortem examinations were performed on 799 of the 893 calves lost. Necropsy procedures were consistent for each

calf autopsied and were similar to procedures recommended by Jones and Gleiser (1954). Examination of carcasses for gross abnormalities and defects preceded in situ inspection of all organ systems. Systems were dissected and organs examined individually for anomaly presence. Necropsy findings were identified per carcass and recorded in detail. Histological studies were not performed.

Lung status (functional versus nonfunctional) was determined for all calves that died. Lungs that floated when placed in a container of water were considered to be inflated and by definition were classed as functional. Calves not autopsied, that were reportedly alive at birth and died sometime thereafter, were classed as having had functional lungs. Specimens of calves dying or suspected of dying as a result of infection due to specific disease pathogen, were submitted to the Montana Veterinary Diagnoistic Laboratory in Bozeman, Montana to obtain cause of death verification. Necropsy reports for all dead calves examined identified (1) actual cause of death and (2) presence of secondary lesions that may or may not have contributed toward the calf's death.

Follow up data collected for dams losing calves included (1) survival status of the dam,(2) information regarding sale of the dam or retention and subsequent exposure for breeding and (3) subsequent fall pregnancy status (pregnant, non-pregnant). Sex ratio and birth weight comparisons between dead calves and live contemporaries reflect

averages of herd mates within herds in which calf losses were recorded, and do not include all calves born. Comparisons made contrast weights of dead and live calves born to dams of the same respective age and parity groupings.

Pregnancy rates for dams losing calves (first calf 2-year-old, first calf 3-year-old and multiparous dams) were compared to overall station pregnancy rates for respective age and parity groupings. Cow inventories by age and parity of dam were collected and indicated the number of cows exposed for breeding and their subsequent fall pregnancy status. Numbers of cows calving per respective age and parity group were also obtained.

Backward and Breech Presention

Incidence of backward and breech presentation of calves at birth was summarized from field calving reports. Data collected pertinent to the summary included: year of occurrence; identification of the calf, dam and sire; sire and dam breed or inbred line; calf sex and birth weight; and calving difficulty score. Cow age and parity, survival status of the cow and calf and fall pregnancy status of the involved dam were also obtained. Calving difficulty scores, in some instances, were confounded by scores of 5 (abnormal presentation), in which case, no indication of assistance rendered to complete delivery was given.

Peripartum Complications

Data used to evaluate subsequent reproductive performance of cows experiencing cesarean section, retained placentae or vaginal or uterine prolapse included: year of occurrence; identification of the calf, dam and sire; sire and dam breed or inbred line; age and parity of the dam; calf sex and birth weight; and posture and presentation of the calf at birth. Additional data collected included: calving difficulty scores; type of prolapse encountered; survival status of the cow and calf; and pregnancy status of the involved dam during the subsequent breeding season. Parity and age of dam groupings included: first calf 2-year-olds; first calf 3-year-olds; and multiparous dams (second calf cows and older).

Cesareans were performed on dams in which delivery was determined unfeasible. Factors necessitating cesarean delivery encountered most often included: disproportion in fetal size relative to pelvic area of the dam and inability to correct an abnormal presentation. In all instances, cesareans were performed by licensed veterinarians, who were in turn responsible for post operative therapy and/or supervision.

Retained placentae, interchangeably referred to as retained fetal membranes, were defined as retained if not shed within 24 hours after parturition. Broad spectrum antibiotics were administered

intrauterine and intramuscular to affected cows with manual extraction of the retained membranes practiced only in instances where removal could be accomplished with a minimum of traction. All complications were treated contingent upon veterinary consultation. Included in the data were records from studies of cows retaining fetal membranes following induction of labor with 10 mg of flumethasone at 272 days of gestation.

Prolapses included in the study were vaginal and uterine, involving instances of peripartal occurrence. Treatment of affected cows was either administered or supervised by a licensed veterinarian. Treatment consisted of sanitary repositioning of the prolapsed organ, treatment with broad spectrum antibiotics and suture as necessary.

All cases of parturient complication were subject to supportive therapy and dams were not allowed re-entry into a breeding herd unless a subjective diagnosis of recovery was made. Sex ratio, birth weight and survival rate comparisons between calves born to affected cows and contemporaries reflect averages of herd mates within the affected herds only, and do not include the total 13,296 calvings. Pregnancy rates for cows experiencing cesarean section, retained placentae, or prolapse of the reproductive tract were compared to overall Station pregnancy rates for the respective age and parity groupings.

Statistical Analysis

Data were analyzed using Chi-square and analysis of variance. Types of data analyzed by Chi-square included enumeration data pertaining to calf death losses, pregnancy rates and peripartum complications. In the analyses of variance dependent variables included birth weight and calving difficulty score. Independent variables where appropriate for particular analyses included age and parity of dam, anatomical status of the calf, time of death (in days from the date of parturition), calving difficulty score and presentation of the calf at birth. All two factor interactions were included when enough subclasses were present to permit analyses. Mean comparisons were calculated according to the Newman and Keuls method (Dixon and Massey, 1969; Snedecor and Cochran, 1976). Statistical analyses were conducted with the aid of the Montana State University math stat package and SPSS, Statistical Package for the Social Sciences (Nie et al., 1975).

RESULTS AND DISCUSSION

I. Death Loss Study

Calf Death Loss Incidence

A total of 893 calves died during the years 1963 through 1977 resulting in a 6.7 percent death loss among the 13,296 calvings. This value is comparable to the report of Baker and Quesenberry (1944), but is slightly lower than the 8.6 percent loss reported by Laster and Gregory (1973).

Table 2 provides a breakdown of the number of calvings and calf losses per year, percentage death loss within year and percent of total death loss contributed per year. A difference ($P < .01$) in number of losses among years was observed, similar to differences reported by Wiltbank *et al.* (1961) and Lindhe (1966).

Number of calvings and calf losses per dam age and parity group appear in table 3. Of the total mortality incidence, 59.3 percent represented losses from first and second parity dams, with 40.9 percent of the total stemming solely from loss to first calf 2 and 3-year-olds. These differences due to age and parity of dam support findings reported by Woodward and Clark (1959) and Anderson and Bellows (1967) indicating a high incidence of mortality in calves born to primiparous females.

A difference ($P < .05$) in incidence of calf loss was observed between first calf 2-year-old (10.9 percent) and 3-year-old dams

TABLE 2. CALVINGS AND CALF LOSSES PER YEAR: 1963-1977[1]

Year	No. of cows calving	Calf loss per year (No.)**	Annual loss (%)	Percent of total loss (%)[2]
1963	667	50	7.4	5.6
1964	672	44	6.5	4.9
1965	730	59	8.0	6.6
1966	719	48	6.6	5.4
1967	947	46	4.8	5.2
1968	798	28	3.5	3.1
1969	917	58	6.3	6.5
1970	938	58	6.1	6.5
1971	950	44	4.6	4.9
1972	923	46	4.9	5.2
1973	938	52	5.5	5.8
1974	981	91	9.2	10.2
1975	1110	147	13.2	16.5
1976	976	58	5.9	6.5
1977	1030	64	6.2	7.2
Total	13,296	893	6.7[3]	100.0

[1]Losses represent deaths occurring from parturition to weaning.

[2]Percent of total loss over the 15 year period.

[3]Fifteen year average calf mortality incidence.

** $P < .01$.

TABLE 3. CALVINGS AND CALF LOSSES PER RESPECTIVE DAM AGE AND PARITY GROUP[1]

Age and parity of dam	No. of cows calving	No. of calf losses	Calf loss within dam age and parity group (%)	Total loss (%)
2-yr-olds	2,257	245	10.9	27.4
1st calf 3-yr-olds	1,394	121	8.7	13.5
2nd calf 3-yr-olds	1,461	60	4.1	6.7
2nd calf 4-yr-olds	1,262	105	8.3	11.7
3rd calf 4-yr-olds	1,032	50	4.8	5.6
5-yr-olds	1,760	76	4.3	8.5
6-yr-olds	1,406	65	4.6	7.3
7-yr-olds	1,050	64	6.1	7.2
8-yr-olds	753	44	5.8	4.9
9-yr-olds	486	30	6.2	3.4
10-yr-olds	298	22	7.4	2.5
11-yr-olds	104	9	8.7	1.0
12-yr-olds	28	2	7.1	.3
13-yr-olds[2]	5	0	0.0	.0
Total	13,296	893	--	100.0

[1]See text for statistical significance.

[2]There were no calvings or calf losses reported in dams 14 years of age and older.

(8.7 percent). Loss percentages within dam age and parity group and percent contribution toward total loss incidence for calves born to 2-year-old dams were 10.9 percent and 27.4 percent, respectively (table 3). Losses to primiparous 2 and 3-year-old dams were different ($P < .01$) from all other dam groupings, except that losses did not differ significantly ($P > .05$) between first calf 3 and second calf 4-year-olds.

Parity comparisons of first and second calvings show percentage loss reductions of 6.8 percent in cows calving first at 2 years of age versus .4 percent in cows calving first at 3 years. A trend toward lower calf mortality following the first parturition continued through 6-year-old dams, but losses tended to increase in dams 7 years of age and older (table 3). Calf losses were lowest among intermediate aged mature dams. Total calf death loss incidence decreased with advancing age of the dam as did the total number of calvings.

Losses to primiparous dams accounted for 41.0 percent of the total calf loss incidence, while 59.0 percent of the total represented losses to multiparous dams (table 4). Of the 526 multiparous dams losing calves, 442 (84.0 percent) weaned calves the year previous to loss, while 84 (16.0 percent) did not. Effect of previous year's lactation status on subsequent calf loss was not determined, since contemporary data were not collected.

TABLE 4. LACTATION STATUS OF DAMS THE YEAR PREVIOUS TO CALF LOSS

Age and parity of dam	No. of cows	Lactation status				
		Primiparous	Lactating[1] (No.)	(%)	Nonlactating[1] (No.)	(%)
2-yr-olds	245	245	--	--	--	--
1st calf 3-yr-olds	121	121	--	--	--	--
2nd calf 3-yr-olds	60	--	45	75.0	15	25.0
2nd calf 4-yr-olds[2]	105	--	80	76.2	24	22.8
3rd calf 4-yr-olds	50	--	42	84.0	8	16.0
5-yr-olds	76	--	63	82.9	13	17.1
6-yr-olds	65	--	58	89.2	7	10.8
7-yr-olds	64	--	58	90.6	6	9.4
8-yr-olds	44	--	44	100.0	--	--
9-yr-olds	30	--	24	80.0	6	20.0
10-yr-olds	22	--	18	81.8	4	18.2
11-yr-olds	9	--	8	88.9	1	11.1
12-yr-olds	2	--	2	100.0	--	--
Total	893	366(41.0)[3]	442(49.5)[3]		84(9.4)[3]	

[1] Lactating dams weaned calves the year previous to calf loss, nonlactating dams did not.

[2] Previous year's lactation status was not available for a 4-year-old dam obtained from Brooksville, Florida.

[3] Numbers in parenthesis represent total percentages comprised per respective dam grouping.

Table 5 summarizes calf losses per herd and/or project. As seen from the table, loss within the straightbred purebred herd accounted for the single largest grouping with regard to percent contribution toward total death loss incidence (17.1 percent) with the second largest loss category arising from the physiology herd (16.0 percent). Contemporary data pertaining to the total number of calves born per respective herd and breed were included in the initial data search; however, due to the nature of the data encompassed in this thesis detailed evaluation regarding effects of breed or inbred line on calf survivability is not feasible.

Time of death becomes an interesting question when discussing calf loss incidence, cause and effects. Table 6 summarizes loss incidence in terms of time of death in days from the date of parturition. The table indicates that the majority of losses (57.4 percent) occurred within the first 24 hours postpartum, which is similar to prior reports regarding occurrence of calf loss relative to time from parturition reported by Rasbech (1967), DeRouen et al. (1967), Koger et al. (1967), Wiltbank et al. (1973) and Young and Blair (1974). Cumulative loss within the first seven days postpartum accounted for 75 percent of the total calf death loss incidence, with only 11 percent of the total occurring from day 42 to weaning.

Time of calf loss per dam age and parity group appears in table 7. Time of loss was consistent for all groups listed, with the

TABLE 5. CALF LOSSES PER HERD AND THE BREEDS OR INBRED HEREFORD LINES INVOLVED

Herd or project	Calves dead (No.)	Total loss (%)	Breeds or inbred Hereford lines involved
Biological type study Phase 1	47	5.3	Angus, Pinzgauer, Red Poll, Simmental sires/Hereford dams
Biological type study Phase 2	7	.8	Shorthorn sires/Phase 1 F_1 females
Catch calf/Cull/Mistake Mating/ Surplus	8	.9	--
Crossbred - Phase 1	38	4.2	Angus, Brown Swiss, Charolais, Hereford
Crossbred - Phase 2	17	1.9	3-way Cross Angus, Charolais, Hereford
Crossbred - Phase 3	127	14.2	Back cross - Beef Beef herd Beef Dairy Herd/Brown Swiss
Forest Service/Grazing Experiment Study	41	4.6	Angus, Charolais, Hereford, Simmental
Grade or Test	19	2.1	Angus, Charolais, Hereford, Brown Swiss
Physiology	143	16.0	Angus, Hereford, Charolais
Purebreds			
Carcass	48	5.4	Line 1 sires/Grade Hereford dams
Genetic Environment Interaction	101	11.3	Florida Herefords, Line 1
Linecross - Phase 1	22	2.5	Lines 1, 4, 6, 9, 10
Linecross - Phase 2	16	1.8	Lines 1, 4, 6, 9, 10
Linecross - Phase 3	106	11.9	Lines 1, 4, 6, 9, 10
Straightbreds	153	17.1	Lines 1-14
TOTAL	893	100.0	

TABLE 6. TIME OF DEATH IN DAYS FROM DATE OF PARTURITION

Time of death in days[1]	No. of calves dead	Total loss (%)	Cumulative loss (%)
000	513	57.4	57.4
001	48	5.4	62.8
002	26	2.9	65.7
003	27	3.0	68.8
004	18	2.0	70.8
005	11	1.2	72.0
006	13	1.5	73.5
007	14	1.6	75.0
008	15	1.7	76.7
009	13	1.5	78.2
010	10	1.1	79.3
011-041	87	9.7	89.0
042-101	51	5.7	94.7
102-weaning	47	5.3	100.0
Total	893	100.0	100.0

[1]Day 000=death occurred within the first 24 hours post partum.
Day 001=death occurred 24-48 hours post partum, etc.

TABLE 7. TIME OF CALF LOSS PER RESPECTIVE DAM AGE AND PARITY GROUP

Age and parity of dam	Time of death in days									
	000		001-010		011-041		042-101		102-Wean	
	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
2-yr-olds	139	56.7	56	22.9	31	12.7	6	2.4	13	5.3
1st calf 3-yr-olds	72	59.5	22	18.2	12	9.9	9	7.4	6	5.0
2nd calf 3-yr-olds	28	46.7	15	25.0	6	10.0	6	10.0	5	8.3
2nd calf 4-yr-olds	65	61.9	19	18.1	3	2.9	10	9.5	8	7.6
3rd calf 4-yr-olds	31	62.0	8	16.0	5	10.0	4	8.0	2	4.0
5-yr olds	49	64.5	15	19.7	7	9.2	4	5.3	1	1.3
6-yr-olds	33	50.8	18	27.7	6	9.2	5	7.7	3	4.6
7-yr-olds	38	59.4	16	25.0	5	7.8	3	4.7	2	3.1
8-yr-olds	22	50.0	12	27.3	5	11.4	2	4.5	3	6.8
9-yr-olds	15	50.0	5	16.7	6	20.0	1	3.3	3	10.0
10-yr-olds	13	59.1	6	27.3	1	4.5	1	4.5	1	4.5
11-yr-olds	6	66.7	3	33.3	-	-	-	-	-	-
12-yr-olds	2	100.0	-	-	-	-	-	-	-	-
Total	513	57.4	195	21.8	87	9.7	51	5.7	47	5.3

majority in all cases highest during the first 24 hours postpartum. Calf losses during days 1 through 10 postpartum ranked second in their contribution to total loss within dam age and parity grouping (21.8 percent), while those incurred from day 11 postpartum through weaning amounted to 20.7 percent of the total. The consistency observed in percentage calf loss within dam age and parity group over time is noteworthy, and to date has not been reported in the literature.

Single births accounted for 856 (95.9 percent) of the 893 recorded deaths. Thirty-five (3.9 percent) of the dead calves included in the study were twins. Type of birth was not recorded for two of the 893 calves.

Table 8 provides a sex ratio comparison for calves included in the study. The difference between sexes in incidence of mortality was highly significant (57.1 percent for males versus 42.1 percent for females) and agrees with findings previously reported by Withers (1952), Dreyer and Leiphitz (1971) and Laster and Gregory (1973). The expected sex ratio used for analysis purposes was obtained from the contemporary herd mate ratio of 50.7 percent males and 49.3 percent females. Calves classes as intersex possessed both testicular and ovarian tissue or exhibited ambiguous morphological criteria of sex.

Table 8. LUNG STATUS EXPRESSED PER SEX OF CALF

Sex of Calf	Lung status: Functional (No.)	(%)	Nonfunctional (No.)	(%)	Not determined (No.)	(%)	Total (No.)	(%)
Males	332	56.8	173	57.5	5	71.4	510	57.1[a]
(%)	65.1		33.9		1.0		100.0	
Females	249	42.6	125	41.5	2	28.6	376	42.1[b]
(%)	66.2		33.2		.5		100.0	
Intersex	0	---	3	1.0	0	---	3	.3
(%)	---		100.0		---		100.0	
Sex not determined	4	.7	0	---	0	---	4	.4
(%)	100.0		---		---		100.0	
Total	585	100.0	301	100.0	7	100.0	893	100.0
(%)	65.5		33.7		.8		100.0	

[a,b]Numbers with different superscripts differ significantly.

Lung status, functional versus nonfunctional, was determined for 886 of the dead calves (table 8). Functional lungs were observed in 585 (65.5 percent) ($P < .01$) of the calves, while 301 (33.7 percent) were found to be nonfunctional. These percentages are greater than reported in prior studies which noted functional status in only 20 to 30 percent of dead calves examined (Anderson and Bellows, 1967; Laster and Gregory, 1973). No difference was observed between sexes regarding lung status classification. Functional lung status was observed in 65.1 percent of the males and 66.2 percent of the females.

Losses occurring within the first 24 hours postpartum accounted for 35.0 percent of the total loss incidence for calves included in the functional lung status group, while cumulative loss within the first ten days postpartum accounted for 68.3 percent of the total. All calves included in the nonfunctional lung status group died within the first 24 hours postpartum.

