Induced calving in beef production

by James Larry Winter

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Animal Science
Montana State University

Abstract:
Eighty-six 2-year-old heifers and 76 aged cows in the fall of 1972 and 30 2-year-old heifers and 275 aged cows in the fall of 1973 were assigned to trials and treatments to determine the effects of corticosteroid induced parturition on cow and calf performance. All animals were part of the Montana State Prison fall calving beef herd and were managed according to usual open range procedures for western range beef production. Three trials consisting of three treatments per trial (1 control and 2 dexamethasone treated) were run in the fall of 1972. The objective of these trials was not only to determine the effects of induced parturition on cow and calf performance, but also to determine if the method of injection of the dexamethasone (intravenously vs. intramuscularly) and/or an increase from one dose to two doses given at a 24 hr interval would result in a reduction in retained placenta and/or an increase in induction success. In the fall of 1973, an induction schedule was developed to divide the 45 day natural calving period of the 275 aged cows into 4 separate induction trials approximately 10 days apart. Each trial consisted of 3 treatment groups (a control and 2 flumethasone treatments). Approximately one-third of the cows were calved as noninduced controls while the other two-thirds were injected with flumethasone to induce parturition. Treated cows in the fall of 1973 were injected between 265-285 days of gestation with 285 days considered normal gestation length. The heifers in the fall 1973 study were assigned to 2 trials having a control and a flumethasone treated group in each trial. Parturition was successfully induced in a high percentage of all cows treated in both years of the study. Heifers and cows responded similarly to the two corticosteroids. Parturition took place on an average of 45-50 hrs after the injection of corticosteroid. In the 1972 study, the methods of induction showed no differences as to retained placenta or induction success. Overall an increase in retained placenta was found in the induced cows over controls in all trials. No decrease in calf vigor at parturition was found in any of the trials. The control cows required 51 days to complete calving compared to 35 days for the flumethasone treated animals in the fall 1973 study. Induced animals generally showed significantly earlier birth dates, shorter gestation lengths and lower birth weights of their calves than the controls in the fall 1973 study. More calving difficulty was found in the induced animals than the controls in certain trials even though birth weight was decreased. General cow health was not affected by the induction treatments, and no differences were found in subsequent fertility when pregnancy rate after a 45 day breeding season and fertility score for the first 25 days of breeding were comparted between groups. Furthermore, subsequent calf performance was not significantly affected by the induction treatments.

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A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree

of

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Approved:

Head, Major Department

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ABSTRACT

Eighty-six 2-year-old heifers and 76 aged cows in the fall of 1972 and 30 2-year-old heifers and 275 aged cows in the fall of 1973 were assigned to trials and treatments to determine the effects of corticosteroid induced parturition on cow and calf performance. All animals were part of the Montana State Prison fall calving beef herd and were managed according to usual open range procedures for western range beef production. Three trials consisting of three treatments per trial (1 control and 2 dexamethasone treated) were run in the fall of 1972. The objective of these trials was not only to determine the effects of induced parturition on cow and calf performance, but also to determine if the method of injection of the dexamethasone (intravenously vs. intramuscularly) and/or an increase from one dose to two doses given at a 24 hr interval would result in a reduction in retained placenta and/or an increase in induction success. In the fall of 1973, an induction schedule was developed to divide the 45 day natural calving period of the 275 aged cows into 4 separate induction trials approximately 10 days apart. Each trial consisted of 3 treatment groups (a control and 2 flumethasone treatments). Approximately one-third of the cows were calved as noninduced controls while the other two-thirds were injected with flumethasone to induce parturition. Treated cows in the fall of 1973 were injected between 265-285 days of gestation with 285 days considered normal gestation length. The heifers in the fall 1973 study were assigned to 2 trials having a control and a flumethasone treated group in each trial. Parturition was successfully induced in a high percentage of all cows treated in both years of the study. Heifers and cows responded similarly to the two corticosteroids. Parturition took place on an average of 45-50 hrs after the injection of corticosteroid. In the 1972 study, the methods of induction showed no differences as to retained placenta or induction success. Overall an increase in retained placenta was found in the induced cows over controls in all trials. No decrease in calf vigor at parturition was found in any of the trials. The control cows required 51 days to complete calving compared to 35 days for the flumethasone treated animals in the fall 1973 study. Induced animals generally showed significantly earlier birth dates, shorter gestation lengths and lower birth weights of their calves than the controls in the fall 1973 study. More calving difficulty was found in the induced animals than the controls in certain trials even though birth weight was decreased. General cow health was not affected by the induction treatments, and no differences were found in subsequent fertility when pregnancy rate after a 45 day breeding season and fertility score for the first 25 days of breeding were comparted between groups. Furthermore, subsequent calf performance was not significantly affected by the induction treatments.

