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# Some factors affecting the reproductive efficiency in beef cattle

Nersa Gonzalez

To the Graduate Council:

I am submitting herewith a thesis written by Nersa Gonzalez entitled "Some factors affecting the reproductive efficiency in beef cattle." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Animal Science.

R. L. Murphree, Major Professor

We have read this thesis and recommend its acceptance:

J. B. McLaren, J. N. Holloway

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

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R L Murphree

Dr. R. L. Murphree, Major Professor

We have read this thesis and recommend its acceptance:

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J. W. Holloway

Accepted for the Council:

L Evans Roth

Vice Chancellor
Graduate Studies and Research

# SOME FACTORS AFFECTING THE REPRODUCTIVE EFFICIENCY IN BEEF CATTLE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Nersa Gonzalez

August 1977

TO THE MEMORY OF MY PARENTS

AND

TO MY NEPHEW ELADIO JUAN

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## ABSTRACT

The ovaries of a total of 346 cows in three University of Tennessee Agricultural Experiment Station herds were palpated within one week prior to the beginning of the breeding season, to determine if the females had resumed postpartum ovarian activity. The numbers and ages of animals within the three herds were: (1) Alcoa herd-78 head, 2- to 4-years, (2) Ames Plantation herd-106 head, 2- to 13-years, and (3) Tobacco Experiment Station herd-172 head, 1- to 7 years of age. Overall the ovaries of only 46 percent of the females contained a corpus luteum.

In the Alcoa herd, presence of a sterile bull with the cows for 45 days prior to the beginning season did not influence the numbers of cows with corpora lutea.

Estimated conception rates in the Tobacco Experiment Station herd, by 21 day periods of the breeding season, indicated that 38 percent of the females conceived during the first 21 day interval of the breeding season. However, 64 percent of the cows which became pregnant during this period had a corpus luteum at the beginning of the breeding season. Extrapolation of these results to all three herds suggests that had all cows been cycling at the beginning of the breeding season, about 67 percent more calves would have been born during the first three weeks of the calving season. This emphasizes the importance of the reproductive status of the cow at the beginning of the breeding season on her subsequent reproductive performance.

TABLE OF CONTENTS

LIST OF TABLES

# I. INTRODUCTION

High reproductive performance is an essential requirement for a successful beef cattle industry. Ideally each female entering the breeding herd should produce a calf the following year. This objective, however, is seldom attained. Among the factors which have been shown to affect the reproductive efficiency of female cattle are age at puberty and length of the postpartum interval of first estrus. If heifers do not reach puberty by the beginning of the breeding season, they either fail to become pregnant or conception is delayed resulting in their calving late the following year. There is evidence indicating that the late calving heifer is likely to be a late calving cow. Furthermore, there appears to be a higher probability that she will subsequently fail to conceive in one or more later years. Similarly, the postpartum cow which does not resume estrous cycles until after the beginning of the breeding season is less likely to conceive early in the season, that is, the cow which has exhibited estrus one or more times prior to the beginning of the breeding season has a higher probability of early conception than does the cow that is not cycling at the beginning of the breeding season.

This thesis presents data on the ovarian status of beef females immediately prior to the beginning of the breeding season in three University of Tennessee Agricultural Experiment Station herds.

## II. REVIEW OF LITERATURE

In this review will be considered various studies in which data have been mentioned as the main factors affecting the age at puberty and length of the postpartum interval in cows.

### Age at Puberty of Heifers

Williams (1943) considered that the age of sexual maturity depends largely on feeding and housing conditions. Wiltbank et al. (1966, 1969) indicated that age and weight at puberty are heritable and are affected by genetic environmental interactions.

Hansel (1959); Bellows et al. (1965) and Wiltbank et al. (1969) concluded that age at first estrus in the bovine is influenced by breed and level of nutrition. Van Rensburg (1956) reported that puberty is usually earlier in dairy heifers than in those of beef breeds. McDowell et al. (1953) demonstrated that there is a tendency for Zebu heifers to reach puberty at a later age as compared with heifers of European breeds. Bellows (1968) studied the effects of energy level on growth and age at puberty in beef heifers; the heifers on the high ration exhibited one more heat period during the breeding season than those on the low energy level. Sixteen percent of the high level group and 50 percent of the low group came in the heat for the first time after the beginning of the breeding season. This means that they would have to conceive to fewer services than heifers that had reached puberty prior to the beginning

of the breeding season and that these heifers are also going to calve later in the calving season.