Lung status classification expressed per anatomical status (normal or abnormal) of the calf is shown in table 9. Functional lung status was observed in 63.0 percent of the normal calves, compared to 61.1 percent of the abnormal calves. These percentages contrast prior findings of Anderson and Bellows (1967), which noted functional lung status in 28.1 percent and 34.8 percent of normal and abnormal calves, respectively. Discrepancies between the two studies may be due to the more critical evaluation of lung status

Table 9. LUNG STATUS CLASSIFICATION EXPRESSED PER ANATOMICAL STATUS

Anatomical Status	Lung Status							
	Functional		Nonfunctional		Status not determined		Total	
	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
Normal	394	67.4	231	76.7	0	---	625	70.0
(%)	63.0		37.0		---		100.0	
Abnormal[1]	110	18.8	70	23.3	0	---	180	20.1
(%)	61.1		38.9		---		100.0	
Status not determined	81	13.8	0	---	7	100.0	88	9.9
(%)	92.0		---		8.0		100.0	
Total	585	100.0	301	100.0	7	100.0	893	100.0
	65.5		33.7		.8		100.0	

[1]Respective anomalies were not recorded for three calves included in the abnormal anatomical status group. One of the three had functional lungs prior to the time of death, two were classed as nonfunctional.

with regard to calves included in the present study.

Detailed post mortem examinations were performed on 799 (89.5 percent) of the 893 calves lost (table 10). Of calves necropsied, 620 (77.6 percent)were anatomically normal compared to 178 (22.3 percent) abnormal. Differences in sex ratio were nonsignificant ($P > .05$) for calves classed as abnormal, but were highly significant for the normal calves. Abnormality incidence for dead calves autopsied compare favorably with prior studies from this same herd summarized by Anderson and Bellows (1967).

Of the 513 calves that died within the first 24 hours postpartum, 116 (22.6 percent) were anatomically abnormal (table 11). Explanation regarding this incidence could in part be due to the 24.6 percent average inbreeding coefficient recorded for 32 of the 116 abnormal calves. This incidence is considerably higher than the 2.6 percent abnormality rate reported among stillborn calves by Withers (1952). Cumulative loss within the first ten days postpartum accounted for 89.4 percent of the deaths among abnormal offspring, which again is notably higher than studies cited by Rasbech (1967) and Leipold (1978b).

Anatomical status was not significantly affected by age or parity of dam (table 12) although a trend toward increased occurrence in dams beyond age 10 was seen. It should be noted that interpretation of such data is difficult due to the small number of dams involved.

Table 10. ANATOMICAL STATUS OF DEAD CALVES NECROPSIED

Anatomical status	Necropsy Status: Calves necropsied (No.)	Calves not necropsied (No.)	Total calves lost (No.)	Total calves lost (%)
Normal	620	5	625	69.9
Males	(360)	(2)	(362)	(40.5)[a]
Females	(259)	(3)	(262)	(29.3)[b]
SNR[1]	(1)	(0)	(1)	(.1)
Abnormal	178	2	180	20.2
Males	(97)	(0)	(97)	(10.9)
Females	(80)	(0)	(80)	(9.0)
Intersex	(1)	(2)	(3)	(.3)
Status not determined	1	87	88	9.9
Males	(1)	(50)	(51)	(5.7)
Females	(0)	(34)	(34)	(3.8)
SNR[1]	(0)	(3)	(3)	(.3)
Total	799	94	893	100.0
(%)	89.5	10.5	100.0	

[1]SNR = Calf sex not recorded.

[a,b]Numbers with different superscripts differ significantly ($P < .01$).

Table 11. TIME OF DEATH RELATIVE TO ANATOMICAL STATUS

Anatomical Status	Time of Death in Days										Total	
	000		001-010		011-041		042-101		102-Wean			
	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)	(No.)	(%)
Normal	381	74.3[a]	143	73.3	60	69.0	22	43.1	19	40.4	625	69.9
(%)	61.0[b]		22.8		9.6		3.5		3.0		100.0	
Abnormal	116	22.6	45	23.1	15	17.2	0	---	4	8.5	180	20.2
(%)	64.4		25.0		8.3		---		2.2		100.0	
Status not determined	16	3.1	7	3.6	12	13.8	29	56.9	24	51.1	88	9.9
(%)	18.2		8.0		13.6		33.0		27.3		100.0	
Total	513	100.0	195	100.0	87	100.0	51	100.0	47	100.0	893	100.0
(%)	57.4		21.8		9.7		5.7		5.3		100.0	

[a]Percent of total number of calves regarding anatomical status per time grouping.

[b]Percent of total number of calves lost over time per anatomical status.

Table 12. ANATOMICAL STATUS OF CALVES PER DAM AGE AND PARITY GROUP

Age and Parity of Dam	Anatomical Status						Total (No.)
	Normal		Abnormal		Status not determined		
	(No.)	(%)	(No.)	(%)	(No.)	(%)	
2-yr-olds	185	75.5	34	13.9	26	10.6	245
1st calf 3-yr-olds	85	70.2	25	20.7	11	9.1	121
2nd calf 3-yr-olds	43	71.7	11	18.3	6	10.0	60
2nd calf 4-yr-olds	70	66.7	25	23.8	10	9.5	105
3rd calf 4-yr-olds	36	72.0	9	18.0	5	10.0	50
5-yr-olds	51	67.1	17	22.4	8	10.5	76
6-yr-olds	39	60.0	20	30.8	6	9.2	65
7-yr-olds	43	67.2	17	26.6	4	6.2	64
8-yr-olds	32	72.7	7	15.9	5	11.4	44
9-yr-olds	23	76.7	4	13.3	3	10.0	30
10-yr-olds	12	54.5	7	31.8	3	13.6	22
11-yr-olds	5	55.6	3	33.3	1	11.1	9
12-yr-old	1	50.0	1	50.0	-	---	2
Total	625	69.9	180	20.2	88	9.9	893

Causes of Calf Mortality

Table 13 summarizes causes of death for 788 of the 893 calves that died. Cause of death was not determined for 105 of the 893 calves. Losses are grouped according to major cause categories with deaths attributed to specific subgroups presented following the main cause groupings.

Delayed and difficult birth accounted for the single largest source of calf mortality resulting in the death of 410 of the total 893 calves lost, or 51.3 percent of the 799 calves autopsied. These data support prior studies which implicate dystocia as the principle contributing factor toward total calf loss incidence reported by Laster and Gregory (1973), Young and Blair (1974) and Philipsson (1976a). Deaths attributed to technician error occurred as a result of errors made while providing obstetrical assistance at the time of parturition and/or over zealous resuscitation techniques practiced following difficult calvings.

Disease accounted for the second largest cause of death category resulting in the loss of 96 calves, 10.8 percent of the total number lost. Specific entities responsible for the majority of the total disease related death loss incidence (69.8 percent) consisted of pneumonia (4.8 percent) and scours (2.7 percent), respectively. These data contrast reports of Pattulo (1973) and Young and Blair (1974)

TABLE 13. CAUSE OF DEATH SUMMARY

Cause of death	No. calves dead		Total calf death loss (%)	
Abandoned and/or starvation	25		2.8	
Accidental death	54		6.0	
Adhesions (internal)	1		.1	
Bloat	3		.3	
Born dead	10		1.1	
Brain damage or anomaly	39	[1]	4.4	[2]
Enlarged ventricles		(6)		(.7)
Hydrocephalus		(30)		(3.4)
Hydrocephalus - external		(2)		(.1)
Injury		(1)		(.2)
Castration hemorrhage	1		.1	
Delayed and difficult birth complex	410		45.9	
Brain hemorrhage and injury		(9)		(1.0)
Drowned in placental fluid		(2)		(.2)
Dystocia		(340)		(38.1)
Heart injury at sternum		(1)		(.1)
Intestines ruptured		(1)		(.1)
Intrauterine hemorrhage and death		(20)		(2.2)
Larynx contained mucous plug		(1)		(.1)
Lungs hemorrhaged		(1)		(.1)
Lungs ruptured		(2)		(.2)
Membrane covering mouth and nasal passages		(4)		(.4)
Skull fracture		(1)		(.1)
Technician error		(10)		(1.1)
Trachea filled with fluid/froth		(2)		(.2)
Umbilical hemorrhage		(16)		(1.8)

TABLE 13. CAUSE OF DEATH SUMMARY (CONTINUED)

Cause of death	No. calves dead		Total calf death loss (%)	
Disease	96		10.8	
Asthma		(1)		(.1)
Diptheria		(1)		(.1)
Emphysema		(2)		(.2)
Enteritis		(4)		(.4)
Enterotoxemia		(6)		(.7)
Gastritis		(5)		(.6)
Inframandibular cellulitis		(1)		(.1)
Leptospirosis		(8)		(.9)
Navel Ill		(1)		(.1)
Pneumonia		(43)		(4.8)
Scours		(24)		(2.7)
Euthanasia	34		3.8	
Exposure and/or shock	45		5.0	
Fetal monster	5		.6	
Hairball	12		1.3	
Heart anomaly or complication	24		2.7	
Common auricle		(2)		(.2)
Fibrillation		(1)		(.1)
Foramen ovale enlarged		(1)		(.1)
Foramen ovale patent		(1)		(.1)
Heart enlarged		(1)		(.1)
Pulmonary artery occluded		(2)		(.2)
Valve defect		(6)		(.7)
Valve hemorrhage		(2)		(.2)
Ventricular abnormality		(8)[3]		(.9)
Hernia - strangulated	1		.1	
Intestinal anomaly or complication	13		1.5	
Aplasia		(1)		(.1)
Blockage of GI tract		(4)		(.4)

TABLE 13. CAUSE OF DEATH SUMMARY (CONTINUED)

Cause of death	No calves dead		Total calf death loss (%)	
Missing segment hind gut		(8)		(.9)
Liver degeneration	2		.2	
Lungs - foreign body pneumonia	6		.7	
Palate and pastern syndrome	1		.1	
Peritonitis and general infection	2		.2	
Premature	3		.3	
Pyloric tumor	1		.1	
Cause of death not determined[4,5]	105		11.8	
Total	893		100.0	

[1] Numbers in parentheses represent incidence of death attributed to the specific subgroup.
[2] Numbers in parentheses represent percent of total calf death loss per respective subgroup.
[3] Includes abnormal opening or joining, persence of holes in the ventricular septum, or a thin ventricle wall.
[4] Category includes calves that were autopsied with cause of death not determined, calves found dead and not examined, or calves missing and never found.
[5] Of the 105 calves in which cause of death was not determined, 57 were either found dead and not examined or were missing at weaning and never found.

which pointed to calf scours and virus pneumonia, respectively, as the number one and two ranking disease entities advancing mortality rates in beef calves.

Losses are summarized in appendix tables 1 through 14 with respect to time and cause of death. Time of death is catalogued on a daily basis for the first ten days postpartum with subsequent losses grouped for days 11 to 41, 42 to 101 and 102 through weaning. These tables provide a breakdown of calf losses with respect to the actual cause of death and the time in days postpartum at which death occurred.

Table 14 summarizes calf losses pertaining to time of death and largest loss category. Death as a result of delayed and difficult birth accounted for the largest loss category the first three days postpartum. Losses due to delayed and difficult birth resulted in 69.6, 39.6, 30.8 and 33.3 percent of the total loss incidence for days 0, 1, 2, and 3 postpartum, respectively. The majority of loss attributed to dystocia occurred within the first 24 hours postpartum and accounted for 40.0 percent of the total loss incidence.

Abnormal calves, euthanized due to presence of gross congenital anomaly, represented the largest loss category at day 4 postpartum, with disease accounting for the largest death loss grouping days 6 through 10 postpartum. Calves missing and never found represented the largest loss category from day 42 postpartum through weaning.

TABLE 14. CALF LOSSES PER TIME OF DEATH AND LARGEST LOSS CATEGORY

Time of Death in Days	Total Loss (No.)	Total Loss (%)	Largest Loss Category (No.)	% of Loss Within day	% of Loss of total loss	Category
0	513	57.4	357	69.6	40.0	Delayed and difficult birth complex[1]
1	48	5.4	19	39.6	2.1	Delayed and difficult birth complex[1]
2	26	2.9	8	30.8	.9	Delayed and difficult birth complex[1]
3	27	3.0	9	33.3	1.0	Delayed and difficult birth complex[1]
4	18	2.0	4	22.2	.4	Euthanasia
5	11	1.2	6	54.6	.6	Accidental death, Disease[2]
6	13	1.5	6	46.2	.7	Disease[2]
7	14	1.6	6	42.9	.7	Disease[2]
8	15	1.7	4	26.7	.4	Disease[2]
9	13	1.5	5	38.5	.6	Disease[2]
10	10	1.1	4	40.0	.4	Disease[2]
11-41	87	9.7	35	40.2	3.9	Disease[2]
42-101	51	5.7	25	49.0	2.8	Cause of death not determined[3]
102-Wean	47	5.3	23	48.9	2.6	Cause of death not determined[4]
Total	893	100.0	511	-	37.2	

[1] Refer to Appendix Tables 1 through 4 for specific causes of death attributed to the delayed and difficult birth complex.

[2] Refer to Appendix Tables 6 through 12 for specific diseases entities.

[3] Of the 25 calves that died during days 42 to 101, 3 were found dead and 22 were missing and never found.

[4] Of the 23 calves that died during days 102 to weaning, 5 were found dead and 18 were missing at weaning and never found.

Post Mortem Autopsy Cases

In order to facilitate a logical and concise summary, discussion will now focus only on calves that were autopsied post mortem. To initiate the discussion, table 15 summarizes losses with respect to average birth weights of calves expressed per dam age and parity group, time and cause of death, sex of calf and anatomical status. The breakdown was made in order to compare birth weights of autopsied calves and to evaluate the effects on birth weight exerted by the respective items listed. Tests were made for main affects and two-way interactions.

Table 16 provides a listing of adjusted averages for independent variables regarding their effects on calf birth weight. All independent variables considered were found to exert a highly significant effect on the birth weights of dead calves autopsied. Comparison of adjusted averages shown in table 16 indicates that birth weights did not differ significantly between first calf 2 and 3-year-old dams. Average birth weights were significantly heavier, however, for calves born to multiparous dams than those from primiparous females.

A 4.1 Kg difference was observed between birth weights of normal and abnormal calves, the average being higher for the normals. Birth weights differed significantly as well, between calves that died in dystocia versus nondystocia related deaths. Average birth weights of calves that died in dystocia related deaths were 5.3 kg heavier

than for calves in the nondystocia related grouping and 2.6 kg heavier than the calculated overall mean weight.

Birth weights were significantly heavier for males calves than females, with a 3.6 kg difference noted between sexes. Comparison of birth weights regarding the respective times listed noted a significant difference between weights of calves that died within the first 24 hours postpartum and all other time groupings. Weights of calves that died within the first 24 hours postpartum were 3.6, 5.3, 6.0 and 5.0 kg lower ($P < .05$) than the four other respective time groupings considered.

Tests for two-way interaction noted a highly significant effect of morphology by time of death on birth weights of the autopsied calves. Reference to table 15 indicates that average birth weights increased for both normal and abnormal calves with respect to the time at which death occurred. Average birth weights for normal and abnormal calves were lowest in deaths occurring at day 0, when compared to birth weights of calves that died following the first 24 hours postpartum. No other significant interactions were observed.

Death Loss of Anatomically Normal Calves

Table 17 summarizes causes of death for autopsied calves classed as anatomically normal. Deaths attributed to the delayed and difficult birth complex accounted for 374 deaths, 60.3 percent of the 620 normal

TABLE 15. AVERAGE BIRTH WEIGHTS EXPRESSED PER DAM AGE AND PARITY GROUP, TIME AND CAUSE OF CALF DEATH, ANATOMICAL STATUS AND CALF SEX

Age and Parity of Dam	Time of Death: Day 000				Day 001–010				Day 011–041				Day 042–101				Day 102–wean			
	Dystocia		Nondystocia		Dystocia		Nondystocia		Dystocia		Nondystocia		Dystocia		Nondystocia		Dystocia		Nondystocia	
	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)	(No.)	Avg. Brwt. (kg.)
2-yr-olds																				
Normal	95	35.0	10	28.2	20	35.8	29	32.1	2	39.6	21	34.1	0	----	2	32.6	0	----	5	33.2
Males	56	36.1	6	28.4	12	37.3	14	32.4	0	____	15	34.8	0	____	1	34.7	0	____	4	35.8
Females	39	33.3	4	27.9	8	33.5	15	31.8	2	39.6	6	32.9	0	____	1	30.6	0	____	1	23.0
Abnormal	9	28.4	16	23.7	0	----	5	32.3	0	----	3	36.6	0	----	0	----	0	____	0	----
Males	4	35.2	9	24.4	0	____	5	32.3	0	____	0	____	0	____	0	____	0	____	0	____
Females	5	23.0	7	22.8	0	____	0	____	0	____	3	36.6	0	____	0	____	0	____	0	____
1st Calf 3-yr-olds																				
Normal	40	34.8	7	29.8	8	35.4	9	32.5	0	----	11	34.7	0	----	7	33.6	0	----	2	22.1
Males	21	36.9	4	29.5	4	36.1	6	32.3	0	____	8	35.6	0	____	3	34.7	0	____	0	____
Females	19	32.4	3	30.3	4	34.7	3	33.3	0	____	3	33.3	0	____	4	32.8	0	____	2	22.1
Abnormal	7	31.7	13	23.6	0	----	4	30.7	0	----	0	----	0	----	0	----	0	____	1	28.8
Males	3	34.5	7	23.6	0	____	3	35.1	0	____	0	____	0	____	0	____	0	____	0	____
Females	4	29.6	6	23.6	0	____	1	17.6	0	____	0	____	0	____	0	____	0	____	1	28.8
Mature dams																				
Normal	189	35.8	38	33.0	17	41.9	59	33.4	2	33.8	21	31.3	0	----	13	37.0	0	----	12	33.9
Males	118	37.2	23	33.7	13	42.8	31	34.7	0	____	8	32.2	0	____	7	38.5	0	____	5	42.9
Females	71	33.6	15	31.9	4	38.8	28	31.9	2	33.8	13	30.8	0	____	6	35.2	0	____	7	32.2
Abnormal	13	28.6	55	23.9	3	32.1	33	31.4	1	36.9	11	38.3	0	----	0	----	0	----	3	35.2
Males	6	30.3	29	26.5	2	30.6	19	34.2	0	____	8	38.3	0	____	0	____	0	____	2	37.8
Females	7	27.0	25	21.5	1	25.1	14	27.5	1	36.9	3	38.4	0	____	0	____	0	____	1	30.2

TABLE 16. EFFECTS OF ANATOMICAL STATUS, CAUSE AND TIME OF DEATH, AGE OF DAM AND CALF SEX ON BIRTH WEIGHT

	Calves Dead No.[1]	Avg. Brwt. (Kg.)[2]	Avg. Brwt. (Kg.)[3]
μ	796	33.2	33.2
Age and parity of dam		**	
2-yr-olds	217	32.4[a]	33.1
1st calf 3-yr-olds	109	32.3[a]	32.3
Multiparous ams	470	33.8[b]	33.5
Anatomical status		**	
Normal	619	34.2[a]	34.7
Abnormal	177	30.0[b]	28.1
Cause of death		**	
Dystocia	407	35.8[a]	35.3
Nondystocia	389	30.5[b]	31.1
Sex of calf		**	
Female	339	31.2[a]	34.8
Male	457	34.8[b]	31.2
Time of death		**	
Day 0	492	31.6[a]	32.7
Days 1-10	187	35.2[b]	33.8
Days 11-41	72	36.9[b]	34.3
Days 42-101	22	37.6[b]	35.5
Days 102-Wean	23	36.6[b]	34.1

** $P < .01$

[a,b]Means with different superscripts differ significantly ($P < .05$).