INTRODUCTION

In the late 1960's, various investigators reported that corticosteroid containing compounds would cause precocious or premature parturition in cattle if injected in the third trimester of pregnancy. Moreover, it has been determined that parturition can be induced within a certain predetermined time when corticosteroids are used at recommended levels.

Calving time is one of the most important times of the year for a livestock producer. Depending on the management at calving a producer can encounter calf losses as low as 0 to 4% or as high as 14 to 100%. A good management system at calving involves 24-hour observation of cows during the entire calving season; not neglecting cows which calve prior to the expected start of calving or those which calve after the estimated end of calving. Obviously, this type of management requires many man hours of qualified labor. However, if calving could be controlled so cows calved at a predetermined time, one might conserve a considerable amount of labor.

The purpose of the present study was to evaluate the effects of corticosteroid-induced parturition on beef production when used under field conditions and to develop a possible management system for calving utilizing induced parturition. The effects on beef production were evaluated by looking at cow and calf performance at calving, subsequent calf performance and subsequent reproductive performance of the cows.

REVIEW OF LITERATURE

Parturition

General. Several hundred years ago Hippocrates suggested that the fetus pushed itself out of the uterus when food stores became depleted. This theory concerning the fetus giving off the signal for the start of parturition was not well accepted in years gone past. Most scientists felt that the maternal organism through her endocrine system terminated pregnancy (Catchpole, 1969; Schofield, 1968). However, Liggins, Kennedy, and Holm (1967) performed a series of elegant studies of the fetal pituitary function in sheep which supported the possibility of fetal factors being important in labor. This work was precipitated by the fact that prolonged pregnancy in various animals had been linked to congenital deformities of the fetus (Lanman, 1968). In one such study, Binns et al. (1960) described a syndrome of prolonged pregnancy in sheep carrying lambs congenitally deformed by a teratogenic agent found in a weed which caused deformities of the fetal endocrine glands. It was found that prolonged pregnancy only occurred when all fetal lambs were afflicted with the condition. Huston and Grier (1958) concluded that prolonged gestation in some hydrocephalic calves was caused because of an endocrine abnormality in the fetus. This abnormality was reported to be aplasia of the fetal adenohypophyses. Jafar, Chapman and Casida (1950) estimated that the genotype of the calf, within sex, and the permanent maternal characteristics were responsible for 48 and 21% of the variation in gestation length, respectively.

DeFries, Touchberry and Hay (1959) showed that in their studies the heritability of gestation length, considered as a character of the fetus alone, was 0.420, and considered as a combined characteristic of fetus and dam it was very little more, 0.474. They concluded that gestation length was primarily determined by the calf.

Liggins _et al_. (1967) hypophysectomized fetal lambs and caused an indefinite prolongation of pregnancy. Comline _et al_. (1970) confirmed the work of Liggins by prolonging gestation by hypophysectomy of fetal lambs. In another study a stalk section in five fetal lambs at 111-126 days of gestation caused prolonged gestation (Liggins and Kennedy, 1968). Holm, Parker and Galligan (1961) postulated that, among ruminants the fetal adrenal is a major determinant in the initiation of labor. Bilateral adrenalectomies were performed on lamb fetuses, and caused delivery 10 days or more beyond term (Drost and Holm, 1968). Liggins (1968) infused ACTH daily into fetal lambs of more than 88 days gestional age causing parturition on day 4 to day 7 of infusion. At birth, the fetal adrenals weighed at least as much as those of normal lambs at term (Liggins, 1968). An increased level of secretion of corticosteroids was evident by the elevated levels of cortisol, and the evidence of the biological action of cortisol (Liggins, 1968). Thorburn _et al_. (1972) demonstrated that the infusion of synthetic ACTH into the goat fetus induced premature parturition preceded by a marked increase in the concentration of corticosteroids in the fetal plasma. Liggins (1968) infused cortisol into the ovine fetus at a rate of 50 mg/24 hrs;