Lesmeister (1973) indicated that the proper application of selection for rapid growth and early sexual maturity in yearling beef heifers and an adequate plane of nutrition are essential for programing beef cows for early reproduction and regular calving throughout their productive lives. Other studies by Wiltbank et al. (1966, 1969) showed that heifers fed higher nutritional planes were younger and heavier at puberty. Joubert (1963) pointed to the fact that age at first estrus is not delayed to the same extent as pubertal inflection of growth by poor nutritional conditions. Similar observations were reported by Hanson (1956); Wiltbank et al. (1957); Reid (1960); and Penny et al. (1962). Joubert (1954) indicated that the animals fed a high plane of nutrition calved at significantly earlier ages than those fed a low plane of nutrition. He concluded that the age at first calving did not permanently influence the size of the animal but that the low nutritional plane delayed puberty an average of 221 days. He also stated that the subsequent reproductive performance was retarded by adverse nutrition during the prepuberal stage. Richter (1926) reported delayed heat in heifers which he attributed to a lack of feed; the major influence of a low nutrient supply upon fertility in mature animals appeared to be manifested in irregular heat periods and in a failure to conceive.

Age at first estrus can be controlled to a certain extent by feeding (Critchon et al. 1959; Wiltbank et al. 1965; Amir et al. 1967;

Short and Bellows, 1976; Dentscher 1973). Wiltbank et al. (1969) found an interaction for age and weight at puberty between level of nutrition and breed of heifers in a study of the effects of two levels of nutrition from weaning to puberty on age at puberty in purebred and crossbred heifers (Angus, Hereford and crosses between the two breeds). The levels of nutrition were such that the average daily gains from 6 to 12 months of age were 0.82 and 0.73 kg for crossbred and straightbred heifers on the high level of feed and 0.30 and 0.36 kg for the crossbred and straightbred heifers on the low level of feed, respectively. Average age at puberty was 381 days for both crossbred and straightbred heifers on the high level of feed as compared with 424 days for crossbred heifers and 572 days for the straightbred heifers on the low level. Average weight at puberty was 330 kg for crossbred heifers and 299 kg for straightbred heifers on the high level of feed and 254 kg and 268 kg for crossbred and straightbred heifers on the low level of feed.

Wiltbank et al. (1966) reported that high winter feed levels hastened puberty. Ariji and Wiltbank (1971) reported high levels of energy had a significant effect on weight at puberty; high preweaning growth rate and heavy weaning weights were associated with early puberty and heavy weight at puberty; also, they found that heifers did not reach puberty until they started to make faster weight gains after the slow winter growth.

Joubert (1954) showed that puberty was hastened by feeding beef heifers with supplementary feed during winter. He also, showed that the

first postpartum estrus occurred 414 days after calving for cows that received no supplementary feed as compared to 267 days for cows that received supplementary feed.

Morris (1958) indicated that heifers fed a daily grain supplement exhibited greater ovarian activity did those not receiving grain. Wiltbank et al. (1965) fed three levels of protein, and three levels of energy. The high protein heifers were fed approximately 0.23 pound of digestible protein per hundred pounds of body weight; the medium level group received approximately 0.15 per pound per hundred pounds weight; and at the low level group received 0.06 pound per hundred pounds weight. Within each total feed (energy) level the heifers on high level rations were fed ad libitum, heifers on medium level rations were fed approximately 66 percent of the feed consumed by those on high level rations at the same body weight. Those on low level rations were fed enough to maintain body weight. They concluded that heifers fed low levels of energy did not reach puberty; the same was true with low levels of protein. Heifers on high energy rations become extremely fat and had trouble in calving. The average postpartum interval to estrus in high and medium energy animals was 180 days after calving. Similar conclusions were reached earlier by Eckles (1929), Joubert (1954) and Bond et al. (1962).

Westmacott (1959) reported that more heifers calved at two years of age when reared on a high level of feed during the first two winters of their life than when reared on a moderate level of feed in both winters or during either of the winters.

Prepartum nutrition of heifers influenced the number of days needed for their progeny to reach puberty since both age and weight influence age at puberty. (Wiltbank et al. 1969; Laster et al. 1973; Corah, 1975).

Asdell (1949) recognized that under unfavourable conditions of environment and nutrition the exhibition of first estrus may be delayed to a greater or lesser extent. Hafez (1967) and Gangwar (1965) demonstrated that the length of the estrous cycle in heifers was longer under hot climatic conditions and there was a higher incidence of clinical anestrous among heifers kept in hot climatic conditions.

Bond and McDowell (1972) studied the long term effects of thermal stress ($32^oC$) on reproductive performance in beef heifers. They found that when heifers were exposed to a high temperature ($38^oC$) they became anestrus (inactive ovaries) but after acclimation estrous cycles were reestablished by the 16th week after first exposure to elevated temperatures. Dunlap and Vincent (1971) determined, in Hereford heifers, that when heifers were exposed to $21^oC$ or $32^oC$ for 72 hours immediately after breeding none (0 of 10) of the heifers held at $32^oC$ maintained pregnancy as compared to 50 percent (5 of 10) pregnancy in heifers exposed to $21^oC$.