[1]Averages do not include birth weights of three of the autopsied calves.

[2]Adjusted mean birth weights.

[3]Unadjusted mean birth weights.

calves autopsied. Lesions encountered at autopsy indicative of dystocia are included as subgroups under the delayed and difficult birth complex heading.

Table 18 provides a complete listing of dystocia related findings accompanying the actual causes of death. Asphyxia due largely to aspiration of placental fluid was observed in 40.4 percent of the normal calves that died in dystocia related deaths. Noticeable lesions further included edema of subcutaneous tissues, intrauterine and intramuscular hemorrhage, fractures and joint dislocations, contusions and visceral damage.

Appendix tables 15 through 28 provide a complete breakdown of death causes for normal calves autopsied and the respective time in days post-partum at which death occurred. Appendix table 15 indicates that 326 (87.2 percent) of the 374 dystocia related deaths occured within the first 24 hours postpartum, resulting in 85.6 percent of the losses incurred during that time. Losses related to or stemming from dystocia further resulted in the majority of normal calf losses on day 1, 2 and 3 postpartum accounting for 57.6, 36.8 and 40.0 percent of the calf losses incurred during those respective days.

Table 19 summzrizes calving difficulty scores of normal calves that died as a result of dystocia. The table is expressed in relation to the effect of dam age and parity group and calf sex on calving difficulty score. Adjusted and unadjusted mean calving difficulty

TABLE 17. CAUSE OF DEATH FOR CALVES CLASSED AS ANATOMICALLY NORMAL

Cause of death	No. calves dead		Total calf death loss[1] (%)	
Abandoned and/or starvation	22		3.5	
Accidental death	43		6.9	
Adhesions (internal)	1		.2	
Bloat	3		.5	
Castration hemorrhage	1		.2	
Delayed and difficult birth complex	374		60.3	
Brain hemorrhage and injury		(9)[2]		(1.5)[3]
Drowned in placental fluid		(2)		(.3)
Dystocia		(313)		(50.5)
Heart injury at sternum		(1)		(.2)
Intestines ruptured		(1)		(.2)
Intrauterine hemorrhage and death		(15)		(2.4)
Larynx contained mucous plug		(1)		(.2)
Lungs ruptured		(1)		(.2)
Membrane covering mouth and nasal passages		(4)		(.6)
Skull fracture		(1)		(.2)
Technician error		(9)		(1.5)
Trachea filled with fluid/froth		(2)		(.3)
Umbilical hemorrhage		(15)		(2.4)
Disease	87		14.0	
Asthma		(1)		(.2)
Diptheria		(1)		(.2)
Emphysema		(2)		(.3)
Enteritis		(3)		(.5)
Enterotoxemia		(6)		(1.0)
Gastritis		(5)		(.8)
Inframandibular cellulitis		(1)		(.2)

TABLE 17. CAUSE OF DEATH FOR CALVES CLASSED AS ANATOMICALLY NORMAL (CONTINUED)

Cause of death	No. calves dead		Total calf death loss[1] (%)	
Leptospirosis		(8)		(1.3)
Navel ill		(1)		(.2)
Pneumonia		(37)		(6.0)
Scours		(22)		(3.5)
Euthanasia	6		1.0	
Exposure and/or shock	43		6.9	
Hairball	9		1.5	
Hernia strangulated	1		.2	
Intestinal complication	4		.6	
Blockage of GI tract		(4)		(.6)
Liver degeneration	1		.2	
Lungs - foreign body pneumonia	5		.8	
Peritonitis and general infection	2		.3	
Premature	1		.2	
Pyloric tumor	1		.2	
Cause of death not determined	16		2.6	
Total	620		100.0	

[1]Percentages reflect the percent of total calf death loss among normal calves.

[2]Numbers in parentheses represent incidence of death attributed to the specific subgroup.

[3]Numbers in parentheses represent the percent of total calf death loss among calves classed as anatomically normal, and reflect losses per respective subgroup.

TABLE 18. RELATED DYSTOCIA FINDINGS ACCOMPANYING ACTUAL DEATH CAUSE

Dystocia related finding	No.		Total dystocia related deaths (%)[1]	
Asphyxia	151		40.4	
Drowned in placental fluid		(107)[2]		(28.6)[3]
Lungs fluid filled		(2)		(.5)
Membranes covering mouth and nasal passages		(1)		(.3)
Trachea filled with blood, froth, placental fluid		(41)		(11.0)
Contusions	24		6.4	
Heart		(9)		(2.4)
Jaw		(2)		(.5)
Legs		(1)		(.3)
Neck		(5)		(1.3)
Rib Cage		(5)		(1.3)
Sternum		(2)		(.5)
Edema	23		6.1	
Head		(12)		(3.2)
Neck		(9)		(2.4)
Tongue		(2)		(.5)
Fractures and joint dislocations	53		14.2	
Jaw		(1)		(.3)
Legs		(8)		(2.1)
Ribs		(40)		(10.7)
Shoulder joints separated		(1)		(.3)
Skull		(1)		(.3)
Vertebral column		(2)		(.5)
Hemorrhage	39		10.4	
Brain		(27)		(7.2)
Intrauterine hemorrhage and death		(3)		(.8)
Larnyx		(2)		(.5)
Lungs		(1)		(.3)
Umbilical		(6)		(1.6)
Visceral damage	13		3.5	
Lungs punctured/ruptured		(13)		(3.5)

[1]Numbers reflect percent of related dystocia findings recorded among the 374 deaths resulting from delayed and difficult birth complex.

[2]Numbers in parentheses represent incidence of related dystocia findings attributed to the specific subgroup.

[3]Numbers in parentheses represent percent of related dystocia findings recorded among the 374 deaths resulting from the delayed and difficult birth complex.

TABLE 19. CALVING DIFFICULTY SCORES OF NORMAL CALVES DYING AS A RESULT OF DYSTOCIA EXPRESSED PER DAM AGE AND PARITY GROUP AND CALF SEX

Age and Parity of Dam	Calving Difficulty Score[1] (1) No assistance (No.)	(%)	(2) Hand pull (No.)	(%)	(3) Mechanical puller (No.)	(%)	(4) Cesarean section (No.)	(%)	(5) Abnormal presentation (No.)	(%)	Total (No.)	(%)
2-yr-olds	16	12.0	7	41.2	46	59.0	20	80.0	25	30.5	114	34.0
(%)		14.0		6.1		40.4		17.5		21.9		100.0
Males	8	6.0	4	23.5	29	37.2	14	56.0	12	14.6	67	20.0
Females	8	6.0	3	17.6	17	21.8	6	24.0	13	15.9	47	14.0
1st calf 3-yr-olds	12	9.0	5	29.4	11	14.1	2	8.0	5	6.1	35	10.5
(%)		34.3		14.3		31.4		5.7		14.3		100.0
Males	4	3.0	2	11.8	8	10.3	2	8.0	2	2.4	18	5.4
Females	8	6.0	3	17.6	3	3.8	0	—	3	3.7	17	5.1
Multiparous dams	105	79.0	5	29.4	21	26.9	3	12.0	52	63.4	186	55.5
(%)		56.5		2.7		11.3		1.6		28.0		100.0
Males	68	51.1	4	23.5	18	23.1	2	8.0	26	31.7	118	35.2
Females	37	27.9	1	5.9	3	3.8	1	4.0	26	31.7	68	20.3
Total	133	100.0	17	100.0	78	100.0	25	100.0	82	100.0	335	100.0
(%)		39.7		5.1		23.3		7.5		24.5		

[1]Calving difficulty scores were not recorded for 39 of the normal calves dying as a result of dystocia.

scores are shown in table 20 for 253 of the 374 calves. Means do not reflect scores of 5 (abnormal presentation), nor do they include the 39 missing cases. Scores of 5 were excluded from the analysis since no indication of level of assistance rendered is given.

Calving difficulty scores were afffected ($P < .01$) by age and parity of dam and calf sex. The influence exerted by respective dam groupings agrees with prior studies reported by Lefever and Wiltbank (1961), Rasbech (1967) and Laster et al. (1973), which point to increased incidence of dystocia and resulting calf loss in primiparous dams. Differences between sexes regarding the occurrence and severity of dystocia coincides with previous reports of increased incidence of calving difficulty and subsequent calf loss in births involving male calves (Lindhe, 1966; Sellers et al., 1968).

Table 21 summarizes average birth weights of normal calves that died as a result of dystocia and is expressed per dam age and parity group, calving difficulty score and calf sex. Adjusted and unadjusted mean birth weights as influenced by the respective independent variables listed are presented in table 22. Birth weights were affected ($P < .001$) by calving difficulty score and calf sex, in addition to age and parity of dam ($P < .05$).

Birth weights were signficantly heavier in parturitions requiring mechanical assistance or cesarean delivery than in normal unassisted births. This finding supports the work of Burfening (1976) and Laster

TABLE 20. EFFECT OF AGE AND PARITY OF DAM AND CALF SEX ON CALVING DIFFICULTY SCORES OF NORMAL CALVES

	Calves dead No.[1]	Mean CD Score[2]	Mean CD Score[3]
μ	253	2.0	2.0
Age and parity of dam		**	
2-yr-olds	89	2.8^{a}	2.8
1st calf 3-yr-olds	30	2.2^{b}	2.1
Multiparous ams	134	1.4^{c}	1.4
Sex of calf		**	
Male	163	2.1^{a}	2.1
Female	90	1.8^{b}	1.8

** $P < .01$.

^{a,b,c}Means with different superscripts differ significantly ($P < .05$).

[1]Mean calving difficulty scores do not include scores for 121 of the 374 normal calves that died as a result of dystocia. The 121 calves excluded include those that lacked calving difficulty scores and those with scores of 5 (abnormal presentation).

[2]Adjusted mean calving difficulty scores.

[3]Unadjusted mean calving difficulty scores.

TABLE 21. AVERAGE BIRTH WEIGHTS OF NORMAL CALVES DEAD AS A RESULT OF DYSTOCIA EXPRESSED PER DAM AGE AND PARITY GROUP, CALVING DIFFICULTY SCORE, AND CALF SEX

Age and Parity of Dam	Calving Difficulty Score[1]									
	(1) No assistance		(2) Hand pull		(3) Mechanical puller		(4) Casarean section		(5) Abnormal presentation	
	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)
2-yr-olds	16	31.3	7	34.3	46	37.1	20	37.0	25	33.3
Males	8	31.7	4	36.6	29	38.1	14	37.4	12	34.6
Females	8	30.9	3	31.4	17	35.5	6	35.9	13	32.1
1st calf 3-yr-old	12	29.8	5	39.2	11	38.8	2	38.7	5	34.9
Males	4	28.4	2	44.8	8	38.2	2	38.7	2	37.4
Females	8	30.5	3	35.4	3	40.5	0	—	3	33.3
Multiparous dams	105	35.6	5	33.0	21	42.0	3	31.4	52	36.5
Males	68	37.4	4	34.1	18	42.4	2	30.3	26	37.1
Females	37	32.3	1	28.8	3	39.2	1	34.2	26	35.9

[1]Calving difficulty scores were not recorded for 39 of the normal calves dead as a result of dystocia.

TABLE 22. EFFECT OF CALVING DIFFICULTY SCORE, AGE AND PARITY OF DAM AND CALF SEX ON BIRTH WEIGHTS OF NORMAL CALVES

	Calves dead (No.)	Avg. brwt. (Kg.)[1]	Avg. brwt. (Kg.)[2]
μ	253	36.1	36.1
Calving difficulty score		**	
1	133	33.9[a]	34.5
2	17	36.1[a,b]	35.4
3	78	39.2[b]	38.7
4	25	37.4[b]	36.4
Age and parity of dam		*	
2 yr-olds	89	34.3[a]	35.8
1st calf 3-yr-old	30	35.2[a,b]	35.3
Multiparous dams	134	37.4[b]	36.4
Sex of calf		**	
Male	163	37.3[a]	37.5
Female	90	33.9[b]	33.4

* $P < .05$.

** $P < .01$.

[a,b]Means with different superscripts differ significantly ($P < .05$).

[1]Calving difficulty scores do not include scores for 121 of the 374 normal calves that died as a result of dystocia. The 121 calves excluded include those that lacked calving difficulty scores and those with scores of 5 (abnormal presentation).

[2]Adjusted mean birth weights.

[3]Unadjusted mean birth weights.

(1976) who report increased need of obstetrical assistance at the time of birth corresponding to paralleled increases in dystocia and calf birth weight.

Birth weights differed significantly as well between calves born to first calf 2-year-olds and multiparous dams. No difference was seen, however, between birth weights of calves born to first calf 3-year-old dams and the other two dam groupings.

Table 23 summarizes birth weights of normal calves that died as a result of dystocia and is expressed per dam age and parity group, presentation of the calf at birth and calf sex. Adjusted and unadjusted mean birth weights as affected by the respective independent variables considered are shown in table 24. Data included in the analysis represent all 374 dystocia cases.

Birth weights were not significantly affected by presentation of the calf at birth or dam age and parity group, although a highly significant affect on birth weight was exerted by calf sex. Birth weights of calves involved in parturitions resulting in complications stemming from hiplock or retracted limbs were significantly heavier than weights of calves presented normally or backward or breech.

It is interesting to note that 122 (32.6 percent) of the 374 dystocia related deaths involved abnormal presentation of the calf, 61.3 percent of which were either backward or breech. A higher ($P < .01$)

TABLE 23. AVERAGE BIRTH WEIGHTS OF NORMAL CALVES DEAD AS A RESULT OF DYSTOCIA EXPRESSED PER DAM AGE AND PARITY GROUP, PRESENTATION AT BIRTH AND CALF SEX

Age and Parity of Dam	Presentation													
	Normal		Backwards		Breech		Hiplock		Leg back		Head back		Other	
	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)
2-yr-olds	76	35.5	13	31.3	4	35.6	14	36.9	9	35.8	0	-	1	35.1
Males	45	36.9	6	32.1	3	36.0	9	36.5	5	36.1	0	-	0	-
Females	31	33.4	7	30.7	1	34.2	5	37.7	4	35.4	0	-	1	35.1
1st calf 3-yr-olds	39	34.9	7	34.7	1	27.9	0	-	1	43.2	0	-	0	-
Males	20	36.8	4	35.3	0		0	-	1	43.2	0	-	0	-
Females	19	32.9	3	33.8	1	27.9	0	-	0	-	0	-	0	-
Multiparous dams	137	36.4	18	36.2	32	34.5	2	48.2	10	39.8	4	34.2	6	35.9
Males	93	38.2	13	36.6	14	34.5	1	46.4	4	39.8	1	49.5	5	35.7
Females	44	32.7	5	35.1	18	34.4	1	50.0	6	39.7	3	29.1	1	36.9

TABLE 24. EFFECT OF PRESENTATION AT BIRTH, AGE AND PARITY OF DAM AND CALF SEX ON BIRTH WEIGHTS OF NORMAL CALVES

	Calves dead (No.)	Avg. brwt. (Kg.)	Avg. brwt. (Kg.)
μ	374	35.8	35.8
Presentation at birth		NS	
Normal	252	36.0[a]	35.9
Backward	38	34.3[a]	34.2
Breech	37	34.4[a]	34.4
Hiplock	16	38.9[b]	38.3
Leg Back	20	38.6[b]	38.2
Head Back	4	34.8[a,b]	34.2
Other	7	35.0[a,b]	35.8
Age and parity of dam		NS	
2-yr-olds	117	34.9[a]	35.2
1st calf 3-yr-olds	48	35.5[a]	34.9
Multiparous ams	209	36.4[b]	36.3
Sex of calf		**	
Male	224	37.2[a]	37.2
Female	150	33.7[b]	33.6

** $P < .01$.

[a,b]Means with different superscripts differ significantly ($P < .05$).

[1]Adjusted mean birth weights.

[2]Unadjusted mean birth weights.

incidence of breech birth among multiparous dams was observed, while a higher incidence ($P < .01$) of hiplock was seen in calves born to first calf 2-year-olds.

First calf 2-year-olds and multiparous dams experienced a significantly higher ($P < .01$) total incidence of abnormal presentation than did first calf 3-year-olds, however, no difference ($P > .05$) in incidence of malpresentation was observed between first calf 2-year-olds and multiparous dams.

Dystocia findings resulting from posterior presentation of the calf, specifically breech, were characterized by lesions similar to those reported by Gopal (1977) confined to perineal, gluteal and external genitalia. Subcutaneous edema and intramuscular hemorrhages were also observed.

Disease accounted for the second largest death loss category among anatomically normal calves accounting for 14.0 percent of the deaths. Pneumonia resulted in 42.5 percent of the disease related losses and 6.0 percent of the total death loss incidence among normal autopsied calves. Scours was the second most frequently occurring disease entity advancing mortality rates in calves, resulting in 22 deaths or 3.5 percent of the total normal calf death loss incidence.

A significantly higher incidence of calf loss due to disease occurred in first calf 2-year-olds as compared to multiparous dams, however no difference was observed between primiparous 2 and 3-year-olds.

No difference between sexes was observed with regard to the number of deaths resulting from disease.

Accidental death, exposure and resulting shock accounted for the third largest death loss category among normal autopsied calves. A total of 86 calves died as the result of the two aforementioned causes, roughly the same number of deaths that resulted from disease.