parturition took place within 5 days. In another study, Liggins (1969) caused premature delivery when glucocorticoids were infused into the ovine fetus. No effect was found when compounds with mineralocorticoid activity were infused into the fetus in the above experiment. These observations suggest that normal parturition in the goat and sheep (Liggins and Kennedy, 1968; Liggins, 1969; Liggens et al., 1973; Bassett and Thurnburn, 1969) is triggered by activation of the pituitary-adrenal axis of the fetus.

Lanman and Schaffer (1968) decapitated fetal lambs in utero; of the three fetuses that survived, two were delivered spontaneously at term, while the third had not initiated parturition by 25 days post term. All three lambs had very small adrenals when lambed, and the two lambs delivered near term could have possibly died before parturition. In rats, removal of the fetuses with the placentas left intact at any time from the fourteenth to the twenty-first day of pregnancy has led to delivery of the retained placentas at normal term (Kirsch, 1938), and similar observations have been made in monkeys (Van Wagene and Newton, 1949). The above studies give some doubt to the hypothesis of Liggins et al. (1973).

Ovine. The major site of progesterone production in the ewe in late pregnancy is the placenta (Linzell and Heap, 1968; Thorburn and Mathner, 1971). The concentration of progesterone in peripheral blood falls during the last few days of pregnancy in the ewe (Bassett et al., 1969; Fylling, 1968, 1970; Thornburn et al., 1972; Chamley et al.,

1973) to a low level on the day of parturition. Short and Rowell (1962) showed that the metabolic clearance rate of progesterone does not change in late pregnancy so a decrease in blood progesterone levels represents diminishing secretion. Total unconjugated estrogens, on the other hand, increase significantly 16-24 hrs prior to parturition in the ewe (Challis, 1971; Obst and Seamark, 1972a; Thorburn et al., 1972; Chamley et al., 1973). Robertson and Smeaton (1973) clearly revealed that a dramatic increase in the concentration of unconjugated estrone, estradiol-17α and estradiol-17β occurs in the jugular venous plasma of the pregnant ewe beginning at about 40 hrs before parturition and reaching a peak of parturition. These workers demonstrated that the concentrations of estradiol-17α and estradiol-17β are very similar and are approximately half that of the concentration of estrone. Liggins et al. (1973) felt that not enough evidence has been accumulated to determine the source of unconjugated estrogens which suddenly appear. However, Challis et al. (1971) and Bedford et al. (1972) demonstrated that the probable source of the estrogens is the conceptus. Chamley et al. (1973) reported a substantial increase in maternal corticosteroid levels beginning 6-18 hrs before birth. An increase in maternal plasma corticosteroid levels at parturition was also observed by Obst and Seamark (1972b) while Bassett and Thorburn (1969) reported no increase. Prostaglandin $F_2\alpha$ is one other hormone which is felt to have a physiological role in the mechanism controlling labor (Liggins et al., 1972; Liggins, 1973). In sheep, an increase in the concentration of $PGF_{2\alpha}$ in the maternal placenta precedes the onset of labor by at least 24 hrs (Liggins and Grieves, 1971). Thorburn et al. (1972) found that $PGF_{2\alpha}$ concentrations increased in uterine venous blood preceding labor.

Bosc (1972) hypophysectomized pregnant ewes at day 50-134 and observed normal parturition, hence, Liggins et al. (1973) theorizes very little importance of the hormones from the maternal anterior pituitary in parturition. However, levels of hormones from the anterior pituitary are of interest. Chamley et al. (1973) found no observable change in LH during parturition. Furthermore, they did find a sharp increase in prolactin starting at about 2 days before parturition with highest levels being found shortly before parturition in most animals. These data were consistent with that of Davis, Reichert and Niswender (1971) and Fell et al. (1972).