Under most practical conditions a large proportion of heifers have not reached puberty at the start of their first breeding season as yearlings (Wiltbank et al. 1969; Arije and Wiltbank, 1971). Gonzalez-Padilla et al. (1975) found that blood levels of prolactin in prepuberal

heifers were similar to those during the estrous cycle and that blood levels of luteinizing hormone (LH) do not increase as the heifers approach puberty. Conversely, Swanson et al. (1972) reported that both LH and prolactin were higher in cyclic heifers than in prepuberal heifers. They also, concluded that the two months preceding the onset of puberty are not characterized by any deficiency in circulating levels of pituitary or hypothalamic hormones.

Administration of 5 to 10 mg of progesterone at the beginning of estrus decreased the interval to ovulation (Hansel and Trimberger, 1959). Gonzalez-Padilla et al. (1975b) noted that formation of corpora-lutea and onset of the cyclic activity could be induced by progesterone and estradiol 17B injections in prepuberal heifers. Thirty-four pre-puberal Angus heifers received on day one of the estrous cycle a single intramuscular injection of 5 mg of estradiol valerate and a 6 mg ear implant of norgestomet; 89 percent of the heifers were detected in estrus within 4 days after removal of the implant (9 days after inser-tion) as compared with the control group which showed estrus within in 18 days after the treatment group (Gonzalez-Padilla et al. 1975a).

Postpartum Interval in Cows

Lasley and Bogart (1943) observed that conception rate in beef cows increased as the time between parturition and first service lengthened. Also VanDemark and Salisbury (1950) reported that breeding efficiency in dairy cattle increased with the length of the postpartum interval up 120 days. Shanon et al. (1952) indicated that a minimum

interval of 50 days postpartum was required for a satisfactory conception rate in dairy cows. Morrow (1966) reported that the interval from parturition to first observed estrus in beef cows ranged from 52 days to 80 days. Hammond (1927) reported that follicle development and ovulation takes place 16 to 21 days after parturition. This agrees with the observations by other workers (Casida and Venzke, 1936; Higaki et al. 1959; Foote et al. 1960; Labhsetwar et al. 1963). In dairy cows, according some workers, it is not recommended that breeding begin less than 60 days postpartum because of detrimental effects on the animal's later reproductive performance (Hofstad, 1941; Williams, 1943 and Trimberg, 1954). However others have demonstrated that shortening of the calving interval can be accomplished in many cows by breeding at an earlier time following calving (Olds and Cooper, 1970; Whitmore, 1974).

Wiltbank (1968) observed in beef cows that the proportion of cows showing estrus during the first 21 days of the breeding season varied from 49 to 95 percent, while, the proportion conceiving at first service increased until approximately 90 days after calving. Similar observations were reported by Kalay (1972), Britt (1974) and Harrison et al. (1974). In a study involving 450 cows with a limited breeding season Wiltbank et al. (1956) reported that the calving interval was shorter in cows calving early in the season than in cows calving late in the season. This agrees with data reported by Whitmore et al. (1974); Reynolds (1967); and Bellows (1968). They concluded that cows which became pregnant early in the breeding season one year

had a better opportunity to become pregnant the next year. Burris and Priode (1958) reported that heifers which calved late in their first calving season tended to have fewer calves during their lifetime than cows which calved early in their first calving season. This indicates that a heifer should conceive early the first breeding season to achieve good reproductivity throughout her life. She has a longer time with the bull following breeding at the first estrus and thus may have several opportunities to be bred if she fails to conceive on the first service. Morrow and Brinks (1968) and Roberts, Fever and Wiltbank (1970) indicated that calves born late in the normal calving season are usually lighter when weaned than those born early in the season. This tends to decrease the total lifetime production of their dams.

The incidence of pregnancy is influenced by body conditions of the cow at time of weaning of her calf; weight, however, of the cow at weaning influenced the incidence of pregnancy only if the cows were not in good conditions (Asdell, 1953; Cole, 1953; Baker, 1968; Armstrong, 1968). Shilling and England (1968) reported that weight change during the breeding season exerted a highly significant effect on subsequent calving percent. They observed that cows which more nearly maintained their weight during the winter had higher conception rates during the subsequent breeding season than those which lost weight; cows which were gaining during the breeding season had an increased calving rate. McIlvain (1958) reported that the average calf crop weaned from cows on (1) heavily grazed pasture (12 acres per cow) was 83 percent, (2) from

cows on moderately grazed (17 acres per cow) was 90 percent, and (3) from cows on lightly grazed pasture (22 acres per cow) was 93 percent. He reported that cows on heavily pasture range calved later than those on moderately grazed range.