Death Loss of Anatomically Abnormal Calves

Table 25 summarizes causes of death for autopsied calves classed as anatomically abnormal. Post mortem examinations performed during the 15 year period studied noted presence of either skeletal or visceral anomalies in 178 of the 799 calves necropsied. Of the 178 malformed calves that died from birth to weaning for which a cause of death was determined, 60.8 percent died as a result of congenital malformation, while 39.2 percent of the calves had nonlethal malformations and died from some other cause. Cause of death was not determined for seven of the 178 abnormal calves.

Appendix tables 29 through 41 further summarize abnormal calf losses according to the specific cause of death and days postpartum on which death occurred. Deaths occurring the first 24 hours postpartum resulted in 64.4 percent of the total abnormal calf death loss, with 75 percent of the total incurred by day 2 postpartum. Cumulative loss within the first 10 days postpartum accounted for 89.6 percent of the

TABLE 25. CAUSE OF DEATH FOR CALVES CLASSED AS ANATOMICALLY ABNORMAL

Cause of death	No. calves dead		Total calf death loss[1] (%)	
Abandoned and/or starvation	3		1.7	
Accidental death	4		2.2	
Born dead	10		5.6	
Brain anomaly	38		21.3	
Enlarged ventricles		(6)[2]		(3.4)[3]
Hydrocephalus		(30)		(16.9)
Hydrocephalus - external		(2)		(1.1)
Delayed and difficult birth complex	33		18.5	
Brain hemorrhage		(1)		(.6)
Dystocia		(25)		(14.0)
Intrauterine death		(3)		(1.7)
Lungs hemorrhaged		(1)		(.6)
Lungs ruptured		(1)		(.6)
Technician error		(1)		(.6)
Umbilical hemorrhage		(1)		(.6)
Disease	9		5.1	
Enteritis		(1)		(.6)
Pneumonia		(6)		(3.4)
Scours		(2)		(1.1)
Euthanasia	27		15.2	
Exposure and/or shock	2		1.1	
Fetal monster	5		2.8	
Hairball	3		1.7	
Heart anomaly or complication	24		13.5	
Common auricle		(2)		(1.1)
Heart enlarged		(1)		(.6)
Fibrillation		(1)		(.6)
Foramen ovale enlarged		(1)		(.6)

TABLE 25. CAUSE OF DEATH FOR CALVES CLASSED AS ANATOMICALLY ABNORMAL (CONTINUED)

Cause of death	No. calves dead		Total calf death loss[1] (%)	
Foramen ovale patent		(1)		(.6)
Pulmonary artery occluded		(2)		(1.1)
Valve defect		(6)		(3.4)
Valve hemorrhage		(2)		(1.1)
Ventricular septal defect or anomaly		(8)		(4.5)
Intestinal anomaly or complication	9		5.1	
Aplasia		(1)		(.6)
Asplastic segment hind gut		(8)		(4.5)
Liver degeneration	1		.6	
Lungs foreign body pneumonia	1		.6	
Palate and pastern syndrome	1		.6	
Premature	1		.6	
Cause of death not determined	7		3.9	
Total	178		100.0	

[1]Percentages reflect the percent of total calf death loss among abnormal calves.

[2]Numbers in parentheses represent incidence of death attributed to the specific subgroup.

[3]Numbers in parentheses represent the percent of total calf death loss among calves classed as anatomically abnormal, and reflect losses per respective subgroup.

total abnormal calf death loss incidence. Observed percentage death loss with respect to time from parturition differs with findings of Rasbech (1967) and Leipold (1978b) who reported a 38 to 50 percent mortality rate at birth of abnormal calves, accompanied with an additional 10 percent death loss within 48 hours following parturition.

Deaths attributed to specific anomalies of the brain, including enlarged ventricles, internal hydrocephalus and external hydrocephalus, represented the largest death loss category among abnormal calves necropsied, accounting for 38 deaths or 21.3 percent of the total abnormal calf death loss incidence. Thirty-seven (97.4 percent) of the 38 deaths associated with abnormalities of the brain occurred within 48 hours following parturition. These data support the work of Baker et al. (1961) who reported observing the most frequent occurrence of death in calves affected with hydrocephalus at birth or within a few days following parturition.

Thirty-three (18.4 percent) of the 178 abnormal calves died as a result of dystocia. Appendix tables 42 through 45 summarize the effects of age and parity of dam, calving difficulty score, presentation of the calf at birth, and calf sex on birth weights of the abnormal calves. None of the independent variables considered exerted a significant affect on birth weights of abnormal calves; however, due to the small number of animals involved definitive interpretation is not feasible.

Table 26 compares average birth weights of normal and abnormal

TABLE 26. AVERAGE BIRTH WEIGHTS OF NORMAL AND ABNORMAL CALVES AUTOPSIED POST MORTEM[1]

	ABNORMALS	NORMALS
No. calves	176	618
Mean birth weight	28.4 kg[a]	34.7 kg[b]
Standard error	.6 kg	.3 kg
Range	9.5 kg - 55.8 kg	10.4 kg - 47.7 kg

[1]Birth weights were not available for 2 of the abnormal calves and 2 of the normal calves.

[a,b]Means with different superscripts differ significantly ($P < .05$).

calves that were autopsied post mortem. Birth weights of the two groups differed significantly, evidenced by the 28.4 kg mean birth weight of 176 abnormal calves and the 34.7 kg mean birth weight of 618 normal calves. Birth weights of abnormal calves ranged from a minimum of 9.5 kg to a high of 55.8 kg. Ranges may be compared to the minimum birth weight for normal calves of 10.4 kg and the maximum of 47.7 kg. The lower mean birth weight of the abnormal calves as compared to the normals agrees with prior work of Anderson and Bellows (1967) in data summarized from this same herd.

Three hundred and ninety single or multiple abnormalities were identified from the 178 abnormal calves necropsied. Tables 27 and 28 summarize congenital defects with respect to either musculoskeletal or visceral involvement, the total number of calves affected and the percent incidence observed. Musculoskeletal abnormalities accounted for 41.8 percent of the total defect occurrence, while visceral defects were responsible for 58.2 percent of the incidence.

Lesions of the central nervous system, specifically hydrocephalus (table 28), were more common than other defects encountered similar to findings reported by Greene et al. (1973b) and Leipold (1978b). Congenital cardiac defects ranked second in percent contribution toward total defect incidence, followed by anomalies of the head, neck and limbs. Cardiac anomalies mainly included ventricular septal abnormalities and valve defects, while skeletal anomalies of the head, neck and

TABLE 27. MUSCULOSKELETAL ANOMALIES

Skeletal abnormality	Calves affected (No.)		Total skeletal abnormalities (%)	
Anomalies of the dorsum and spinal column	25		15.3	
Kyphoscoliosis		(18)[1]		(11.0)[2]
Scoliosis		(6)		(3.7)
Spinal column discontinuation		(1)		(.6)
Anomalies of the ear	2		1.2	
Absence of cartilage		(2)		(1.2)
Anomalies of the head and neck	52		31.9	
Brachygnathia		(12)		(7.4)
Campylognathia		(4)		(2.5)
Palatoschisis		(23)		(14.1)
Prominence of the forehead		(9)		(5.5)
Torticollis		(4)		(2.5)
Anomalies of the limbs	42		25.8	
Ankylosis		(12)		(7.4)
Arthrogryposis		(10)		(6.1)
Joints - loose		(1)		(.6)
Legs - anomalous and webbed		(19)		(11.7)
Anomalies of the ribs and rib cage	4		2.5	
Anomalous shape (R-shaped, spade shaped, pinched)		(4)		(2.5)
Anomalies of the shoulders	3		1.8	
Displaced should blades		(1)		(.6)
Malformation		(1)		(.6)
Scapulae - detached		(1)		(.6)

TABLE 27. MUSCULOSKELETAL ANOMALIES (CONTINUED)

Skeletal abnormality	Calves affected (No.)		Total skeletal abnormalities (%)	
Anomalies of the teeth	20		12.3	
Abnormal placement and structure		(16)		(9.8)
Unerupted		(4)		(2.5)
Body - compressed	1		.6	
Brisket - pointed	3		1.9	
Fetal monster	5		3.1	
Kangaroo rat appearance	1		.6	
Palate and pastern syndrome	2		1.2	
Pelvis - malformation	1		.6	
Rear or front quarter rotation	2		1.2	
Total recorded incidence of mulculoskeletal anomalies.	163		100.0	

[1]Numbers in parenthesis represent occurrence of specific subgroups.

[2]Numbers in parenthesis represent percent of total skeletal abnormality incidence per respective subgroup.

TABLE 28. VISCERAL ANOMALIES

Visceral abnormality	Calves affected (No.)		Total visceral abnormalities (%)	
Abdominal organs exterior to body cavity	1		.4	
Adhesions - internal	1		.4	
Alopecia	1		.4	
Anomalies of the brain	87		33.3	
Enlarged ventricles		(25)[1]		(11.0)[2]
Hydrocephalus		(56)		(24.7)
Hydrocephalus - external		(6)		(2.6)
Anomalies of the eye	2		.9	
Iris discoloration (gray)		(1)		(.4)
Oculus atrophic or aplastic		(1)		(.4)
Anomalies of the heart	62		27.3	
Absence of adipose tissue		(1)		(.4)
Auricle common (three chambered heart)		(2)		(.9)
Chordae tendineae - anomalous		(2)		(.9)
Diaphragm - adhered to heart		(1)		(.4)
Fibrillation		(1)		(.4)
Foramen ovale - hypertrophic		(1)		(.4)
Foramen ovale patent		(1)		(.4)
Heart - hypertrophic		(8)		(3.5)
Heart - malformation		(1)		(.4)
Musculi papillares - hypoplastic		(1)		(.4)
Pericardial fluid - excess		(1)		(.4)
Pulmonary artery - occluded		(3)		(1.3)
Valve - defect		(13)		(5.7)
Valve - hemorrhage		(6)		(2.6)
Ventricles - foamy		(1)		(.4)
Ventricles - hypertrophic		(2)		(.9)
Ventricle wall hypertrophic		(1)		(.4)
Ventricle wall - thin		(1)		(.4)

TABLE 28. VISCERAL ANOMALIES (CONTINUED)

Visceral abnormality	Calves affected (No.)		Total visceral abnormalities (%)	
Ventricular septal aplasia or anomalous aperture		(15)		(6.6)
Anomalies of the intestines	18		7.9	
Colon - hypertrophic		(1)		(.4)
Congenital malformation		(1)		(.4)
Intestinal aplasia		(1)		(.4)
Intestines - aplastic segment of the hind gut		(10)		(4.4)
Intestines - discoloration		(1)		(.4)
Intestines - protruding from body cavity		(3)		(1.3)
Obstructed GI tract		(1)		(.4)
Anomalies of the kidneys	3		1.3	
Adipose tissue - absent		(1)		(.4)
Kidneys - hypertrophic		(1)		(.4)
Kidneys - lobulated		(1)		(.4)
Anomalies of the liver	16		7.0	
Degeneration		(4)		(1.8)
Discoloration		(3)		(1.3)
Liver - hypertrophic		(4)		(1.8)
Liver - lobulated		(5)		(2.2)
Anomalies of the lung	10		4.4	
Hypoplasia		(10)		(4.4)
Ataxia	4		1.8	
Gall bladder embedded in liver	1		.4	
Paralysis	1		.4	
Plyoric sphincter restricted	1		.4	
Spastic	5		2.2	

TABLE 28. VISCERAL ANOMALIES (CONTINUED)

Visceral abnormality	Calves affected (No.)	Total visceral abnormalities (%)
Testicles - undescended	10	4.4
Thymus gland hypertrophic	2	.9
Trachea - abnormal	2	.9
Total recorded incidence of visceral anomalies	227	100.0

[1]Numbers in parenthesis represent occurrence of specific subgroups.
[2]Numbers in parenthesis represent percent of total visceral abnoramlity incidence per respective subgroup.

limbs were comprised mainly of palatoschisis, brachygnathia (superior or inferior), and leg defects including ankylosis and arthrogryposis.

Due to the scope and nature of this project explanation regarding the origin of congenital anomalies identified at necropsy was not elucidated. The wide range of genetic and/or environmental factors capable of producing such defects necessitates comprehensive study apart from determining frequency of anomaly occurrence and the effects of such occurrence on calf survivability.

Combined occurrences of congenital musculoskeletal and visceral defects are summarized in table 29. The total number of calves affected with respective abnormalities are listed, in addition to the observed combined defect incidence, the expected combined defect incidence and p values indicating relationship between defects listed.

Arthrogryposis has been reported to occur as a single defect or with other anomalies such as torticollis, scoliosis and palatoschisis (Greene et al., 1973a), however, in general few associated defects and lesions have been described. The highly significant p values shown on table 29 indicate that combined defect occurrences listed were not independent of one another, and that in fact a relationship did exist in regard to their expression. Relationships between hydrocephalus and ventricular septal defects, kyphoscoliosis and palatoschisis, and kyphoscoliosis and hypoplastic lungs are relatively novel findings and may warrant further study.

TABLE 29. COMBINED OCCURRENCE OF CONGENITAL MUSCULOSKELETAL AND VISCERAL DEFECTS

Abnormality	(No.)	Abnormality	(No.)	Combined occurrence (No.)	Expected combined occurrence[1] (No.)	P-value
Ankylosis	12	Arthrogryposis	10	7	.7	.00
Arthrogryposis	10	Palotoschisis	23	4	1.3	.01
Hydrocephalus	51	Ventricular Septal Defects	13	7	3.6	.03
Kyphoscoliosis	18	Palatoschisis	23	9	1.8	.00
Kyphoscoliosis	18	Hypoplastic Lungs	10	7	1.0	.00

[1]Expected counts derived assuming independence of defects considered.

Appendix tables 46 and 47 list sires and dams by respective herd and breed that were involved in producing more than one abnormal progeny. Five dams produced 11 of the 178 abnormal calves, four of which each produced two abnormal calves, while one dam was found to have produced three abnormal offspring. Seventy-nine (44.4 percent) of the abnormal calves were sired from 29 sires, of which 18 sired two abnormal progeny, six sired three, three sired four, one sired five and one sired eight. Evidence implied from these data suggest that genetic inheritance may have been a factor in the expression of certain observed defects.

Subsequent Reproductive Performance of Cows Losing Calves

The effects of calf loss on subsequent reproductive performance of involved females are summarized in table 30 with respect to dam age and parity group, total number of cows exposed for breeding and percent pregnancy rate. No significant difference was elicited between dam groupings when comparing dams that lost calves.

Table 31 summarizes fall pregnancy rates of first calf 2-year-olds, first calf 3-year-olds and multiparous dams which either weaned or lost calves, respectively. First calf 2 and 3-year-old dams experienced no significant reduction in subsequent pregnancy rate following calf loss, however, multiparous dams experienced a significant reduction in fall pregnancy rate as compared to contemporaries. Fall pregnancy

TABLE 30. EFFECTS OF CALF LOSS ON SUBSEQUENT REPRODUCTIVE PERFORMANCE OF DAMS RETAINED FOR BREEDING

Age and parity of dam	Total cows	Cows exposed for breeding		Pregnancy rate	
		No.	(%)	(No.)	(%)
2-yr-olds	245	196	80.0	137/196[a]	69.9
1st calf 3-yr-olds	121	112	92.6	87/112	77.7
2nd calf 3-yr-olds	60	44	73.3	35/44	79.5
2nd calf 4-yr-olds	105	92	87.6	66/92	71.7
3rd calf 4-yr-olds	50	32	64.0	23/32	71.9
5-yr-olds	76	60	78.9	43/60	71.7
6-yr-olds	65	52	80.0	36/52	69.2
7-yr-olds	64	52	81.3	31/52	59.6
8-yr-olds	44	39	88.6	33/39	84.6
9-yr-olds	30	22	73.3	13/22	59.1
10-yr-olds	22	15	68.2	13/15	86.7
11-yr-olds	9	5	55.6	5/5	100.0
12-yr-olds	2	1	50.0	1/1	100.0
Total	893	722	80.9	523/722	72.4

[a]Number of dams pregnant/number of dams exposed.

TABLE 31. SUBSEQUENT PREGNANCY RATES OF COWS LOSING CALVES AS COMPARED TO CONTEMPORARIES

Age and parity of dam	Cows exposed for breeding	Pregnancy rate (No.)	Pregnancy rate (%)
2-year-olds	196	137/196	69.9
Contemporary 2-year-olds	2,053	1,536/2,053	74.8
1st calf 3-year-olds	112	87/112	77.7
Contemporary 3-year-olds	1,377	1,081/1,377	78.5
Multiparous dams	414	299/414	72.2[a]
Contemporary multiparous dams	9,481	7,630/9,481	80.5[b]
Total	722	523/722	72.4[a]
Contemporary total	12,911	10,247/12,911	79.4[b]

[a,b]Percentages with different superscripts differ significantly ($P < .01$).

rate of dams that lost calves and reentered breeding herds was 72.4 percent (table 31) compared to the overall herd pregnancy rate of 79.4 percent ($P < .01$).

Table 32 lists pregnancy rates of dams that lost anatomically normal calves in dystocia versus nondystocia related deaths. Pregnancy rates did not differ significantly among dam groups following calf loss, nor were there any differences observed with respect to cause of death. Pregnancy rates were significantly lower in multiparous dams that lost calves in either dystocia or nondystocia related deaths compared to contemporaries weaning calves, although no reduction in pregnancy rate was observed in the primiparous females.

Table 33 summarizes pregnancy rates of dams that lost anatomically abnormal calves in dystocia and nondystocia related deaths. Pregnancy rates did not differ between dam groups within respective cause of death categories, although subsequent pregnancy rates were significantly higher in multiparous dams which lost calves in dystocia related deaths compared to the nondystocia cases.

Dams losing calves that were not included in the subsequent fall pregnancy examination inventory are accounted for in appendix table 48. A total of 171 dams were involved, of which 30 (17.5 percent) died or were destroyed, 133 (77.8 percent) were sold following calf loss and prior to breeding, 4 (2.3 percent) were exposed for breeding and sold prior to the end of the breeding season and 4 (2.3 percent) were exposed

TABLE 32. FALL PREGNANCY RATES OF DAMS THAT LOST ANATOMICALLY NORMAL CALVES IN DYSTOCIA AND NONDYSTOCIA RELATED DEATHS

Age and Parity of Dam	Dystocia			Nondystocia		
	Exposed (No.)	Pregnant (No.)	(%)	Exposed (No)	Pregnant (No.)	(%)
2-yr-olds	88	58	65.9	59	40	67.8
1st calf 3-yr-olds	42	34	81.0	36	27	75.0
Multiparous dams	156	106	67.9	120	81	67.5
Total	286	198	69.2	215	148	68.8

TABLE 33. FALL PREGNANCY RATES OF DAMS THAT LOST ANATOMICALLY ABNORMAL CALVES IN DYSTOCIA AND NONDYSTOCIA RELATED DEATHS

Age and Parity of Dam	Dystocia			Nondystocia		
	Exposed (No.)	Pregnant (No.)	Pregnant (%)	Exposed (No.)	Pregnant (No.)	Pregnant (%)
2-yr-olds	5	4	80.0	23	18	78.3
1st calf 3-yr-olds	6	5	83.3	16	11	68.8
Multiparous dams	12	12	100.0[a]	79	63	79.7[b]
Total	23	21	91.3[a]	118	92	78.0[b]

a,b
Means with different superscripts differ significantly.

for breeding and subsequently died or were reported missing.