Many scientists assume that oxytocin from the maternal pituitary plays an important role in the initiation and maintenance of labor (Fuchs, 1971; Chard, 1972). However, in a review of the role of oxytocin in parturition, Chard (1972) found evidence of an abrupt release of oxytocin at the time of delivery and not earlier in the ovine. Chard (1972) felt that if this release has a function, it must be to expedite the process of delivery itself, and it is unlikely that oxytocin is responsible for the initiation of labor.

In the ovine fetus, a rapid increase in adrenal weight is found in the last week of gestation (Comline and Silver, 1961).

Nathanielsz et al. (1972) confirmed these data by showing a marked rise in adrenal weight during gestation starting 10 days before birth. Nathanielsz et al. (1972) observed that this growth takes place primarily in the adrenal cortex. This adrenal growth is paralleled by marked increases in the plasma corticosteroid concentration of the fetus (Bassett and Thorburn, 1969; Bassett, Thorburn and Nicol, 1973; Nathanielsz et al., 1972; Alexander et al., 1968) and an increase in corticosteroid turnover rate (Comline et al., 1970). Also an increase in ACTH was found at this time (Alexander et al., 1971). Liggins et al. (1973) found a sharp rise in cortisol levels in fetal plasma starting on day 4 prepartum with high levels 48 hrs prior to parturition. The transfer of cortisol across the placenta in either direction is relatively small but increases near term (Liggins et al., 1973). Findlay and Cox (1970) showed a high level of estrogen sulphates in fetal plasma, but no rise in fetal unconjugated estrogen at time of parturition has been reported (Thorburn et al. 1972). The fetal adrenal has also been shown to produce precursors for estrogen production of the placenta (Van Kampen and Ellis, 1972; Findlay and Semark, 1971).

With the information available at the present time, Liggins (1972) and Liggins et al. (1973) have proposed that the stimulus to parturition in the ewe originates in the fetal hypothalmus (Figure 1). However, the actual factors influencing hypothalamic activity and determining the timing of the mechanism remain uncertain. Liggins et al. (1973) has