Warnick (1959) reported that among cows supplemented with protein on grass pasture the time required to conceive was shorter than for cows receiving grass only. He, also,demonstrated that with an inadequate level of protein, estrus was delayed in both heifers and suckled cows. Christian et al. (1956) concluded that the addition of alfalfa hay to a medium energy ration shortened the interval between calving and first ovulation. Foster et al. (1945) reported that the calf crop of cows grazing on pasture varied according to the level of protein supplement received. Cows that received two pounds of protein supplement per day had an average calf crop of 48 percent as compared to 63 percent for those that had received four pounds of protein supplement per day and 68 percent for those that had received six pounds of protein supplement.

McClure (1968) suggested that poor nutrition may cause hypoglycemia and that hypoglycemia affects hypothalamic functions. Hill et al. (1970) found that undernourishment increased the variation in length of estrus cycles and reduced the proportion of heifers or mature cows with normal fertilized ova. They considered undernourishment as 85 percent of the maintenance requirements for both energy and protein. Others studies associated undernourishment with infertility in beef cows.

Pregnancy rates at first service in underfed cows was lower than in normal cows (Warnick et al. 1960; Wiltbank et al. 1962, 1964; Lamond, 1969).

Bellows (1968) and Loyacano et al. (1974) concluded that when adequate nutrition is provided by grass or hay and protein supplement, energy supplementation did not significantly increase reproductive performance. Whitmore et al. (1974) demonstrated in dairy cows that among those on a high level of nutrition as compared to average nutrition the interval to first postpartum estrus was longer and cows on high nutrition had more retained placentas than those on average nutrition. Earlier, Marshall and Peel (1910) found fat deposits in the ovaries and few follicles in a limited number of cows which were both fat and sterile. They did not, however present research data that demonstrated excessive fat caused sterility.

The importance of good nutrition before and after calving in order to decrease the postpartum interval to estrus and ovulation and improve the fertility of cattle during this period has been recorded by Wiltbank et al. (1961); Dunn et al. (1964) and Zimmerman (1961). Dunn et al. (1969) and Wiltbank et al. (1962) found that a low level of energy before or after calving lengthens the interval from calving to first estrus. In one experiment, Hereford and Angus heifers bred to calve at two years of age were fed 4.3 pound of TDN (low energy) or 8 pound of TDN (high energy) for 120 days before calving. After calving both groups received 13 pound of TDN. The proportions of cows

which had shown estrus by 40 days after calving were 7 and 22 percent, 49 and 81 percent at 60 days, 73 and 92 percent at 80 days, and 88 and 97 percent at 100 days for heifers fed the low and high levels of TDN respectively (Dunn et al. 1969). Similar data from older cows were reported by Wiltbank et al. (1962). Dunn (1969), Hight (1966), and Corah (1975) report that restricting feeding of both heifers and cows during the last 100 days of gestation caused a reduction in calf birth weight. Even though prepartum maternal nutrition lowered the birth weight, there was no effect on the percentage of assisted birth in either heifers or cows. Zimmerman et al. (1961) reported that the interval between calving and first estrus was lengthened if the intake of energy was low for 140 days before calving.

Donaldson (1968) reported that cows calving first at two years of age produced more calves than cows calving at three years or older ages despite the severe nutritional and lactational strain placed on the cows calving first at the younger ages. Witt et al. (1958) considered that low protein in the ration reduced the percentages of animals ovulating and this effect was more prevalent in younger cows than in older cows. Wallace (1948) found that the thinner the condition of the dam prior to calving the lighter and generally weaker was the calf. Bellows et al. (1972) pointed out that restricted feed intake prior to calving may also influence the performance of calves by lowering the milk production of the dam.

Wiltbank et al. (1964) fed TDN levels 25 percent below or 50 percent above recommended levels (NRC) to beef cows and found that low

levels of TDN (25 percent of NRC) after calving reduced the subsequent calving percent. Bellows (1967) also, found that low levels of dietary energy delayed the onset of the first postpartum estrus and reduced the pregnancy rate.

Casida (1950) reported that Holstein cows with four or more parturitions tended to have longer intervals from parturition to estrus and ovulation than younger cows. Wiltbank (1965) observed that the occurrence of estrus in cows following second calving did not appear to be affected markedly by previous rations.

Warnick (1955) observed no differences among cows bred at the first or second estrous periods. The percentages of cows calving when bred at first estrus was 72 percent and 78.3 percent at the second estrus. These data would seem to indicate that there is a greater variation in fertility at the various intervals following calving than the particular estrous period at which they were bred. He suggested that the short postpartum estrual intervals were accompanied by an anovulatory estrus, which would be infertile. This agrees with the report by Burns et al. (1954).

Clapp, (1937) showed that the interval from calving to first estrus was longer in suckled cows than milked cows (Holstein cows milked two times daily, 46 days; milked four times daily, 69 days; and suckled cows, 72 days). In other studies the interval from calving to first estrus in suckled and non suckled cows varied from 15 to 52 days (Wiltbank and Cook, 1958; Graves et al. 1968; Reisen et al. 1868). In

suckled cows, the first estrus was reported to have occurred more than 30 days (Wagner and Hansel, 1969; Saiduddin et al. 1968) and 84 days (Wiltbank and Cook, 1958; Foote et al. 1960) after calving. However, Hammond (1927) noted that in cows nursing calves the first postpartum estrus did not occur until three to four months after parturition.