General Discussion

Studies regarding the incidence and cause of neonatal and post-natal bovine mortality provide useful information pertinent to discussion of factors relating to reproductive efficiency. An attempt was made in this study to (1) summarize incidence of calf loss under typical range conditions, (2) extract causative factors resulting in calf mortality and (3) evaluate the effects of calf loss on subsequent reproductive performance of the affected dam.

Results from the study pointed to an average annual calf death loss incidence from birth to weaning of 6.7 percent, with calf losses highest in first calf 2 and 3-year-old dams, lowest losses in 5 and 6-year-old dams and a trend toward rising calf loss in dams 7 years of age and older.

Comparison of calf losses within dam age and parity group revealed a difference between cows calving first as 2-year-olds versus those calving first at three. Percent calf loss reductions from first to second parity were much larger among dams calving first as 2-year-olds compared to dams calving first as 3-year-olds. Although the data were not illustrated in table form, 66.6 percent of the total calf death loss incidence within the 5-year-old dam grouping, occurred in third calf 5-year-olds which was the group that calved first at 3 years of age.

Prior to making any assumptions, one must consider culling rates imposed on the two groups from first to second parity; 35.3 percent in 2-year-olds, versus 9.5 percent in the first calf 3-year-olds. This difference may be an indication that the majority of the 2-year-olds that experienced problems were culled, hence avoiding potentially recurrent problems in subsequent years. Perhaps, too, an unresolved physiological difference between the two dam groupings exists; however, actual cause of the dissimilarity was not explained from these data.

Death losses were highest the first 24 hours following parturition. Losses continued to be high throughout the first 3 days postpartum, but decreased over time. Approximately 40 percent of the calves that died at birth were found to have had functional lungs. Losses involving male calves accounted for the majority of the total death loss incidence, perhaps due to higher birth weights and possible increased gestation lengths relative to births involving males. Calf loss attributed to delayed and difficult birth accounted for the single largest cause of death. Dystocia related losses incurred the first 7 days postpartum resulted in the death of 367 anatomically normal calves, 54.8 percent of the total number of calves lost during that time period. To parallel this finding based on evidence obtained from calving difficulty scores, 52.6 percent of the normal calves that died as a result of dystocia received scores of one and were afforded no assistance at the time of parturition.

Consideration of these data leads to the conclusion that more than 50 percent of the calf loss incurred during the first week post calving may be prevented through closer observation of animals at the time of parturition, judicious exercise of obstetrical assistance should the need arise, and proper means of disease control relating specifically to pneumonia and scours. These data support prior studies of Bellows (1972) and emphasize the need for sound management practices throughout the neonatal period.

Consideration of factors responsible for the occurrence of dystocia, relating specifically to calf birth weight, pointed to an interesting comparison between birth weights of calves involved in parturitions receiving calving difficulty scores of 3 versus those receiving scores of 4. The higher mean birth weight of calves involved in parturitions requiring mechanical assistance compared to those requiring cesarean delivery was not explained from data collected. One may surmise, however, that the heavier calf birth weights unique to parturitions in which mechanical assistance was provided to facilitate delivery, indicates that many of the deliveries should have been accomplished by cesarean sections rather than mechanical assistance.

Research efforts have recently contributed toward expansion of knowledge pertaining to occurrence of dystocia, causative factors and methods of control. Studies by Burfening et al. (1978c) have shown that selection for calving ease would be more effective than direct selection

against large birth weights, with regard to reduction in incidence of calving difficulty. The study indicated that selection for calving ease would decrease gestation length with little effect on birth weight. This finding is logical when considering the influence of gestation length on calving ease is primarily expressed through effects on birth weight.

Disease was the second largest cause-of-death grouping, with the majority of the disease related loss attributed to pneumonia and scours. As indicated by the National Academy of Science (1968), evaluation of disease problems must encompass a comprehensive review of management, nutrition, heredity and environment prior to determination of an animal's predisposition to disease or choide of a means of control.

The relatively high incidence of congenital anomaly observed in calves autopsied (20.2 percent) can perhaps be partially explained by inbreeding programs at LARRS; however, one cannot rule out causal factors linked to certain species of toxic plants, chromosomal aberration and the viruses of Bluetongue or BVD. Defects of the cardiac ventricular septum identified at necropsy bear a certain resemblance to those found in 40 percent of humans affected with Down's Syndrome (Penrose, 1934; Penrose, 1966). Such similarity warrants future study to ascertain lack or presence of the condition in the bovine.

Relationships elicited between congenital defects including

hydrocephalus and cardiac ventricular septal defects, kyphoscoliosis and palatoschisis and kyphoscoliosis and hypoplastic lungs perhaps too, warrant further evaluation and more careful scrutiny. Indictment of causal agents inciting such defects at this stage of study is not feasible and hence is subject only to conjecture. Work by Bellows et al. (1975) disproved suspicion of detrimental affects on bovine embryonic survival and development from treatment of pregnant dams with organic phosphate systemic insecticides. However, one cannot overlook hazards related to early pregnancy diagnosis (< 45 days) and deep-felt palpation (Rowson and Dott, 1963), which was performed on some of these herds.

Fall pregnancy rates of dams that lost calves and reentered breeding herds were considerably lower ($P < .01$) than the overall herd pregnancy rate. Pregnancy rates were significantly reduced among multiparous dams; however no significant reduction in fertility was observed in first calf 2 and 3-year-olds. The reduction in pregnancy rate leaves one questioning the exact reason as to why the decrease arose and whether or not the majority of cows which lost calves and failed to conceive were ones which calved late during the regular calving season. This latter point was not investigated.

Further inquiry should focus on resolving actual source of the reduction, as it relates to failure of involved dams to resume a normal estrous cycle or resumption of estrous cycles and actual conception

failure. Differences observed were not explained from data collected, although one may speculate as to the effect of previous year's lactation status and trauma of the reproductive tract as a sequel to dystocia on subsequent fertility of the involved dams. Previous year's lactationstatus relative to effects on body condition may have in turn effected subsequent reproductive performance; while trauma of the reproductive tract resulting from dystocia may have exerted its effects via uterine infection and inflammation with resulting detrimental effects on resumption of normal estrus.

Cause of calf mortality and its relationship to subsequent reproduction must be considered, with special attention directed to losses stemming from dystocia and their resulting effects on the dam. Prior studies conducted at LARRS found pregnancy rates 12.8 percent higher in females provided obstetrical assistance early in stage two of parturition compared to females receiving only emergency assistance. Beneficial effects on postpartum interval were also realized (Doornbos, 1978). These findings may be applicable to results obtained in the present study and their implications cannot be overlooked. Implications from these findings suggest that the decrease in pregnancy rate observed in the present study may have largely been attributed to lack of timely obstetrical assistance.

The reproductive failure incurred via calf mortality (6.7 percent) and decreased pregnancy rate of involved dams (7.0 percent) resulted in

a 13.7 percent total average annual reduction in reproductive efficiency. This reduction reflects only females maintained for breeding and does not include loss of efficiency stemming from forced culling or death of involved dams. Hence, the percent reduction reported is a minimum value and clearly demonstrates that problems evolving from calf loss may further result in decreased reproductive performance of involved dams, thus reducing net profit return.

II. Incidence of Backward and Breech Presentation

During the years 1963 through 1977 a total of 215 calves or 1.6 percent of all births involved either backward or breech presentations. Table 34 summarizes the incidence of backward and breech presentation and is expressed per dam age and parity group and calf sex.

Backward presentations occurred more frequently than did breech, and were seen more often in primiparous dams. Recorded occurrence of backward presentation was associated with 2.3 percent of all 2-year-old parturitions and 5.6 percent of all first calf 3-year-old parturitions, findings similar to observations reported by Donald (1963). Incidence of backward presentation was highest in first calf 3-year-old dams and was significantly higher ($P < .01$) in births involving male calves. No difference regarding the occurrence of breech birth was noted among dam groupings, nor were there any differences elicited between sexes.

Table 35 lists average birth weights of calves born backward or breech and is expressed per dam age and parity group and calf sex. Adjusted and unadjusted mean birth weights as influenced by the respective independent variables listed are presented in table 36. Birth weights were affected ($P < .01$) by dam age and parity group, and calf sex, in addition to backward or breech presentation.

Birth weights differed among calves born to 2-year-old dams and

TABLE 34. INCIDENCE OF BACKWARD AND BREECH PRESENTATION EXPRESSED PER DAM AGE AND PARITY GROUP AND CALF SEX

Age and Parity of Dam	Backward (No.)	Backward Total calves born[1] (%)	Breech (No.)	Breech Total calves born[1] (%)
2-yr-olds	52	2.3[a]	11	.5
Males	34**[2]	65.4[3]	7	63.6
Females	18	34.6	4	36.4
1st calf 3-yr-olds	78	5.6[b]	9	.6
Males	49**	62.8	5	55.6
Females	29	37.2	4	44.4
Multiparous dams	85	.8[c]	59	.6
Males	55**	64.7	27	45.8
Females	30	35.3	32	54.2

a,b,c Percentages with different superscripts differ significantly ($P < .01$).

**$P < .01$.

[1]Percentages reflect total number of calves born within dam age and parity group.

[2]Number of calves within dam age and parity group per respective sex.

[3]Percent of total number of calves within dam age and parity group per respective sex.

TABLE 35. AVERAGE BIRTH WEIGHTS OF CALVES BORN BACKWARD OR BREECH EXPRESSED PER DAM AGE AND PARITY GROUP AND CALF SEX

	Backward		Breech	
	(No.)	Avg. brwt. (kg.)	(No.)	Avg. brwt. (kg.)
2-yr-olds	52	32.2	11	33.2
Males	34	33.4	7	34.7
Females	18	30.0	4	30.7
1st calf 3-yr-olds	78	35.6	9	31.1
Males	49	36.9	5	30.1
Females	29	33.5	4	32.4
Multiparous dams	85	36.5	59	33.9
Males	55	37.4	27	36.6
Females	30	34.8	32	31.6

TABLE 36. EFFECT OF AGE AND PARITY OF DAM, CALF SEX AND BACKWARD OR BREECH PRESENTATION ON CALF BIRTH WEIGHTS

	Calves (No.)	Avg. brwt. (kg.)[1]	Avg. brwt. (kg.)[2]
μ	294	34.7	34.7
Age and parity of dam		**	
2-yr-olds	63	32.1[a]	32.4
1st calf 3-yr-olds	87	34.8[b]	35.1
Multiparous dams	144	35.8[b]	35.4
Sex of calf		**	
Male	177	36.0[a]	36.0
Female	117	32.6[b]	32.6
Presentation at birth		**	
Backward	215	35.2[a]	35.1
Breech	79	33.4[b]	33.5

** $P < .01$

[a,b]Means with different superscripts differ significantly ($P < .05$).

[1]Adjusted mean birth weights.

[2]Unadjusted mean birth weights.

the other two dam groups, however no difference was observed between birth weights of calves born to first calf 3-year-olds and multiparous dams. Birth weights were significantly heavier in parturitions involving male calves and were heavier as well for calves born backward.

Survival rates for calves presented backward and breech were lower ($P < .01$) than contemporary survival rates of 89.1, 91.3, and 94.5 percent for first calf 2-year-old, first calf 3-year-old and multiparous dams, respectively (table 37). Backward presentations resulted in higher ($P < .01$) survival rates than did breech presentations (70.7 percent versus 32.9 percent), although no difference was elicited regarding calf survival rate among dam groupings or between calf sexes. Comparison of combined average birth weights of calves born backward and breech were heavier for calves that lived (36.1 kg) than of those that died (32.4 kg).

General Discussion

The increased incidence of backward presentation observed in calves born to first calf 3-year-old dams again highlights the apparent difference between cows calving first at three versus those at two. Although reports from prior studies point to increased incidence of malpresentation in first calving dams (Donald, 1963), none have specifically dealt with the topic regarding differencesbetween first parity dams of differing ages.

The 5.6 percent incidence of backward presentation among first

TABLE 37. SURVIVAL STATUS OF CALVES BORN BACKWARD OR BREECH

Age and Parity of Dam	Backward		Breech	
	Born (No.)	Survived (%)	Born (No.)	Survived (%)
2-yr-olds	52	59.6	11	54.5
Males	34	61.8	7	57.1
Females	18	55.6	4	50.0
1st calf 3-yr-olds	78	80.8	9	33.3
Males	49	81.6	5	40.0
Females	29	79.3	4	25.0
Multiparous dams	85	68.2	59	28.8
Males	55	70.9	27	37.0
Females	30	63.3	32	21.9
Total	215	70.7[a]	79	32.9[b]
Males	138	72.5	39	41.0
Females	77	67.5	40	25.0

[a,b]Percentages with different superscripts differ significantly ($P < .01$).

calf 3-year-olds represents a substantial percentage of the total number of parturitions and cannot be overlooked as a contributing factor toward incidence of dystocia and possible calf loss. Lack of difference regarding incidence of breech presentation among the three dam groupings implies that occurrence may not relate solely to lack of adequate uterine space, but may depend on the total body capacity of the involved dam. One cannot overlook, however, the fact that postural changes occur frequently and may take place shortly before parturition onset.

It is also interesting to note from these data that the pooled average birth weights of calves presented backward or breech were higher among calves that lived. This observation is difficult to explain, but is perhaps due to increased levels of assistance provided to heavier calves at the time of parturition, since evidence of dystocia may have been more apparent.

III. Peripartum Complications and Subsequent Reproductive Performance

Cesarean Section.

A total of 121 cesarean sections (.9 percent of all calvings) were performed during the years 1963 through 1977. The total cesarean incidence involved: 90 first calf 2-year-olds (4.0 percent of all 2-year-olds calving); 14 first calf 3-year-olds (1.0 percent of all first calf 3-year-olds calving); and 17 multiparous dams (.02 percent of all multiparous dams calving table 38). The difference observed in numbers of primiparous and multiparous dams requiring cesarean delivery was highly significant and is comparable to reports by Sloss (1974) and Foulley et al. (1976). Work by Foulley et al. (1976) is further supported by the contrast observed in the incidence of cesarean delivery between primiparous 2 and 3-year-old dams.

Birth weight averages of calves delivered by cesarean section in primiparous dams were generally higher than those of contemporaries (table 39). These findings support the work of Burfening (1976) and Laster (1976) which indicate an increased need of obstetrical assistance corresponding to paralleled rise in calf birth weight. Male calves born to first calf 2 and 3-year-old dams were an average of 3.2 and 2.6 kilograms heavier at birth respectively, than contemporary averages.

In parturitions completed by cesarean section in which calf sex was recorded, 75.6 percent were male and 24.4 percent were female

($P < .01$; table 38). This agrees with reported increased incidence of dystocia and percent assisted births in parturitions involving male calves (Anderson and Bellows, 1967; Bellows et al., 1971). Abnormal presentation of the calf was observed in 33 (27.3 percent) of the cesareans, of which 27 (81.8 percent) were either backward or breech. Three (2.5 percent) of the calves delivered by cesarean section were anatomically abnormal, compared with a 22 percent incidence reported by Wright (1958).

Survival rates for calves delivered by cesarean section were 66.7, 71.4 and 53.3 percent for first calf 2-year-old, first calf 3-year-old, and multiparous dams, respectively ($P < .05$; table 40). These calf survival rates were lower ($P < .01$) than contemporary survival rates of 89.1, 91.3 and 94.5 percent for first calf 2-year-old, first calf-3-year-old and multiparous dams, respectively. Of calves dying following cesarean delivery, 75.6 percent were males and 24.4 percent were female ($P < .05$) Maternal survival rate following cesarean delivery was 93.4 percent.

The subsequent pregnancy rate of cows experiencing cesareans was 52.4 percent compared to the overall herd pregnancy rate of 79.4 percent ($P < .01$). This result is consistent with findings of Foulley et al. (1976), who observed a significant reduction in subsequent pregnancy rate of cows having cesareans. A highly significant reduction in pregnancy rate following cesarean section was experienced by first

calf 2 and 3-year-old dams, however pregnancy rates were not significantly reduced in multiparous dams (table 41).

Retained Placenta.

Retained fetal membranes were associated with 116 calvings, 49 of which occurred following a non-induced parturition, while 67 were a result of labor induced with adrenal steroids (table 38). Incidence of retained placenta following non-induced and induced parturitions was associated with dystocia in 21.7 and 50.7 percent of the respective cases. Birth weights in cases of retained placenta following non-induced parturition were slightly higher for male calves born to first calf 2-year-old dams compared to the contemporary averages in cases resulting from induced parturition (table 39). This agrees with one study of retained placenta following induced parturition (Carroll, 1974), which indicated a relationship between the occurrence of retained fetal membranes and the day of gestation on which parturition is induced, the lowest incidence occurring when induced labor occurs near normal term.

Birth of male calves was associated with retained placenta in 29 (38.8 percent) and 38 (56.7 percent) of the non-induced and induced parturitions, respectively. The value in the non-induced group is lower than studies reported in dairy cattle (Erb et al., 1958) in which male births were associated with 56.0 percent of the cases of retained placenta following non-induced parturition. Survival rates of calves born to cows experiencing retained fetal membranes in cases of non-induced and induced parturitions were 83.7 percent ($P > .05$) and 80.6

percent ($P < .01$), respectively, compared to 93.3 percent for the non-retained contemporary calvings (table 40).

Subsequent pregnancy rates for cows retaining fetal membranes following non-induced parturition were not different ($P > .05$) from the herd average (table 41). Pregnancy rate was significantly reduced ($P < .01$), however, in cases of retained placenta resulting from induced parturition, which agrees with the report of Moody and Han (1976).

Prolapse.

A total of 153 cases of prolapse were recorded from 1963 through 1977, for a 1.2 percent incidence, which is similar to findings of Woodward and Quesenberry (1956) in data from this same herd. Incidence of uterine and vaginal prolapse among primiparous dams accounted for 40.3 percent and 82.8 percent of the total incidence, respectively (table 38). Cases of prolapse in which calving difficulty scores were recorded indicated occurrence of dystocia (scores greater than one) in 39.0 percent of the vaginal prolapses and 45.0 percent of the uterine prolapses.