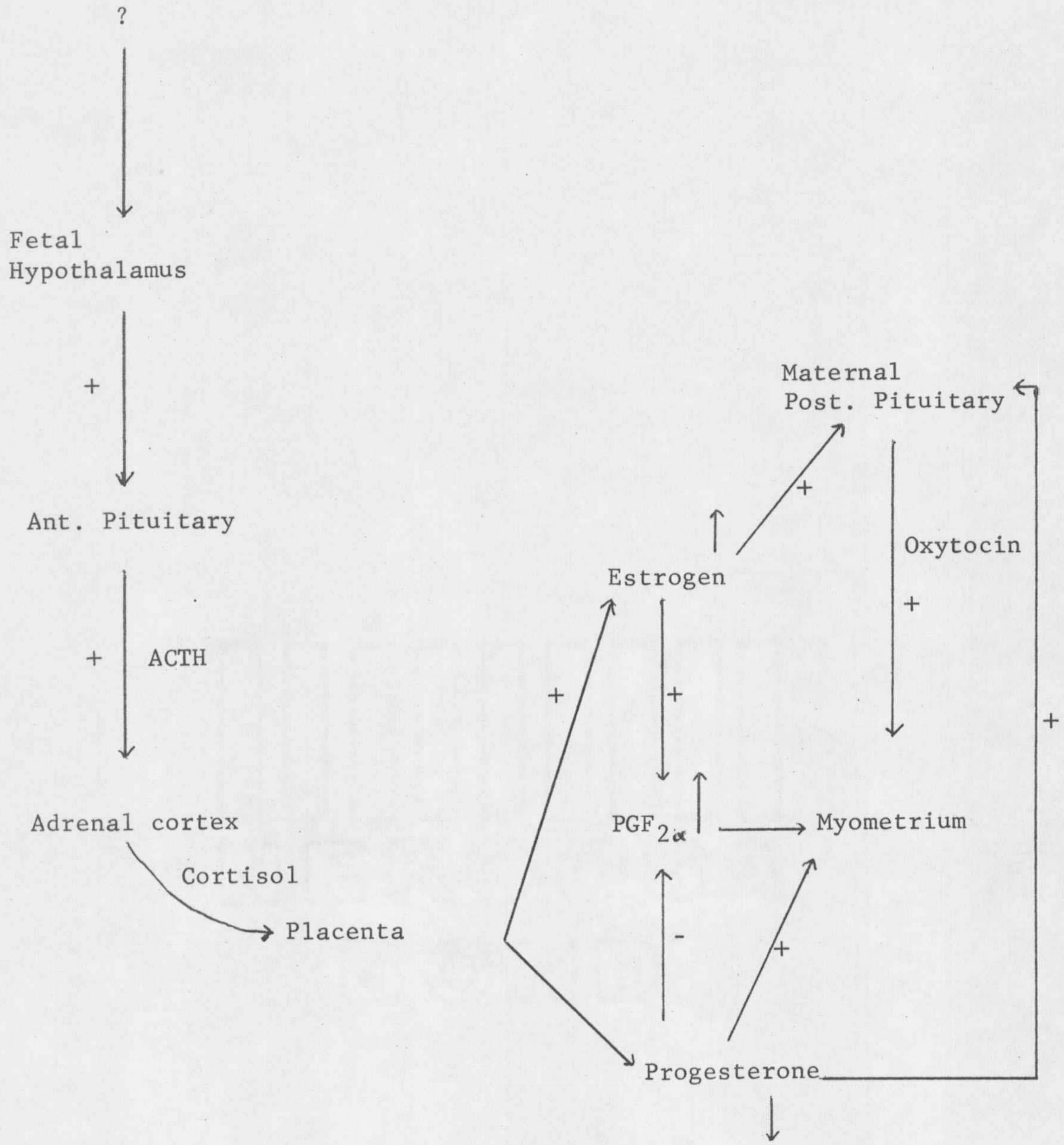

Figure 1. Proposed model of the mechanism controlling the initiation of parturition in the ewe. (Liggins _et al._, 1973)

summarized his theory of the mechanism of parturition in the ewe:

> As a result of hypothalamic and pituitary activity, the rate of secretion of cortisol increases rapidly owing to the combined effects of cortical growth, of activation of the enzyme 11β-hydroxylase, and of increased responsiveness of the adrenal cortex to ACTH.
>
> Cortisol in relatively high concentrations in the fetal blood acts on the placenta by unknown mechanisms to reduce the secretion of progesterone and to increase the secretion of estrogen. Simultaneously, greater production of androgen by the fetal adrenal cortex may promote estrogen synthesis in the placenta. Associated with a rising concentration of unconjugated estrogen - and probably induced by it - is an equally sharp increase in the concentration of $PGF_{2}\alpha$ in maternal cotyledons and myometrium. At the same time the concentration of $PGF_{2}\alpha$ in uterine venous blood is elevated.
>
> The myometrium responds to $PGF_{2}\alpha$ with heightened sensitivity to oxytocin, which may permit unchanged levels of circulating oxytocin to induce uterine contractions. It is uncertain in the sheep whether $PGF_{2}\alpha$ itself has a direct oxytocic action.
>
> Finally, distension of the cervix and vagina by descent of the fetus reflexly stimulates release of oxytocin from the posterior pituitary gland. Complete delivery of the lamb is rapidly accomplished through the combined efforts of uterine contractions augmented by oxytocin and reflexly excited contraction of the maternal abdominal musculature.

Bovine. The corpus luteum is the major source of progesterone throughout gestation (Gomes and Erb, 1965) in the bovine, as compared, to the placenta being the major source of progesterone for the ovine in the last half of gestation. This basic difference in the endocrinology of gestation makes extrapolation of information on parturition between species quite speculative (Liggins, 1972). Jöchle (1971) feels that the maternal adrenal is a more important producer of progesterone for maintenance of pregnancy in the last trimester of gestation in the bovine than the ovary.

Plasma progesterone levels in the cow are constant throughout most of pregnancy, but about 10 days before parturition they start to decline (Short, 1960). Smith et al. (1973) showed a precipitous decline in serum progestins beginning 72 to 48 hrs prepartum. Others have also measured this drop in progesterone levels in the cow prior to parturition (Short, 1958; Stabenfeldt et al., 1970; Henricks et al., 1972).