Wiltbank et al. (1961) observed that dry cows had a lower conception rate than lactating cows in all breeds except those of the Brahman breeds. Lasley and Bogart (1943) found that non lactating Hereford cows had a lower conception than lactating cows. England et al. (1963) reported that a cow of British breeding should be culled if she fails to calve one year. They indicated that the probability that she will produce a calf the following year is relatively small; conversely, Brahman cows that are dry in one year are more likely to conceive during the next breeding season than are lactating Brahman cows. The postpartum estrual interval in British breeds of cattle has been shown to range between 46 and 80 days (Clapp, 1937; Lasley and Bogart, 1943; Warnick, 1955; Lindley et al. 1962). However Donaldson (1962) recorded the absence of estrus in crossbred Zebu cows which were suckling calves under four months of age. Similar observations have been reported by other workers (Clamohoy, 1952; Nazareno, 1954; Joubert, 1954; Anderson, 1961; Wiltbank et al. 1961 and Baker, 1968).

Baker (1968) observed that reestablishment estrous cycles postpartum is preceded by variable follicular activity. In all lactation periods studied follicular activity commenced in 20-37 percent of

the cows at 22 to 60 days before the first postpartum estrus. These findings agree with those of Hammond and Sanders (1923), Casida and Wisnicky (1950), Anderson (1951), Kidder et al. (1952), Burns et al. (1954), Mylrea (1962) and Graves et al. (1968). Graves et al. (1968) recorded the incidence of quiet ovulations postpartum as 42.4 percent for nonsuckled cows and 70.6 percent for suckled cows. Casida and Wisnicky (1950) indicated that 68 percent of the cows showed at least one silent ovulation prior to the first standing estrus. Similar results were obtained by Kidder et al. (1952) and Trimberger and Fincher (1956). Menge et al. (1962) and Labhsetwar et al. (1963) suggested that silent estrus was more prevalent during the early postpartum period than at the time of service later in this postpartum period.

Baker (1969) found, in beef cows, if body weight of lactating cows was low at the commencement of lactation and remained low during the lactation period, there was a positive relationship between the length of the suckling period and the interval to first estrus. That is, if they failed to gain body weight during lactation the onset of estrous cycles was delayed.

Wagner and Oxenreider (1971) found that in dry cows low energy intake had an effect similar to suckling in cows fed at recommended levels of protein and minerals. Those on low energy (66 percent NRC) had 10 mm follicles at 16 days postpartum as compared to 12 days for the medium energy level (100 percent NRC) and 10 days for the high energy group (133 percent NRC). Low energy intake did not prolong the interval to first ovulation although it did reduce the percentage of cows ovulating prior to 56 days postpartum.

Buch et al. (1955) found a significant positive correlation between the postpartum interval to estrus and uterine involution. They suggested a possible influence of ovarian hormones on the rate of uterine involution. By contrast Perkins et al. (1963) postulated that the involutionary status of the uterus in beef cows is of lesser importance than the length of the postpartum interval prior to breeding in achieving a satisfactory conception rate. Contrary to above reports, Foote et al. (1960) did not find a correlation between postpartum interval and conception rate in beef cows.

Menge et al. (1958) and Casida and Venzke (1936) observed that uterine involution was delayed in cows which were heavier at parturition ($r = 0.17$ between calving weight and interval to uterine involution). Buch et al. (1955) reported that the uteri of primipara cows was involuted at 42 days and in pluripara cows at 50 days following a normal parturition. These results agree with those of Foote et al. (1960) who observed a shorter interval to uterine involution following the first than the second parturition. Similar differences were observed by Rasbeck (1950). However Tenant et al. (1967) did not find such a difference. Tenant et al. (1967), Morrow et al. (1966) and Buch et al. (1955) reported that the rate of involution of the gravid uterine horn was most rapid during the initial three to four weeks following parturition but a further gradual reduction in uterine horn diameter continued to occur. Casida and Venzke (1936) and Rasbeck (1950), however, did not find the initial rapid response but a continual rate of involution.

Foote and Hunter (1964) shortened the time to uterine involution and to first ovulation by injecting beef cows with progesterone and estradiol.

Environmental Factors

Studies in several species have demonstrated that presence of males with females may initiate estrus in noncyclic females. Heape (1901) suggested that the presence of males stimulate females to exhibit estrus. Beach (1948) attributed the stimulatory action of "teasing or heckling" by male mink as a factor contributing to early breeding of females. Introduction of rams to anestrous ewes shortly prior to the beginning of the breeding season resulted in initiation of estrus in a high proportion of the ewes (Riches and Watson, 1954; Schinckel, 1954).