Birth weight averages were higher for male calves born to multiparous dams in parturitions involving prolapse than for contemporary herd mates. Birth weights were slightly lower than contemporary averages, however, for calves born to primiparous dams (table 39).

Births involving male calves accounted for 58.8 percent of the total number of prolapse cases ($P < .05$); with males reported in 58.3 percent of the vaginal prolapses and 60.7 percent of the uterine prolapses. Survival rates for cows experiencing prolapse and the calves born to those cows were 84.3 percent and 86.5 percent ($P < .01$), respectively (table 40).

A marked reduction in subsequent pregnancy rate was noted following all types of prolapse, with highly significant reductions in pregnancy rates elicited among all dam age and parity groupings. Pregnancy rates among primiparous and multiparous dams that prolapsed were 28.0 percent and 57.9 percent, respectively (table 41).

General Discussion

Study pertaining to the incidence and effects of peripartal complication on subsequent reproductive performance is of particular benefit to producers and is a topic that until now has received little attention. Decisions regarding retention of dams following instances of peripartal complication must be based upon consideration of the specific case involved, relative to duration of the condition, prescribed treatment, trauma and injury sustained by the particular animal and evidence from documented studies. Data pertinent to this study clearly illustrated that cesarean sections, retained placenta resulting from induced parturition and prolapse of the reproductive tract resulted in detrimental effects on subsequent fertility of involved dams.

TABLE 38. INCIDENCE OF CESAREAN SECTION, RETAINED PLACENTAE AND PROLAPSE AMONG RESPECTIVE DAM AGE GROUPS

Item	1st calf 2-yr-olds				1st calf 3-yr-olds				Multiparous dams				Total
	Male	Female	SNR[a]	Subtotal (%)	Male	Female	SNR[a]	Subtotal (%)	Male	Female	SNR[a]	Subtotal (%)	
Cesarean section	69	21	-	90(74.4)	11	3	-	14(11.6)	10	5	2	17(14.0)	121
Retained placenta													
Non-induced	3	4	-	7(14.3)	1	4	-	5(10.2)	15	22	-	37(75.5)	49
Induced[b]	3	5	-	8(11.9)	-	1	-	1(1.5)	35	23	-	58(86.6)	67
Prolapse													
Vaginal	17	10	2	29(23.4)	15	6	-	21(16.9)	38	34	2	74(59.7)	124
Uterine	6	7	1	14(48.3)	7	3	-	10(34.5)	4	1	-	5(17.2)	29

[a]SNR = calf sex not recorded.

[b]Parturition induced with 10 mg Flumethasone at 272 days of gestation.

TABLE 39. BIRTH WEIGHT AVERAGE (KG) FOR MALE AND FEMALE CALVES BORN TO DAMS HAVING CEAREAN SECTIONS, RETAINED PLACENTAE OR PROLAPSE [a]

	1st calf 2-yr-olds				1st calf 3-yr-olds				Multiparous dams			
	Male		Female		Male		Female		Male		Female	
Item	No.	Birth weight (kg.)	No.	Birth weight (kg.)	No.	Birth weight (kg.)	No.	Birth weight (kg.)	No.	Birth weight (kg.)	No.	Birth weight (kg.)
Cesarean section	69	38.6	21	34.0	11	39.7	3	37.3	10	36.4	5	37.2
Retained placenta												
Non-induced	3	35.9	4	23.3	1	40.9	4	30.0	15	35.1	22	33.1
Induced	3	32.5	5	30.3	-	--	1	32.3	35	33.6	23	29.9
Prolapse												
Vaginal	17	34.8	10	32.5	15	36.8	6	35.7	38	39.3	34	38.3
Uterine	6	32.2	7	31.9	7	38.2	3	35.9	4	41.5	1	39.9
Contemporaries	812	35.4	810	33.5	473	37.1	408	35.6	3315	38.9	3247	36.3

[a] Sex of calf not recorded in two cases of cesarean and five cases of prolapse.

TABLE 40. SURVIVAL STATUS OF CALVES BORN TO DAMS HAVING CESAREAN SECTIONS, RETAINED PLACENTAE OR PROLAPSE [a]

Item	1st calf 2-yr-olds		1st calf 3-yr-olds		Multiparous dams		Total	
	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)	Male (%)	Female (%)
Cesarean section								
No. (%)	69[b] (70.0)	21 (57.1)	11 (63.6)	3 (100.0)	10 (40.0)	5 (80.0)	90 (65.6)	29 (65.5)
Retained placenta								
Non-induced								
No. (%)	3 (66.7)	4 (50.0)	1 (100.0)	4 (75.0)	15 (93.3)	22 (86.4)	19 (89.5)	30 (80.0)
Induced								
No. (%)	3 (66.7)	5 (80.0)	0 (---)	1 (00.0)	35 (80.0)	23 (87.0)	38 (78.9)	29 (82.8)
Prolapse								
Vaginal								
No. (%)	17 (88.2)	10 (60.0)	15 (93.3)	6 (100.0)	38 (84.2)	34 (91.2)	70 (87.1)	50 (86.0)
Uterine								
No. (%)	6 (100.0)	7 (85.7)	7 (85.7)	3 (100.0)	4 (50.0)	1 (100.0)	17 (82.4)	11 (90.9)

[a] Survival rates were compared to herd survival rates of 89.1%, 91.3%, and 94.5% for calves born to 1st calf 2-yr-old, 1st calf 3-yr-old and mature dams, respectively.

[b] Number of calves born; (%) survival.

TABLE 41. EFFECT OF CESAREAN SECTION, RETAINED PLACENTAE AND PROLAPSE ON SUBSEQUENT REPRODUCTIVE PERFORMANCE OF DAMS RETAINED FOR BREEDING[a]

Item	Total Cows	Cows exposed for breeding		Pregnancy rate					
		No.	(%)	1st calf 2-yr-olds	(%)	1st calf 3-yr-olds	(%)	Multiplarous Dams	(%)
Cesarean section	121	105	(86.8)	39/77[b]	(50.6)	7/14	(50.0)	9/14	(64.3)
Retained placenta									
Non-induced	49	45	(91.8)	5/6	(83.3)	3/5	(60.0)	29/34	(85.3)
Induced	67	67	(100.0)	4/6	(66.7)	0/1	(0)	30/60	(50.0)
Combined incidence	116	112	(96.6)	9/12	(75.0)	3/6	(50.0)	39/94	(62.8)
Prolapse									
Vaginal	124	92	(74.2)	6/22	(27.3)	3/15	(20.0)	31/54	(57.4)
Uterine	29	15	(51.7)	3/9	(33.3)	2/4	(50.0)	2/3	(66.7)
Combined incidence	153	107	(70.0)	9/31	(29.0)	5/19	(26.3)	33/57	(57.9)

[a]Pregnancy rates were compared with station herd pregnancy rates of 74.8%, 78.5%, and 80.5% for first calf 2-year old, first calf 3-year-old and multiparous dams, respectively.

[b]Number of dams pregnant/number of dams exposed.

It is difficult to rationalize differences in fertility observed between dams retaining fetal membranes following induced versus non-induced parturition; however, explanation may arise from factors relating to exogenous hormone treatment and the possible resulting hormonal imbalance incited following labor induction. This line of thought does not, however, encompass the lack of decreased fertility in dams not retaining fetal membranes following induced labor.

The other enigma raised in this study and present throughout the data summarized in this thesis pertains to the generalized increased occurrence of complication in births involving male calves. Increased birth weights relative to males is an acknowledged fact and certainly is responsible for a portion of the total problem. Loss of efficiency resulting from such situations, however, leaves one searching for solutions and hinting toward the need of expanded research dealing specifically with predetermination of sex. Although evidence pertaining to increased incidence of complications relative to births involving males has been reported, the underlying cause is yet to be verified. Resolution of the problem relates directly to existing differences between the sexes and suggests that investigation of hormonal influence exerted by the conceptus may be the answer.

SUMMARY

Death Loss Study

Data from 13,296 calvings collected at the Livestock and Range Research Station, Miles City, Montana summarizing the years 1963 through 1977 were studied to determine incidence and cause of neonatal and postnatal bovine mortality and to evaluate effects of calf loss on subsequent reproductive performance of involved dams. The study included investigation into the incidence of backward and breech presentation and evaluation of the effects of peripartum complication on subsequent fertility.

A total of 893 calves died during the 15 year period studied, accounting for a 6.7 percent average annual loss. Of the total mortaility incidence, 40.9 percent stemmed solely from loss to first calf 2 and 3-year-old dams. Losses reported within dam age and parity group were: first calf 2-year-olds, 10.9 percent; first calf 3-year-olds, 8.7 percent; second calf 3-year-olds, 4.1 percent; second calf 4-year-olds, 8.3 percent; third calf 4-year-olds, 4.8 percent and dams 5 years of age and older, 5.3 percent.

The majority of calf loss realized (57.4 percent) occurred within the first 24 hours postpartum, with 75 percent of the total incurred by day 7. Time of calf loss per dam age and parity group was consistent among dam groupings, with the majority in all cases highest the first 24 hours following parturition.

Sex ratio comparison of calves that died noted 510 (57.1 percent) males ($P < .01$) and 376 (42.1 percent) females. Determination of lung status prior to the time of death noted functional status in 65.5 percent ($P < .01$) of the calves, while 33.7 percent were non-functional. Functional lung status was observed in 63.0 percent of the normal calves, compared to 61.1 percent of the abnormal calves.

Detailed post mortem examinations were performed on 799 (89.5 percent) of the 893 calves lost. Of calves necropsied, 620 (77.6 percent) were anatomically normal compared to 178 (22.3 percent) abnormal. Loss of abnormal calves during the first 24 hours postpartum accounted for 22.6 percent of the total death loss incidence incurred within that time period.

Delayed and difficult birth accounted for the single largest factor effecting loss of calves, resulting in the death of 410 of the total 893 calves lost, 51.3 percent of the 799 calves autopsied. Loss due to delayed and difficult birth accounted for the single largest death loss category the first 3 days postpartum, resulting in 69.6, 39.6, 30.8 and 33.3 percent of the total loss incidence for days 0, 1, 2 and 3 postpartum, respectively.

Disease accounted for the second largest cause of death grouping resulting in the loss of 96 calves, 10.8 percent of the total number dead. Disease related loss was mainly attributed to pneumonia and scours. Birth weights of dead calves autopsied were affected by dam

age and parity, time and cause of death, calf sex and anatomical status.

Deaths attributed to delayed and difficult birth accounted for 374 (60.3 percent) of the 620 anatomically normal calves lost. Calving difficulty scores of involved calves were affected by dam age and parity and calf sex, with higher scores reported among primiparous dams and in births involving male calves.

Birth weights of normal autopsied calves were significantly heavier in parturitions requiring mechanical assistance or cesarean delivery than in normal unassisted births. Birth weights were also higher in males and for calves born to multiparous dams.

One hundred and twenty-two (32.6 percent) of the 374 dystocia related deaths, involved abnormal presentation of the calf, 61.3 percent of which were either backward or breech. Incidence of breech birth was highest among multiparous dams, while first calf 2-year-olds experienced the higher incidence of hiplock.

Disease accounted for the second largest death loss category among anatomically normal calves accounting for 14.0 percent of the deaths. Pneumonia resulted in 42.5 percent of the disease related loss and 6.0 percent of the normal calf death loss incidence. Loss due to scours resulted in 3.5 percent of the total incidence reported.

Of the 178 malformed calves that died from birth to weaning, 60.8 percent died as a result of congenital malformation, while 39.2 percent

of the calves had nonlethal malformations and died from some other cause. Cumulative loss within the first 10 days postpartum accounted for 89.6 percent of the total abnormal calf death loss incidence, 75 percent of which was incurred by the second day following parturition. Death attributed to lethal malformation of the brain represented the largest death loss category among abnormal calves, the bulk of which was due to internal hydrocephalus.

Thirty-three (18.5 percent) of the 178 abnormal calves died as a result of dystocia. Birth weights of abnormal calves ranged from a low of 9.5 kg to a high of 55.8 kg. Musculoskeletal and visceral anomalies accounted for 41.8 percent and 58.2 percent of the total defect incidence, respectively. Relationships regarding anomaly occurrence were elicited between hydrocephalus and ventricular septal defects, kyphoscoliosis and palatoschisis, and kyphoscoliosis and hypoplastic lungs.

Fall pregnancy rate of dams which lost calves and reentered breeding herds was 72.4 percent compared to the overall herd pregnancy rate of 79.4 percent. Primiparous 2 and 3-year-old dams experienced no significant reduction in subsequent pregnancy rate following calf loss, however a highly significant reduction was noted among multiparous dams.

Backward and Breech Presentation

A total of 215 calves or 1.6 percent of all births involved either

backward or breech presentations. Backward presentation occurred more frequently than did breech and was seen most often in primiparous dams. Incidence of backward presentation was highest in calves born to primiparous 3-year-old dams and in births involving male calves. No difference regarding incidence of breech birth was noted among dam groupings nor was any difference elicited regarding calf sex. Birth weights were heavier in cases of backward presentation than in breech, while survival rates of calves presented either backward or breech were significantly lower than contemporary survival rates.

Peripartum Complications

A total of 121 cesarean sections (.9 percent of all calvings) were performed during the years 1963 through 1977 with the highest incidence reported in first calf 2 and 3-year-old dams. Fall pregnancy status of the 105 dams having had cesarean deliveries was 52.4 percent, which was 26.6 percent lower than the herd average.

Fetal membranes were retained following 116 calvings; 56 (57.8 percent) of which were the result of induced parturition. Dams that retained fetal membranes following induced parturition had a significant reduction in subsequent pregnancy rate. Pregnancy rates were not significantly altered in dams retaining fetal membranes following non-induced parturitions.

A total of 153 calvings were associated with prolapse including 124 (81.0 percent) vaginal prolapses and 29 (19.0 percent) uterine

prolapses. Subsequent pregnancy rate of cows experiencing prolapses were lower than the herd average. Pregnancy rates following prolapse in primiparous and multiparous dams were 28.0 percent and 57.9 percent respectively.

These data indicate cesarean section, retained placentae resulting from induced parturition, and vaginal or uterine prolapse resulted in significant reductions in subsequent pregnancy rates of affected dams.

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LITERATURE CITED

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APPENDIX

APPENDIX TABLE 1. TIME AND CAUSE OF DEATH SUMMARY

Cause of death	Day 0[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	.2	.1
Accidental death	10	1.9	1.1
Adhesions (internal)	1	.2	.1
Born dead[2]	10	1.9	1.1
Brain damage or anomaly	36	7.0	4.0
Enlarged ventricles	(6)[3]	(1.2)[4]	(.7)[5]
Hydrocephalus	(29)[6]	(5.7)	(3.2)
Hydrocephalus-external	(1)	(.2)	(.1)
Delayed and difficult birth complex	357	69.6	40.0
Brain injury and hemorrhage	(5)	(1.0)	(.6)
Drowned in placental fluid	(2)	(.4)	(.2)
Dystocia	(309)	(60.2)	(34.6)
Intestines ruptured	(1)	(.2)	(.1)
Intrauterine hemorrhage and death	(20)	(3.9)	(2.2)
Lungs ruptured	(2)	(.4)	(.2)
Membrane covering mouth and nasal passages	(4)	(.8)	(.4)
Trachea filled with fluid	(1)	(.2)	(.1)
Umbilical hemorrhage	(13)	(2.5)	(1.8)
Disease	9	1.8	1.0
Enteritis	(1)	(.2)	(.1)
Leptospirosis	(8)	(1.6)	(.9)
Euthanasia[7]	11	2.1	1.2
Exposure and/or shock	28	5.5	3.1
Fetal monster[8]	5	1.0	.6
Heart anomaly or complication	10	1.9	1.1
Common auricle	(1)	(.2)	(.1)
Fibrillation	(1)	(.2)	(.1)

APPENDIX TABLE 1. TIME AND CAUSE OF DEATH SUMMARY (CONTINUED)

Cause of death	Day 0[1] No. calves dead	Day total (%)		Total calf death loss (%)	
Foramen ovale enlarged		(1)	(.2)		(.1)
Valve defect[9]		(2)	(.4)		(.2)
Valve hemorrhage		(1)	(.2)		(.1)
Ventricles-joined		(1)	(.2)		(.1)
Ventricles-abnormal opening		(3)	(.6)		(.3)
Intestinal anomaly or complication	2	.4		.2	
Aplasia		(1)	(.2)		(.1)
Missing segment hind gut		(1)	(.2)		(.1)
Liver degeneration	1	.2		.1	
Lungs - foreign body pneumonia	1	.2		.1	
Palate and pastern syndrome	1	.2		.1	
Premature	2	.4		.2	
Cause of death not determined	28	5.5		3.1	
Total	513	100.0		57.4	

[1] Day 0-time of death occurred within the first 24 hour postpartum.
[2] Nine calves born dead were noted at autopsy to have had numerous skeletal and visceral abnormalities including: palatoschisis, scoliosis, kyphosis, ankylosis, arthrogryposis, torticollis, and brachygnathia. The carcass of one calf born dead was partially consumed by coyotes, making determination of cause unidentifiable.
[3] Numbers in parentheses represent incidence of death attributed to the specific subgroup.
[4] Numbers in parentheses represent percent of total daily calf loss.
[5] Numbers in parentheses represent percent of total calves lost.
[6] Respective cases noted both absence or presence of additional skeletal and/or visceral anomalies.
[7] Calves possessing severe skeletal and/or visceral anomaly were euthanized soon after parturition.
[8] Classification of calves as fetal monsters was made in instances of pronounced developmental anomaly, in which case calves were grotesque and nonviable.
[9] Valve defects included bicuspid and tricuspid valves.

APPENDIX TABLE 2. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 1[1]			
	No. calves dead		Day total (%)	Total calf death loss (%)
Accidental death	7		14.6	.8
Brain damage or anomaly	1		2.1	.1
Hydrocephalus		(1)	(2.1)	(.1)
Delayed and difficult birth complex	19		39.6	2.1
Brain hemorrhage		(1)	(2.1)	(.1)
Dystocia		(15)	(31.3)	(1.7)
Larynx contained mucous plug		(1)	(2.1)	(.1)
Umbilical hemorrhage		(2)	(4.2)	(.2)
Disease	3		6.3	.3
Emphysema		(1)	(2.1)	(.1)
Enterotoxemia		(1)	(2.1)	(.1)
Gastritis		(1)	(2.1)	(.1)
Euthanasia	5		10.4	.6
Exposure and/or shock	4		8.3	.4
Heart anomaly or complication	1		2.1	.1
Common auricle		(1)	(2.1)	(.1)
Intestinal anomaly or complication	2		4.2	.2
Missing segment hind gut		(2)	(4.2)	(.1)
Liver degeneration (fatty)	1		2.1	.1
Lungs - foreign body pneumonia	1		2.1	.1
Cause of death not determined	4		8.3	.4
Total	48		100.0	5.4

[1] Time of death occurred during hours 24 to 48 postpartum.
[2] Refer to footnotes 3, 4, and 5 in Appendix Table 1.