Holm and Galligan (1966) showed elevated levels of estradiol and estrone in plasma during the last month of pregnancy and a sharp decline during the postpartum period. Henricks et al. (1972) confirmed the above observation by showing that total estrogens consistently rose in concentration from 14 days prepartum to calving with highest level measured on day of parturition. Smith et al. (1973) showed an increase in plasma levels of estrone and estradiol from start of measurement at 26 days prepartum to a peak at day 2 prepartum. Thereafter, serum estrogens declined rapidly. Estrone showed much higher levels than did estradiol during time of measurement (Smith et al., 1973). Robertson (1974) confirmed these data by showing a rise in the concentration of unconjugated estrone, estradiol-17α and estradiol-17β in the maternal plasma over the last 20 days of pregnancy. At parturition, the concentration of the free estrogens fall to a low level within 24 hrs (Robertson, 1974).

Smith et al. (1973) showed very little change in serum glucocorticoids in the cow from 26 days to 1 day before parturition. However, an increase approximately 12 hrs before parturition and a peak at parturition was detected in blood glucocorticoids (Smith et al., 1973). Increased glucocorticoids in serum at parturition in the bovine agrees with results reported by Adams and Wagner (1970). Adams and Wagner (1970) showed that glucocorticoids increased markedly to day 4 prepartum then plateaued through parturition not falling until 2 days postpartum. This conflicts with the findings of Smith et al. (1973).

To the knowledge of this author no report of levels of plasma prostaglandin $F_{2\alpha}$ at time of parturition in the bovine have been published. This hormone is thought to be important in the mechanism of parturition in the ovine (Liggins, 1973). Thorburn et al. (1972) has shown increased $PGF_{2\alpha}$ in uterine vein plasma of the goat starting at 24 hrs prepartum and feels that, as in the ovine, $PGF_{2}\alpha$ is important in the mechanism of parturition of the goat. Pharriss, Tillson and Erickson (1972) have shown evidence that $PGF_{2}\alpha$ is luteolytic in various species. Thorburn et al. (1972) theorized that since the goat depends on the CL for progesterone throughout pregnancy (Meites et al., 1951) and progesterone falls prior to parturition because of CL regression that $PGF_{2}\alpha$ could possibly be involved in this regression. However, progesterone levels start decreasing prior to the increase in $PGF_{2}\alpha$ (Thorburn et al., 1972). Nevertheless, Thorburn et al. (1972) feels that since his results were obtained from a single animal in which samples were collected only once daily, the possibility exsists that brief surges of $PGF_{2}\alpha$ were missed. Since the goat and the cow are both corpus luteum depend, as reported, one might speculate similarities in their mechanisms of parturition.

Ingalls, Convey and Hafs (1973) described changes in serum LH, growth hormone and prolactin concentration in bovine serum during late gestation, parturition and early lactation. Prolactin showed a significant ($P<.01$) increase at -2 and -1.5 days prepartum and reached a peak 1 day before parturition (Ingalls et al., 1973). Ingalls et al. (1973) also demonstrated an increase in maternal serum levels of growth hormone starting on day 9 prepartum through day of parturition with the sharpest increases occurring around parturition. No significant changes were found in plasma LH levels around parturition (Ingalls et al., 1973). Schalms et al. (1972) confirmed the above report on LH levels at parturition. As in the ovine, oxytocin levels show only small changes during labor, but rise to a peak at the actual moment of delivery, and decline rapidly thereafter in the bovine (Chard, 1972).

Plasma cortisol levels were measured in both the bovine fetus and maternal unit by Lin, Oxender and Hafs (1973) at 90, 180 and 260 days of gestation. Their results revealed an increase in fetal cortisol from day 180 to 260 and that maternal cortisol is higher than fetal cortisol throughout gestation. Lin et al. (1973) also reported that cows with a male fetus have a higher maternal cortisol level than cows with a female fetus and male fetuses were found to have higher plasma cortisol levels at 260 days than female fetuses.