Watson and Radford (1960) concluded that either smell or sounds of the ram was a sufficient stimulus to cause earlier onset of estrus in ewes. Lamond (1969) showed that the time of introduction of the ram relative to the beginning of the breeding season influenced the incidence of estrus and synchronization of estrus in ewes. Byrum (1957) reported that the boar can stimulate earlier onset of estrus in prepuberal gilts. Baker (1969) mentioned that stimulation of estrus by the association with the opposite sex adequately demonstrated in sheep, goats, and pigs may well operate for cattle; however, experimental data have not been presented.

Several studies indicated that the season of the year had an effect on the interval from parturition to first estrus. (Chapman and Casida, 1937; Buch et al. 1955; Carman 1955); they indicated that cows

calving during the spring season required the longest interval and cows producing calves during the fall had the shortest interval from parturition to first estrus. The decreases in calving percent for spring bred cows according Loyacano et al. (1974) is due more to increased temperature during the breeding season than difference in the nutritive intake of the cows. However, Bellows et al. (1968) found no significant effects on reproductive performance when beef cows were fed grain prior to or during spring breeding season. In contrast, others indicated that this interval was not correlated with season. (Herman and Edmondson, 1950; Warnick, 1955; Wiltbank and Cook, 1958). Workers have presented data which shows the relationship of pregnancy rate to lactation status. Under tropical conditions lactating cows were less fertile and in poorer body conditions than nonlactating cows (Warnick et al. 1960; Donaldson, 1962; Rose et al. 1963; Lamond and Takken, 1966; Donaldson et al. 1967; and Baker, 1968). Baker and Quesenberry (1944) reported calf crops of 77 percent and 68 percent in years following rainfall. When efficient management practices have been followed the calving percentages have been increased, Asdell (1953); Cole (1953); and Rose et al. (1963).

Parlow (1964) and Graves et al. (1968) reported that in rats lactation simulated by nursing profoundly influenced gonadotropin secretion. Pituitary content of FSH and LH was lowered. They also found higher pituitary prolactin levels in nonsuckling pospartum cows as compared to cows suckling calves. Oxenreider (1968) indicated that

gonadotropic activity is low during the postpartum anestrus period in suckled beef cows. Grosvenor and Turner (1957) reported that lactation clearly demands an increased prolactin release which exerts an inhibitory effect on FSH and LH secretion in rats.

Numerous experiments have been performed in efforts to alter postpartum physiology with exogenous hormones. Foote, Hauser and Casida (1960) showed a delay in postpartum ovulation and estrus in the beef cows administered 2.2 mg of progesterone per kg of body weight at 14 days postpartum. Casida and Wisnicky (1950) did not find changes in the postpartum interval after treatment with 20 mg diethylstilbestrol. Saiduddin et al. (1968) obtained shorter postpartum intervals to ovulation and estrus in response to progesterone and estrogen treatments. Although one injection of 10 mg estradiol-17B was as effective alone as when preceded by 10 to 15 daily injections of 50 mg progesterone in hastening ovarian activity, conception occurred earliest in cows given both hormones. This effect could be obtained when progesterone treatment was initiated at either 5 or 18 days postpartum.

The ovaries of lactating cows have been reported to be responsive to exogenous gonadotropic hormone treatment (Casida et al. 1950; Foote et al. 1966; Oxenreider, 1968). However, variability in response at different stages of lactation has been characteristic of treatment with exogenous gonadotropins.

The data reviewed here cover two major problems affecting reproductive efficiency in beef cattle. They are age at puberty of heifers

and the postpartum interval to first estrus in older cows. First calf heifers are likely to have a longer interval than older cows. Many older cows, however, may not have resumed estrous cycles by the beginning of the breeding season. Nutrition of the prepuberal heifer and postpartum cow is potentially a major cause of delayed reproductive capability. However, delayed puberty or prolonged postpartum intervals in older cows occurs in well fed herds.

The following studies were conducted to determine the reproductive status of the cows at the beginning of the breeding season in The University of Tennessee Agricultural Experiment Station herds.

## III. EXPERIMENTAL ANIMALS AND PROCEDURES

### Alcoa Herd, 1977

Seventy-eight postpartum beef cows (64 Angus and 14 Herefords) were assigned to a study conducted to determine if exposure to a sterile bull prior to beginning of the breeding season would influence the frequency of corpora lutea immediately prior to the beginning of the breeding season. From November 21, 1976, until one week postpartum (in January-March, 1977) the cows were fed corn silage, grass silage or hay, ad libitum. From one week postpartum and through the experimental period they were fed corn silage, ad libitum, on pasture. However, due to the extremely severe winter weather during January and February little grass was available until early March.