APPENDIX TABLE 3. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 2[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	3.9	.1
Accidental death	5	19.2	.6
Delayed and difficult birth complex	8	30.8	.9
Brain hemorrhage	(1)	(3.8)	(.1)
Dystocia	(6)	(23.1)	(.7)
Technician error[3]	(1)	(3.8)	(.1)
Disease	2	7.7	.2
Pneumonia	(1)	(3.8)	(.1)
Scours	(1)	(3.8)	(.1)
Euthanasia[4]	2	7.7	.2
Exposure and/or shock	2	7.7	.2
Hairball	1	3.9	.1
Heart anomaly or complication	3	11.5	.3
Enlarged heart	(1)	(3.8)	(.1)
Occluded pulmonary artery	(1)	(3.8)	(.1)
Opening between ventricles	(1)	(3.8)	(.1)
Intestinal anomaly or complication	2	7.7	.2
Blockage of GI tract	(1)	(3.8)	(.1)
Missing segment hind gut	(1)	(3.8)	(.1)
Total	26	100.0	2.9

[1] Time of death occurred during hours 48 to 72 postpartum.
[2] Refer to footnotes 3, 4, and 5 in Appendix Table 1.
[3] Technicain error occurred during or following parturition.
[4] Both calves euthanized were hydrocephalic.

APPENDIX TABLE 4. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 3[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	3	11.1	.3
Accidental death	2	7.4	.2
Delayed and difficult birth complex	9	33.3	1.0
Dystocia	(3)	(11.1)	(.3)
Lungs hemorrhaged	(1)	(3.7)	(.1)
Skull fracture	(1)	(3.7)	(.1)
Technician error	(4)	(14.8)	(.4)
Disease	2	7.4	.2
Enterotoxemia	(1)	(3.7)	(.1)
Scours	(1)	(3.7)	(.1)
Exposure and/or shock	3	11.1	.3
Heart anomaly or complication	2	7.4	.2
Hole in ventricular septum	(1)	(3.7)	(.1)
Valve defect	(1)	(3.7)	(.1)
Intestinal anomaly or complication	2	7.4	.2
Missing segment hind gut	(2)	(7.4)	(.2)
Cause of death not determined	4	14.8	.4
Total	27	100.0	3.0

[1] Time of death occurred during hours 72 to 96 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.

APPENDIX TABLE 5. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 4[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	5.6	.1
Accidental death	3	16.7	.3
Delayed and difficult birth complex	2	11.1	.2
Dystocia	(2)	(11.1)	(.2)
Disease	3	16.7	.3
Enteritis	(1)	(5.6)	(.1)
Pneumonia	(2)	(11.1)	(.1)
Euthanasia[3]	4	22.2	.4
Exposure and/or shock	3	16.7	.3
Hairball	2	11.1	.2
Total	18	100.0	2.0

[1] Time of death occurred during hours 96 to 120 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.
[3] Three calves euthanized were abnormal, 1 calf was near death due to starvation.

APPENDIX TABLE 6. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 5[1] No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	3	27.3	.3
Disease	3	27.3	.3
Scours	(3)	(27.3)	(.3)
Hairball	1	9.1	.1
Heart anomaly or complication	2	18.2	.2
Opening between ventricles	(1)	(9.1)	(.1)
Valve defect	(1)	(9.1)	(.1)
Intestinal anomaly or complication	2	18.2	.2
Blockage of GI tract	(1)	(9.1)	(.1)
Missing segment hind gut	(1)	(9.1)	(.1)
Total	11	100.0	1.2

[1] Time of death occurred during hours 120 to 144 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.

APPENDIX TABLE 7. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 6[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	7.7	.1
Accidental death	1	7.7	.1
Delayed and difficult birth complex	2	15.4	.2
Heart injury at sternum	(1)	(7.7)	(.1)
Trachea filled with froth	(1)	(7.7)	(.1)
Disease	6	46.2	.7
Enteritis	(1)	(7.7)	(.1)
Pneumonia	(2)	(15.4)	(.1)
Scours	(3)	(23.1)	(.3)
Exposure and/or shock	1	7.7	.1
Heart anomaly or complication	1	7.7	.1
Valve defect	(1)	(7.7)	(.1)
Cause of death not determined	1	7.7	.1
Total	13	100.0	1.5

[1] Time of death occurred during hours 144 to 168 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.

APPENDIX TABLE 8. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 7[1] No. calves dead		Day total (%)		Total calf death loss (%)	
Abandoned and/or starvation	1		7.1		.1	
Accidental death	2		14.3		.2	
Delayed and difficult birth complex	3		21.4		.3	
Dystocia[3]		(1)		(7.1)		(.1)
Technician error		(2)		(14.3)		(.2)
Disease	6		42.9		.7	
Enterotoxemia		(1)		(7.1)		(.1)
Scours		(5)		(35.7)		(.6)
Euthanasia[4]	1		7.1		.1	
Premature	1		7.1		.1	
Total	14		100.0		1.6	

[1] Time of death occurred during hours 168 to 192 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.
[3] Death was a result of complications incurred at birth, i.e., broken legs, which necessitated euthanasia.
[4] Calf was spastic.

APPENDIX TABLE 9. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 8[1] No. calves dead		Day total (%)		Total calf death loss (%)	
Abandoned and/or starvation	2		13.3		.2	
Accidental death	1		6.7		.1	
Delayed and difficult birth complex	3		20.0		.3	
Dystocia		(1)		(6.7)		(.1)
Technician error		(1)		(6.7)		(.1)
Umbilical hemorrhage		(1)		(6.7)		(.1)
Disease	4		26.7		.4	
Pneumonia		(2)		(13.3)		(.2)
Scours		(2)		(13.3)		(.2)
Lungs - foreign body pneumonia	2		13.3		.2	
Cause of death not determined	3		20.0		.3	
Total	15		100.0		1.7	

[1] Time of death occurred during hours 192 to 216 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.

APPENDIX TABLE 10. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 9[1] No. calves dead		Day total (%)		Total calf death loss (%)	
Abandoned and/or starvation	3		23.1		.3	
Delayed and difficult birth complex	1		7.7		.1	
Technician error		(1)		(7.7)		(.1)
Disease	5		38.5		.6	
Pneumonia		(4)		(30.8)		(.4)
Scours		(1)		(7.7)		(.1)
Hernia - strangulated	1		7.7		.1	
Intestinal anomaly or complication	1		7.7		.1	
Missing segment hind gut		(1)		(7.7)		(.1)
Cause of death not determined	2		15.4		.2	
Total	13		100.0		1.5	

[1] Time of death occurred during hours 216 to 240 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.

APPENDIX TABLE 11. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 10[1]					
	No. calves dead		Day total (%)		Total calf death loss (%)	
Abandoned and/or starvation	1		10.0		.1	
Accidental death	1		10.0		.1	
Delayed and difficult birth complex	1		10.0		.1	
Dystocia		(1)		(10.0)		(.1)
Disease	4		40.0		.4	
Enterotoxemia		(1)		(10.0)		(.1)
Pneumonia		(3)		(30.0)		(.3)
Euthanasia[3]	1		10.0		.1	
Exposure and/or shock	2		20.0		.2	
Total	10		100.0		1.1	

[1] Time of death occurred during hours 240 to 264 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.
[3] Calf was euthanized due to extensive brain and nerve damage.

APPENDIX TABLE 12. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 11-41[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	10	11.5	1.1
Accidental death	6	6.9	.7
Delayed and difficult birth complex	5	5.7	.6
Brain injury	(2)	(2.3)	(.2)
Dystocia	(2)	(2.3)	(.2)
Technician error	(1)	(1.1)	(.1)
Disease	35	40.2	3.9
Diptheria	(1)	(1.1)	(.1)
Enterotoxemia	(1)	(1.1)	(.1)
Gastritis	(3)	(3.4)	(.3)
Navel Ill	(1)	(1.1)	(.1)
Pneumonia	(22)	(25.3)	(2.5)
Scours	(7)	(8.0)	(.8)
Euthanasia[3]	5	5.7	.6
Exposure and/or shock	2	2.3	.2
Hairball	4	4.6	.4
Heart anomaly or complication	4	4.6	.4
Pulmonary artery occluded	(1)	(1.1)	(.1)
Valve defect	(1)	(1.1)	(.1)
Valve hemorrhage	(1)	(1.1)	(.1)
Ventricle wall thin	(1)	(1.1)	(.1)
Lungs - foreign body pneumonia	1	1.1	.1
Cause of death not determined	15	17.2	1.7
Total	87	100.0	9.7

[1] Time of death grouping includes deaths occurring during days 11 to 41 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.
[3] Three calves euthanized had broken legs, two were hydrocephalic (one internal, one external).

APPENDIX TABLE 13. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 42-101[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	2.0	.1
Accidental death	7	13.7	.8
Bloat	2	3.9	.2
Disease	6	11.8	.7
Enteritis	(1)	(2.0)	(.1)
Pneumonia	(4)	(7.8)	(.4)
Scours	(1)	(2.0)	(.1)
Euthanasia[3]	2	3.9	.2
Hairball	4	7.8	.4
Intestinal anomaly or complication	1	2.0	.1
Blockage of GI tract	(1)	(2.0)	(.1)
Peritonitis and general infection	2	3.9	.2
Pyloric tumor	1	2.0	.1
Cause of death not determined	25	49.0	2.8
Total	51	100.0	5.7

[1] Time of death grouping includes deaths occurring during days 42 to 101 postpartum.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.
[3] One calf was euthanized because of paralysis, and 1 due to a spinal abscess.

APPENDIX TABLE 14. TIME AND CAUSE OF DEATH SUMMARY

Cause of death[2]	Day 102-Weaning[1] No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	6	12.8	.7
Bloat	1	2.1	.1
Brain damage or anomaly	2	4.3	.2
Hydrocephalus (external)	(1)	(2.1)	(.1)
Injury	(1)	(2.1)	(.1)
Castration hemorrhage	1	2.1	.1
Disease	8	17.0	.9
Asthma	(1)	(2.1)	(.1)
Emphysema	(1)	(2.1)	(.1)
Enterotoxemia	(1)	(2.1)	(.1)
Gastritis	(1)	(2.1)	(.1)
Inframandibular Cellulitis	(1)	(2.1)	(.1)
Pneumonia	(3)	(6.4)	(.3)
Euthanasia[3]	3	6.4	.3
Heart anomaly or complication	1	2.1	.1
Foramen ovale patent	(1)	(2.1)	(.1)
Intestinal anomaly or complication	1	2.1	.1
Blockage of GI tract	(1)	(2.1)	(.1)
Lungs - foreign body pneumonia	1	2.1	.1
Cause of death not determined	23	48.9	2.6
Total	47	100.0	5.3

[1] Time of death grouping includes deaths occurring during days 102 through weaning.
[2] Refer to footnotes 3, 4 and 5 in Appendix Table 1.
[3] Calves euthanized included cases involving throat tumor, hydrocephalus, and ataxia.

APPENDIX TABLE 15. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death	Day 0[1] No. calves dead	Day Total (%)		Total calf death loss[2] (%)	
Accidental death	9	2.4		1.4	
Adhesions (internal)	1	.3		.2	
Delayed and difficult birth complex	326	85.6		52.2	
Brain injury and hemorrhage	(4)[3]		(1.0)[4]		(.6)[5]
Drowned in placental fluid	(2)		(.5)		(.3)
Dystocia	(286)		(75.1)		(45.8)
Intestines ruptured	(1)		(.3)		(.2)
Intrauterine hemorrhage and death	(15)		(3.9)		(2.4)
Lungs ruptured	(1)		(.3)		(.2)
Membranes covering mouth and nasal passages	(4)		(1.0)		(.6)
Trachea filled with fluid	(1)		(.3)		(.2)
Umbilical hemorrhage	(12)		(3.1)		(1.9)
Disease	8	2.1		1.3	
Leptospirosis	(8)		(2.1)		(1.3)
Exposure and/or shock	27	7.1		4.3	
Liver degeneration	1	.3		.2	
Premature	1	.3		.2	
Cause of death not determined	8	2.1		1.3	
Total	381	100.0		61.0	

[1]Death occurred within the first 24 hours postpartum.

[2]Percentages represent percent of total normal calf loss (625 calves).

[3]Numbers in parentheses represent incidence of death attributed to the specific subgroup.

[4]Numbers in parentheses represent percent of total daily normal calf loss.

[5]Numbers in parentheses represent percent of total normal calf loss.

APPENDIX TABLE 16. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 1[1] No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	7	21.2	1.1
Delayed and difficult birth complex	19	57.6	3.0
Brain hemorrhage	(1)	(3.0)	(.2)
Dystocia	(15)	(45.5)	(2.4)
Larynx contained mucous plug	(1)	(3.0)	(.2)
Umbilical hemorrhage	(2)	(6.1)	(.3)
Disease	3	9.1	.5
Emphysema	(1)	(3.0)	(.2)
Enterotoxemia	(1)	(3.0)	(.2)
Gastritis	(1)	(3.0)	(.2)
Exposure and/or shock	3	9.1	.5
Lungs - foreign body pneumonia	1	3.0	.2
Total	33	100.0	5.3

[1]Death occurred during hours 24 to 48 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 17. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 2[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	5.3	.2
Accidental death	5	26.3	.8
Delayed and difficult birth complex	7	36.8	1.1
Brain hemorrhage	(1)	(5.3)	(.2)
Dystocia	(5)	(26.3)	(.8)
Technician error	(1)	(5.3)	(.2)
Disease	2	10.5	.3
Pneumonia	(1)	(5.3)	(.2)
Scours	(1)	(5.3)	(.2)
Exposure and/or shock	2	10.5	.3
Hairball	1	5.3	.2
Intestinal complication	1	5.3	.2
Blockage of GI tract	(1)	(5.3)	
Total	19	100.0	3.0

[1]Death occurred during hours 48 to 72 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 18. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 3[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	3	15.0	.5
Accidental death	2	10.0	.3
Delayed and difficult birth complex	8	40.0	1.3
Dystocia	(3)	(15.0)	(.5)
Skull fracture	(1)	(5.0)	(.2)
Technician error	(4)	(20.0)	(.6)
Disease	2	10.0	.3
Enterotoxemia	(1)	(5.0)	(.2)
Scours	(1)	(5.0)	(.2)
Exposure and/or shock	3	15.0	.5
Cause of death not determined	2	10.0	.3
Total	20	100.0	3.2

[1]Death occurred during hours 72 to 96 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 19. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 4[1]		
	No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	7.7	.2
Accidental death	3	23.1	.5
Delayed and difficult birth complex	2	15.4	.3
Dystocia	(2)	(15.4)	(.3)
Disease	3	23.1	.5
Enteritis	(1)	(7.7)	(.2)
Pneumonia	(2)	(15.4)	(.3)
Exposure and/or shock	3	23.1	.5
Hairball	1	7.7	.2
Total	13	100.0	2.1

[1]Death occurred during hours 96 to 120 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 20. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 5[1]		
	No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	3	42.9	.5
Disease	3	42.9	.5
Scours	(3)	(42.9)	(.5)
Intestinal complication	1	14.3	.2
Blockage of GI tract	(1)	(14.3)	(.2)
Total	7	100.0	1.1

[1]Death occurred during hours 120 to 144 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 21. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 6[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	9.1	.2
Accidental death	1	9.1	.2
Delayed and difficult birth complex	2	18.2	.3
Heart injury at sternum	(1)	(9.1)	(.2)
Trachea filled with froth	(1)	(9.1)	(.2)
Disease	5	45.5	.8
Enteritis	(1)	(9.1)	(.2)
Pneumonia	(1)	(9.1)	(.2)
Scours	(3)	(27.3)	(.5)
Exposure and/or shock	1	9.1	.2
Cause of death not determined	1	9.1	.2
Total	11	100.0	1.8

[1]Death occurred during hours 144 to 168 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 22. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 7[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	10.0	.2
Accidental death	1	10.0	.2
Delayed and difficult birth complex	3	30.0	.5
Dystocia	(1)	(10.0)	(.2)
Technician error	(2)	(20.0)	(.3)
Disease	5	50.0	.8
Enterotoxemia	(1)	(10.0)	(.2)
Scours	(4)	(40.0)	(.6)
Total	10	100.0	1.6

[1]Death occurred during hours 168 to 192 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 23. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 8[1]					
	No. calves dead		Day total (%)		Total calf death loss (%)	
Abandoned and/or starvation	2		16.7		.3	
Accidental death	1		8.3		.2	
Delayed and difficult birth complex	2		16.7		.3	
Dystocia		(1)		(8.3)		(.2)
Umbilical hemorrhage		(1)		(8.3)		(.2)
Disease	4		33.3		.6	
Pneumonia		(2)		(16.7)		(.3)
Scours		(2)		(16.7)		(.3)
Lungs - foreign body pneumonia	2		16.7		.3	
Cause of death not determined	1		8.3		.2	
Total	12		100.0		1.9	

[1]Death occurred during hours 192 to 216 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 24. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 9[1]					
	No. calves dead		Day total (%)		Total calf death loss (%)	
Abandoned and/or starvation	3		33.3		.5	
Delayed and difficult birth complex	1		11.1		.2	
Technician error		(1)		(11.1)		(.2)
Disease	3		33.3		.5	
Pneumonia		(3)		(33.3)		(.5)
Hernia - strangulated	1		11.1		.2	
Cause of death not determined	1		11.1		.2	
Total	9		100.0		1.4	

[1]Death occurred during hours 216 to 240 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 25. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 10[1] No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	1	11.1	.2
Delayed and difficult birth complex	1	11.1	.2
Dystocia	(1)	(11.1)	(.2)
Disease	4	44.4	.6
Enterotoxemia	(1)	(11.1)	(.2)
Pneumonia	(3)	(33.3)	(.5)
Euthanasia	1	11.1	.2
Exposure and/or shock	2	22.2	.3
Total	9	100.0	1.4

[1]Death occurred during hours 240 to 264 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 26. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 11-41[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	9	15.0	1.4
Accidental death	4	6.7	.6
Delayed and difficult birth complex	4	6.7	.6
Brain injury	(2)	(3.3)	(.3)
Dystocia	(1)	(1.7)	(.2)
Technician error	(1)	(1.7)	(.2)
Disease	31	51.7	5.0
Diptheria	(1)	(1.7)	(.2)
Enterotoxemia	(1)	(1.7)	(.2)
Gastritis	(3)	(5.0)	(.5)
Navel ill	(1)	(1.7)	(.2)
Pneumonia	(18)	(30.0)	(2.9)
Scours	(7)	(11.7)	(1.1)
Euthanasia	3	5.0	.5
Exposure and/or shock	2	3.3	.3
Hairball	3	5.0	.5
Lungs - foreign body pneumonia	1	1.7	.2
Cause of death not determined	3	5.0	.5
Total	60	100.0	9.6

[1]Death occurred during days 11 to 41 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 27. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 42 - 101[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	4.5	.2
Accidental death	3	13.6	.5
Bloat	2	9.1	.3
Disease	6	27.3	1.0
Enteritis	(1)	(4.5)	(.2)
Pneumonia	(4)	(18.2)	(.6)
Scours	(1)	(4.5)	(.2)
Euthanasia	2	9.1	.3
Hairball	4	18.2	.6
Intestinal complication	1	4.5	.2
Blockage of GI tract	(1)	(4.5)	(.2)
Peritonitis and general infection	2	9.1	.3
Pyloric tumor	1	4.5	.2
Total	22	100.0	3.5

[1]Death occurred during days 42 to 101 postpartum.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 28. TIME AND CAUSE OF DEATH REPRESENTING LOSSES AMONG ANATOMICALLY NORMAL CALVES

Cause of death[2]	Day 102 - Weaning[1]		
	No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	3	15.8	.5
Bloat	1	5.3	.2
Brain injury	1	5.3	.2
Castration hemorrhage	1	5.3	.2
Disease	8	42.1	1.3
Asthma	(1)	(5.3)	(.2)
Emphysema	(1)	(5.3)	(.2)
Enterotoxemia	(1)	(5.3)	(.2)
Gastritis	(1)	(5.3)	(.2)
Inframandibular cellulitis	(1)	(5.3)	(.2)
Pneumonia	(3)	(15.8)	(.5)
Euthanasia	1	5.3	.2
Intestinal complication	1	5.3	.2
Blockage of GI tract	(1)	(5.3)	(.2)
Lungs - foreign body pneumonia	1	5.3	.2
Cause of death not determined	2	10.5	.3
Total	19	100.0	3.0

[1]Death occurred during days 102 through weaning.