At present an accurate theory for the mechanism of parturition in the bovine has not been developed. However, a functional hypothalmic-pituitary-adrenal axis in the fetus is a prerequisite for normal parturition at a predictable term (Holm et al., 1961; Adams, 1969; Liggins, 1972).

Induction of Parturition

General. Liggins (1968), as mentioned earlier, found that infusion of cortisol or ACTH into the ovine fetus leads to premature parturition. He later found that infusion of glucocorticoids into the ovine fetus also leads to premature parturition (Liggins, 1968). However, Liggins (1968) and Liggins (1969) could not induce premature labor in ewes by infusion of cortisol or 4 mg/day of dexamethasone, respectively, into the maternal organism. Nevertheless, much larger dose levels of glucocorticoid given to the ovine mother late in the gestation period causes precocious parturition (Van Rendsburg, 1967; Adams and Wagner, 1970; Skinner et al., 1970; and Fylling, 1971).

In the latter 1960's, veterinary practitioners observed unexplained parturitions in cows treated with corticoid containing drugs during late pregnancy (Carroll, 1974). Adams (1969) confirmed these reports by inducing parturition in 22 cows that were 235 to 280 days pregnant at the time of treatment with flumethasone. At present, successful induction of parturition after maternal injection with glucocorticoids has been reported in rabbits (Kendall and Liggins, 1971; Adams and

Wagner, 1969), goats (Van Rendsburg, 1970), swine (North et al., 1973; First and Staigmiller, 1973; Coggins and First, 1973), and horses (Alm et al., 1972).

There are three major glucocorticoids used at present to induce parturition: dexamethasone, flumethasone and betametasone (Jöchle, 1971). Flumethasone and dexamethasone are the two most commonly used in the United States. The therapeutic efficacy ratio between dexamethasone and flumethasone is 1:4 (Jöchle, 1971). These corticosteroids used in the free alcohol or soluble ester form will induce parturition in cows 2 or 3 days following injection (Welch, Newling and Anderson, 1973). Suspensions or insoluble esters of the above steroids can also be used for inducing parturition, but they usually take about 2 weeks to induce calving after injection (Welch et al., 1973). Some synthetic corticoids do not induce parturition when used at maximum therapeutic doses in late gestation (Lauderdale, 1972).

Zerobin, Jöchle and Steingruber (1973) have shown that prostaglandin $F_{2\alpha}$ or prostaglandin E_2 administered by intravenous or introuterine application will terminate pregnancy during the last trimester of gestation in the bovine with a live viable calf as a result.

A review of what hormones terminate pregnancy in the bovine during gestation is presented in table 1 (Jöchle, 1973; Zerogin et al., 1973; Lamond et al., 1973).

After parturition is induced prematurely by the infusion of synthetic ACTH or dexamethasone into the fetal lamb, the changes in the plasma concentration of fetal corticosteroids and maternal progesterone are similar to those seen during normal parturition (Bassett *et al.*, 1969). Thorburn *et al.* (1972) confirmed the above observation by showing the usual decrease in maternal progesterone before parturition after infusion of synthetic ACTH into the fetal lamb. He also showed

TABLE 1. HORMONALLY INDUCED TERMINATION OF GESTATION IN CATTLE (ADAPTED FROM JÖCHLE, 1973; LAMOND *et al.*, 1973; ZEROBIN *et al.*, 1973)

Compounds used	Trimester		
	I	II	III
(a) Estrogens	+	(+)	(+)
(b) Corticosteroids	-	+	++
(c) Prostaglandins	++	(+)	++
Combination (a) + (b)	+	++	++