The cows were assigned to two comparable groups on the basis of date of birth of calf, age and breed. However, due to the small number of Hereford cows, breed was not considered in the analyses of the data. Only those cows which were nursing a calf throughout the experimental period were included in this study. Since there were no significant differences in body weight associated with the preparturition feeding regimes, this factor was not considered in allocation of cows to treatments groups in this study. The numbers and ages of cows were 31 - 2 years, 32 - 3 years and 15 - 4 years old. On February 7, 1977, the two groups were moved to comparable pastures, separated by a 25-foot wide road, and an epididymectomized bull was turned with one group.

The mean interval from turning the bull with one half of the cows to ovaria palpation was 45 days. On March 24 the ovaries of all cows were palpated via the rectum to determine the presence or absence of a corpus luteum. In some cows, in which a corpus luteum could not be definitely identified, a difference in size of the two ovaries was considered as evidence that a corpus luteum was present. Failure to detect a significant structure(s) on the ovaries and both of similar size was considered evidence that ovulation had not occurred or was not imminent.

Ames Plantation Herd, 1977

To determine the reproductive status of the females immediately prior to the beginning of the breeding season the ovaries of 106 (98 lactating and 8 dry) Angus cows were palpated on March 17, 1977, to determine the presence or absence of a corpus luteum in the ovaries. The interval from parturition to palpation ranged from 33 to 79 days. The ages of the cows in this study ranged from 2 to 13 years. The animals were maintained on pasture throughout the year. Pasture was supplemented with corn silage during the winter months when needed.

Tobacco Experiment Station Herd, 1976-1977

The beef cattle herd (Herefords) at the Tobacco Experiment Station, Greeneville, Tennessee are a part of a long-term genetic selection study. During the approximately 90 days breeding season (April-June each year) the females are divided into 8 sires groups with 15 females

per bull. Cows and bulls are separated about July 1 each year and the females managed as a single herd until the beginning of the next breeding season. During the winter months, when adequate pasture is not available, they are fed corn silage. About 20 percent of the cows are replaced each year with yearling heifers. Thus, the age of the females in the herd range from yearling heifers to 7-year-old cows.

To determine the reproductive status of the females immediately prior to the beginning of the breeding season, 1976, the ovaries were palpated via the rectum to determine the presence or lack of a corpus luteum in the ovary. Subsequently, the date of conception in the 1976 breeding season was estimated by subtracting 282 days from the date of birth of the calves the following year. The numbers of conceptions by 21 day periods were then tabulated. On April 1, 1976, the ovaries of 111 females (91 cows and 20 heifers) were palpated. The bulls were turned with the females in April 1976.

In the 1977 season the ovaries of 61 females (48 cows and 13 yearling heifers) were palpated on March 30.

Statistical tests using chi-square were applied to the data to test for significance of differences.

## RESULTS AND DISCUSSION

### Alcoa Herd

The results from ovarion palpation of the cows in this herd are summarized in Table I. The ovaries of 40 (51 percent) of the 78 cows

TABLE I

EFFECT OF PRESENCE OF A BULL ON THE FREQUENCY OF CORPORA IN POSTPARTUM COWS, ALCOA HERD, 1977

| Treatment[a] | Total Number of cows | Age of Cows (Years) 2 | 3 | 4 |
|---|---|---|---|---|
| Bull | 39 (23)[b] | 13 (5) | 17 (12) | 9 (6) |
| No-Bull | 39 (17) | 18 (4) | 15 (8) | 6 (5) |
| Total | 78 (40) | 31 (9) | 32 (20) | 15 (11) |
| Percent | 51 | 29 | 62 | 73 |

[a]An epidiymectomized bull was with the first group of cows for 45 days prior to ovarian palpation; cows in the no-bull group did not have contact with a bull during the experimental period.

[b]The first number indicates number of cows per subgroup and the number in parenthesis is the number having a corpus luteum.

contained a corpus luteum when palpated on March 24. The frequency of corpora lutea was 59 percent (23 of 39 cows) and 44 percent (17 of 39 cows) in the bull and no-bull groups, respectively. This difference was not significant ($X^2 = 1.84$; $P = 0.19$). The frequency of corpora lutea in the 2-, 3-, and 4-year old females was 29, 62, and 73 percent, respectively. The difference between the 2- and 3-year old cows was statistically significant ($X^2 = 5.82$; $P < 0.025$). When the 2-year old females are compared with 3- and 4-year old females the difference is even greater ($X^2 = 12.2$; $P < 0.005$).

The relationship of interval from parturition to palpation on the frequency of corpora lutea are summarized in Table II. There was no effect of the bull on numbers of cows with corpora lutea at the various postpartum intervals. The very low frequency of cows having a corpus luteum at less than 40 days postpartum agree with the findings of other investigators (Clapp, 1937; Lasley and Bogart, 1943; Warnick, 1955; Wiltbank and Cook, 1958; Lindley et al. 1962.