[2]Refer to footnotes 2, 3, 4, and 5 in Appendix Table 15.

APPENDIX TABLE 29. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES.

Cause of death	Day 0[1] No. calves dead	Day total (%)	Total calf death loss[2] (%)
Abandoned	1	.9	.6
Accidental death	1	.9	.6
Born dead	10	8.6	5.6
Brain damage or anomaly	36	31.0	20.0
Enlarged ventricles	(6)[3]	(5.2)[4]	(3.3)[5]
Hydrocephalus	(29)	(25.0)	(16.1)
Hydroecphalus-external	(1)	(.9)	(.6)
Delayed and difficult birth complex	31	26.7	17.2
Brain hemmorhage	(1)	(.9)	(.6)
Dystocia	(23)	(19.8)	(12.8)
Intrauterine hemmorhage and death	(5)	(4.3)	(2.8)
Lungs ruptured	(1)	(.9)	(.6)
Umbilical hemorrhage	(1)	(.9)	(.6)
Disease	1	.9	.6
Enteritis	(1)	(.9)	(.6)
Euthanasia	11	9.5	6.1
Exposure	1	.9	.6
Fetal monster	5	4.3	2.8
Heart anomaly or complication	10	8.6	5.6
Auricle - common	(1)	(.9)	(.6)
Fibrillation	(1)	(.9)	(.6)
Foramen Ovale - hypertrophic	(1)	(.9)	(.6)
Valve defect	(2)	(1.7)	(1.1)
Valve hemorrhage	(1)	(.9)	(.6)
Ventricular septal aplasia or anomalous aperture	(4)	(3.4)	(2.2)

APPENDIX TABLE 29. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES (CONTINUED)

Cause of death	Day 0[1] No. calves dead	Day total (%)	Total calf death loss[2] (%)
Intestinal anomaly or complication	2	1.7	1.1
Aplasia	(1)	(.9)	(.6)
Missing segment hind gut	(1)	(.9)	(.6)
Lungs - foreign body pneumonia	1	.9	.6
Palate and pastern syndrome	1	.9	.6
Cause of death not determined	5	4,3	2,8
Total	116	100.0	64.4

[1]Time of death occurred within the first 24 hours postpartum.
[2]Percentages represent percent of total abnormal calf loss (180 calves).
[3]Numbers in parenthesis represent incidence of death attributed to the specific subgroup.
[4]Numbers in parenthesis represent percent of total daily abnormal calf loss.
[5]Numbers in parenthesis represent percent of total abnormal calf loss.

APPENDIX TABLE 30. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 1[1] No. calves dead	Day total (%)	Total calf death loss (%)
Brain damage of anomaly	1	8.3	.6
Hydrocephalus	(1)	(8.3)	(.6)
Euthanasia	5	41.7	2.8
Exposure	1	8.3	.6
Heart anomaly or complication	1	8.3	.6
Auricle-common	(1)	(8.3)	(.6)
Intestinal anomaly or complication	2	16.7	1.1
Missing segment hind gut	(2)	(16.7)	(1.1)
Liver degeneration	1	8.3	.6
Cause of death not determined	1	8.3	.6
Total	12	100.0	6.7

[1]Time of death occurred during hours 24 to 48 postpartum.

[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 31. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 2[1] No. calves dead	Day total (%)	Total calf death loss (%)
Delayed and difficult birth complex	1	14.3	.6
Dystocia	(1)	(14.3)	(.6)
Euthanasia	2	28.6	1.1
Heart anomaly or complication	3	42.9	1.7
Enlarged heart	(1)	(14.3)	(.6)
Occluded pulmonary artery	(1)	(14.3)	(.6)
Opening between ventricles	(1)	(14.3)	(.6)
Intestinal anomaly or complication	1	14.3	.6
Missing segment hind gut	(1)	(14.3)	(.6)
Total	7	100.0	3.9

[1]Time of death occurred during hours 48 to 72 postpartum.
[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 32. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 3[1] No. calves dead		Day total (%)		Total calf death loss (%)	
Delayed and difficult birth complex	1		20.0		.6	
Lungs hemorrhaged		(1)		(20.0)		(.6)
Heart anomaly or complication	2		40.0		1.1	
Hole in ventricular septum		(1)		(20.0)		(.6)
Valve defect		(1)		(20.0)		(.6)
Intestinal anomaly or complication	2		40.0		1.1	
Missing segment hind gut		(2)		(40.0)		(1.1)
Total	5		100.0		2.8	

[1]Time of death occurred during hours 72 to 96 postpartum.

[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 33. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES.

Cause of death[2]	Day 4[1] No. calves dead	Day total (%)	Total calf death loss (%)
Destroyed	4	80.0	2.2
Hairball	1	20.0	.6
Total	5	100.0	2.8

[1]Time of death occurred during hours 96 to 120 postpartum.

[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 34. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 5[1] No. calves dead	Day total (%)	Total calf death loss (%)
Hairball	1	25.0	.6
Heart anomaly or complication	2	50.0	1.1
Opening between ventricles	(1)	(25.0)	(.6)
Valve defect	(1)	(25.0)	(.6)
Intestinal anomaly or complication	1	25.0	.6
Missing segment hind gut	(1)	(25.)	(.6)
Total	4	100.0	2.3

[1]Time of death occurred during hours 120 to 144 postpartum.
[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 35. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 6[1] No. calves dead	Day total (%)	Total calf death loss (%)
Disease	1	50.0	.6
Pneumonia	(1)	(50.0)	(.6)
Heart anomaly or complication	1	50.0	.6
Valve defect	(1)	(50.0)	(.6)
Total	2	100.0	1.1

[1]Time of death occurred during hours 144 to 168 postpartum.
[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 36. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 7[1] No. calves dead	Day total (%)	Total calf death loss (%)
Accidental death	1	25.0	.6
Euthanasia	1	25.0	.6
Disease	1	25.0	.6
Scours	(1)	(25.0)	(.6)
Premature	1	25.0	.6
Total	4	100.0	2.2

[1] Time of death occurred during hours 168 to 192 postpartum.
[2] Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 37. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 8[1] No. calves dead	Day total (%)	Total calf death loss (%)
Delayed and difficult birth complex	1	50.0	.6
Technician error	(1)	(50.0)	(.6)
Cause of death not determined	1	50.0	.6
Total	2	100.0	1.1

[1] Time of death occurred during hours 192 to 216 postpartum.
[2] Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 38. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 9[1] No. calves dead	Day total (%)	Total calf death loss (%)
Intestinal anomaly or complication	1	33.3	.6
Missing segment **hind gut**	(1)	(33.3)	(.6)
Disease	2	66.7	1.1
Pneumonia	(1)	(33.3)	(.6)
Scours	(1)	(33.3)	(.6)
Total	3	100.0	1.7

[1]Time of death occurred during hours 216 to 240 postpartum.
[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 39. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 10[1] No. calves dead	Day Total (%)	Total calf death loss (%)
Starvation	1	100.0	.6
Total	1	100.0	.6

[1]Time of death occurred during hours 240 to 264 postpartum

[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 40. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[2]	Day 11-41[1] No. calves dead	Day total (%)	Total calf death loss (%)
Abandoned and/or starvation	1	6.7	.6
Accidental death	2	13.3	1.1
Delayed and difficult birth complex	1	6.7	.6
Dystocia	(1)	(6.7)	(.6)
Disease	4	26.7	2.2
Pneumonia	(4)	(26.7)	(2.2)
Euthanasia	2	13.3	1.1
Hairball	1	6.7	.6
Heart anomaly or complication	4	26.7	2.2
Pulmonary artery occluded	(1)	(6.7)	(.6)
Valve defect	(1)	(6.7)	(.6)
Valve hemorrhage	(1)	(6.7)	(.6)
Ventricle wall thin	(1)	(6.7)	(.6)
Total	15	100.0	8.3

[1]Time of death grouping includes deaths occurring during days 11 to 41 postpartum.

[2]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 41. TIME AND CAUSE OF DEATH SUMMARY REPRESENTING LOSSES AMONG ANATOMICALLY ABNORMAL CALVES

Cause of death[3]	Day 102-Weaning[1,2] No. calves dead	Day total (%)	Total calf death loss (%)
Brain damage or anomaly	1	25.0	.6
Hydrocephalus-external	(1)	(25.0)	(.6)
Euthanasia	2	50.0	1.1
Heart anomaly or complication	1	25.0	.6
Foramen ovale patent	(1)	(25.0)	(.6)
Total	4	100.0	2.2

[1]Time of death grouping includes deaths occurring during days 42 to 101 postpartum.

[2]No abnormal calf losses were incurred from day 42 through 101 postpartum.

[3]Refer to footnotes 2, 3, 4 and 5 in Appendix Table 29.

APPENDIX TABLE 42. AVERAGE BIRTH WEIGHTS OF ABNORMAL CALVES DEAD AS A RESULT OF DYSTOCIA EXPRESSED PER DAM AGE AND PARITY GROUP, CALVING DIFFICULTY SCORE AND CALF SEX

Age and Parity of Dam	Calving Difficulty Score[1] (1) No assistance (No.)	(kg.)	(2) Hand pull (No.)	(kg.)	(3) Mechanical puller (No.)	(kg.)	(4) Cesarean section (No.)	(kg.)	(5) Abnormal presentation (No.)	(kg.)
2-yr-olds	3	18.1	1	32.9	1	35.1	0	-	2	41.9
Males	1	32.4	0	–	0	–	0	–	2	41.9
Females	2	11.0	1	32.9	1	35.1	0	–	0	–
1st calf 3-yr-olds	2	24.3	0	-	1	41.0	0	-	0	-
Males	1	28.8	0	–	1	41.0	0	–	0	–
Females	1	19.8	0	–	0	–	0	–	0	–
Multiparous dams	6	25.5	0	-	2	30.8	1	28.8	5	31.5
Males	2	23.2	0	–	2	30.8	1	28.8	2	38.7
Females	4	26.7	0	–	0	–	0	–	3	26.7

[1]Calving difficulty scores were not recorded for nine of the abnormal calves dead as a result of dystocia.

APPENDIX TABLE 43. EFFECT OF DAM AGE AND PARITY GROUP, CALVING DIFFICULTY SCORE AND CALF SEX ON BIRTH WEIGHTS OF ABNORMAL CALVES

	Calves dead (No.)	Avg. Brwt. (Kg.)	Avg. Brwt. (Kg.)
μ	33	26.8	26.8
Calving difficulty score		NS	
1	11	23.5	23.3
2	1	37.1	32.8
3	4	33.3	34.4
4	1	26.4	28.8
Age and parity of dam		NS	
2-yr-olds	5	23.9	24.5
1st calf 3-yr-olds	3	29.3	29.8
Multiparous dams	9	27.6	27.0
Sex of calf		NS	
Male	8	28.3	29.8
Female	9	25.4	24.0

[1]Adjusted mean birth weights.

[2]Unadjusted mean birth weights.

APPENDIX TABLE 44. AVERAGE BIRTH WEIGHTS OF ABNORMAL CALVES DEAD AS A RESULT OF DYSTOCIA EXPRESSED PER DAM AGE AND PARITY GROUP, PRESENTATION AT BIRTH AND CALF SEX

Age and Parity of Dam	Presentation													
	Normal		Backwards		Breech		Hiplock		Leg back		Head back		Other	
	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)	(No.)	(kg.)
2-yr-olds	6	24.5	0	-	1	30.7	0	-	1	38.7	0	-	1	45.0
Males	2	28.6	0	—	0	—	0	—	1	38.7	0	—	1	45.0
Females	4	22.5	0	—	1	30.7	0	—	0	—	0	—	0	—
1st calf 3-yr-olds	2	31.3	3	29.8	2	34.9	0	-	0	-	0	-	0	-
Males	1	33.8	2	34.2	0	—	0	—	0	—	0	—	0	—
Females	1	28.8	1	19.8	2	34.9	0	—	0	—	0	—	0	—
Multiparous dams	10	29.8	3	33.0	2	29.3	0	-	0	-	1	29.3	1	19.8
Males	4	29.1	2	38.7	0	—	0	—	0	—	1	29.3	1	19.8
Females	6	30.2	1	21.6	2	29.3	0	—	0	—	0	—	0	—

APPENDIX TABLE 45. EFFECT OF PRESENTATION AT BIRTH, AGE AND PARITY OF DAM AND CALF SEX ON BIRTH WEIGHTS OF ABNORMAL CALVES

	Calves dead (No.)	Avg.Brwt. (Kg.)[1]	Avg.Brwt. (Kg.)[2]
μ	33	29.8	29.8
Presentation at birth		NS	
Normal	18	28.2	28.8
Backward	6	31.4	29.3
Breech	5	30.7	32.7
Hiplock	0	----	----
Leg Back	1	37.6	38.7
Head Back	1	26.0	29.3
Other	2	30.2	32.4
Age and parity of dam		NS	
2-yr-olds	9	27.9	28.5
1st Calf 3-yr-olds	7	31.5	31.7
Multiparous dams	17	30.1	29.7
Sex of calf		NS	
Male	15	32.7	32.5
Female	18	27.3	27.5

[1]Adjusted mean birth weights.

[2]Unadjusted mean birth weights.

APPENDIX TABLE 46. DAMS PRODUCING MORE THAN ONE ABNORMAL PROGENY

Dam No.	No. Abnormal Offspring	Herd/Breed or Line	
0173	2	01-009	Line 9
0115	2	15-001	GEI, Line 1
1312	2	01-009	Line 9
2065	3	05-001	GEI, Line 1
4049	2	08-001	Physiology, Hereford

APPENDIX TABLE 47. SIRES PRODUCING MORE THAN ONE ABNORMAL PROGENY

Sire No.	No. Abnormal Offspring	Herd/Breed or Line	
0643	2	15-001	GEI, Line 1
1162	8	01-011	Line 11
1166	2	14-001	Phase 3 Linecross, Line 1
1175	3	15-001	GEI, Line 1
1192	4	01-009	Line 9
1220	3	01-001	Line 1
1276	2	01-009	Line 9
1691	2	14-025	Phase 3 Linecross, Line 10
2061	3	12-019	Phase 1 Linecross, Line 9
2080	3	07-001	Carcass
2259	4	01-001	Line 1
2429	3	14-257	Phase 3 Linecross, Synthetic variety
3054	2	15-002	GEI, Brooksville
3182	2	15-001	GEI, Line 1
3248	5	07-001	Carcas
3945	2	16-001	Purchased, Purebred Hereford
4255	2	15-001	GEI, Line 1
4323	2	15-002	GEI, Brooksville
4513	3	12-019	Linecross Phase 1, Line 9
5094	2	09-002	Phase 1 Crossbred, Hereford x Angus
5591	2	07-001	Carcass
5982	2	15-003	GEI, Control
6267	2	07-001	Carcass
6983	2	17-001	Purchased, Grade Hereford
8191	2	01-014	Line 14
8572	2	01-009	Line 9
9135	2	16-016	Purchased, Angus
9991	4	16-001	Purchased, Hereford
9996	2	16-031	Purchased, Charolais

APPENDIX TABLE 48. DAMS LOSING CALVES NOT INCLUDED IN THE SUBSEQUENT FALL PREGNANCY EXAMINATION INVENTORY

Age and Parity of Dam	Status of Dams						
	Died (No.)	Destroyed (No.)	Sold not exposed[1] (No.)	Exposed sold[1] (No.)	Exposed died or missing[1] (No.)	Total No.	Total (%)
2-yr-olds	9	1	39	0	0	49	28.7
1st calf 3-yr-olds	3	0	3	0	3	9	5.3
2nd calf 3-yr-olds	3	0	13	0	0	16	9.4
2nd calf 4-yr-olds	0	1	12	0	0	13	7.6
3rd calf 4-yr-olds	3	0	15	0	0	18	10.5
5-yr-olds	1	0	14	0	1	16	9.4
6-yr-olds	1	1	10	1	0	13	7.6
7-yr-olds	2	1	7	2	0	12	7.0
8-yr-olds	0	0	5	0	0	5	2.9
9-yr-olds	2	0	6	0	0	8	4.7
10-yr-olds	1	0	5	1	0	7	4.1
11-yr-olds	1	0	3	0	0	4	2.3
12-yr-olds	0	0	1	0	0	1	.5
Total (No.)	26	4	133	4	4	171	100.0
(%)	15.2	2.3	77.8	2.3	2.3	100.0	

[1]Exposed for breeding.

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