Legend: - not active
(+) activity questionable
+ active, but not consistently
++ active, consistently

that the estrogen changes in maternal plasma after induced parturition were similar to those found at normal parturition. Emadi and Noakes (1973) found a definite fall in maternal blood progesterone before parturition when parturition was induced by a maternal injection of glucocorticoid. In the goat plasma conticosteroid concentration increased steadily in the fetus prior to parturition while maternal plasma progesterone levels fell on the day before parturition after induction of parturition with synthetic ACTH infusions into the fetus (Thorburn _et al._, 1972). The pattern of maternal estrogen changes was similar in both the normal and ACTH-treated goats (Thorburn _et al._, 1972). Wright _et al._ (1970) found that doses of flumethasone given to the female bovine during late gestation caused prompt regression of the corpus luteum as measured by sharp declines in plasma progesterone concentrations, and decreased the estimated size of the CL in those cows responding. Cows not responding did not have reduced progesterone levels. Evans, Wagner and Adams (1971) confirmed the above work by showing a decrease in plasma progesterone within 24 hrs of treatment and a further decrease during the 24 hrs pre-calving. Wagner _et al._ (1974b) reported that maternal plasma progesterone and estrogen levels of induced cows at time of induced parturition were similar to those of normal cows at parturition. However, the estrogen peak prior to parturition in the induced animals was not of the same magnitude as that of a normal cow. Osinga (1970) showed a short, dramatic rise in urinary estrogen excretion followed by an equally sharp drop in cows induced with corticosteroids.

Response. Adams (1969) induced parturition in 22 cows that were 235 to 280 days pregnant with 20 mg of dexamethasone which is the highest recommended therapeutic dose for the bovine. Adams and Wagner (1970) in a later study used 20 mg of dexamathasone to attempt induction of parturition in cows varying in gestation lengths from 197 to 293 days.

Forty-six of 54 animals were successfully induced with a successful induction defined as one in which labor was initiated within 72 hrs from time of dexamethasone injection. The mean interval to fetal expulsion was 49 hrs after dexamethasone injection with a range of 22-80 hrs (Adams and Wagner, 1970). The mean age of pregnancy for the successes was 274 days with a range of 250-293 days; while the mean age of pregnancy for failures was 254 days with a range of 197-289 days. Adams and Wagner (1970) concluded that since rate of induction failure increased as the dexamethasone was injected earlier in pregnancy, the mechanism apparently becomes more sensitive as the fetus approaches maturity. Bosc (1971) injected either 8 or 16 mg dexamethasone into cows with gestation lengths of 265 or 274 days, and demonstrated that the response varied with the amount injected and the day of pregnancy. The mean hours from injection to parturition was 51.24, 127.93, 34.89 and 58.72 for cows injected with 16 mg on day 265, 8 mg on day 265, 16 mg on day 274 and 8 mg dexamethasone on day 274 of gestation, respectively. Wagner (1972) studied the effect of injecting different levels of dexamethasone on induction of parturition, and showed that in cows in late gestation 30 mg dexamethasone seemed sufficient.

Jöchle (1971) reviewed all available liaterature on the use of flumethasone for induction of parturition. The accumulated data revealed that 5 to 10 mg flumethasone given parenterally 10 to 14 days before calculated termination of pregnancy induced premature parturition.

in more than 80% of all treated cows within 48 to 72 hrs. These parturitions are remarkably fast, smooth and uncomplicated. Calf viability is good. These reports also show that larger dose levels are required for successful induction of parturition as you induce earlier in gestation. Jöchle (1971) concluded that the closer the gestation period is to term, the more sensitive the maternal organism becomes to this specific corticosteroid effect. Wagner et al. (1971) and Wagner (1972) have confirmed the above data by showing that doses of 5 to 10 mg flumethasone cause parturition in cows when injected in late gestation. Carroll (1974) studied the effects of two dose levels of flumethasone given to cows on day 270 of pregnancy. Hours from treatment to parturition were 56.5 and 52.2 for cows treated with 5 mg flumethasone or 10 mg flumethasone, respectively. There was no significant difference in the response between the dose levels, and there was no correlation between response and weight of cow within each level of treatment (Carroll, 1974). Wiltbank (1973) reported on three trials at Colorado State University in which 10 mg flumethasone was used to induce parturition in the bovine. Average hours from injection to parturition were 50, 44 and 46 hrs, and percent induced were 90, 93 and 96% for Trials I, II and III, respectively.

Bosc (1972b) compared single injections of 4, 8 or 16 mg dexamethasone given to ewes on the 144th day of gestation. Whatever dose of dexamethasone was injected on the 144th day of gestation, the treated animals lambed earlier than the controls. Furthermore, when the dose