Although the results of this preliminary study failed to demonstrate that the presence of a bull with early postpartum cows stimulated an earlier onset of the estrous cycle this phenomenon should receive further study. The extremely severe winter weather during the calving season and until shortly before palpation may have retarded resumption of cyclic ovarian in all cows in this study.

TABLE II

EFFECT OF POST-PARTUM INTERVAL ON THE FREQUENCY OF CORPORA LUTEA IN POST-PARTUM COWS, ALCOA HERD, 1977

| Interval from Parturition to Palpation (Days) | Total | Age of Cows (Years) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2 | | 3 | | 4 | |
| | | Bull | No Bull | Bull | No Bull | Bull | No Bull |
| <40 | 12 (3) | 3 (1)[a] | 3 (1) | 1 (0) | 3 (0) | 1 (0) | 1 (1) |
| 41 - 60 | 41 (19) | 7 (2) | 9 (2) | 11 (8) | 10 (5) | 3 (2) | 1 (0) |
| 61 - + | 25 (18) | 3 (2) | 6 (2) | 5 (4) | 2 (2) | 5 (4) | 4 (4) |
| | 78 (40) | 13 (5) | 18 (5) | 17 (12) | 15 (7) | 9 (6) | 6 (5) |

[a]The first number indicates number of cows per subgroup and number in parenthesis is the number having a corpus luteum.

Ames Plantation Herd

The results of palpation of the ovaries of 98 lactating cows are summarized in Table III. Only 41 of the 98 cows (43 percent) had corpora lutea. There is a difference in frequency of corpora lutea among age groups. Examination of the age group contributions to the total chi-square indicated that the 6-year old and older cows were significantly different from all younger aged cows ($X^2$ = 7.68, P = .003). It may be that the older cows are less susceptible to the stresses of lactation than are the younger cows. It is generally considered that by 6 years of age cows have reached their mature body weight and thus no longer have as high nutrient requirements for growth as do younger females. The frequency of corpora lutea by age of cows and postpartum interval are summarized in Table IV. The number of animals with corpus luteum increased with time after paturition.

Tobacco Experiment Station Herd

A total of 127 females (106 cows and 21 heifers) were palpated on 4-1-76, one day before turning the bulls with females. The results are summarized in Table V. A corpus luteum was present in the ovaries of 54 percent of these females. Examination of the data in Table V shows that fewer of the yearling and 2-year old heifers had had ovulated than had the older cows ($X^2$ = 5.17; $P < 0.025$) immediately prior to the beginning of the breeding season.

TABLE III

AGE AND FREQUENCY OF CORPORA LUTEA IN THE OVARIES OF POSTPARTUM COWS, AMES PLANTATION HERD, 1977

| Age of Cows (Years) | Total Number of Cows[a] | Number of Cows: With Corpora Lutea | Number of Cows: Without Corpora Lutea | Percent With Corpora Lutea |
|---|---|---|---|---|
| 2 | 17 | 5 | 12 | 29 |
| 3 | 16 | 4 | 12 | 25 |
| 4 | 10 | 4 | 6 | 40 |
| 5 | 9 | 2 | 7 | 22 |
| 6+ | 46 | 26 | 20 | 56 |
| Total | 98 | 41 | 57 | 42 |

[a]Eight nonlactating cows, of which 5 had a corpus luteum, are not included in the table.

TABLE IV

RELATIONSHIP OF POSTPARTUM INTERVAL AND FREQUENCY OF CORPORA LUTEA IN COWS, AMES PLANTATION HERD, 1977

| Age of Cows | Total | Postpartum <40 | Interval (Days) 41-60 | 61+ |
|---|---|---|---|---|
| 2 | 17 (5) | -- | 7 (1)[a] | 10 (4) |
| 3 | 16 (4) | 1 (0) | 4 (0) | 11 (4) |
| 4 | 10 (4) | 3 (0) | 5 (2) | 2 (2) |
| 5 | 9 (2) | 4 (0) | 5 (2) | -- |
| 6+ | 46 (26) | 7 (1) | 21 (11) | 18 (14) |
| Total | 98 (41) | 15 (1) | 42 (16) | 41 (24) |

[a]The first number indicates number of cows per subgroup and number in parenthesis is the number with a corpus luteum.

TABLE V

AGE OF FEMALES AND FREQUENCY OF CORPORA LUTEA, TOBACCO EXPERIMENT STATION HERD, 1976

| Age of Females (Years) | Total Number of Cows | Number of Cows | |
|---|---|---|---|
| | | With Corpora Lutea | Without Corpora Lutea |
| 1 | 21 | 8 | 13 |
| 2 | 20 | 8 (3)[a] | 12 |
| 3 | 16 | 9 (3) | 7 |
| 4 | 23 | 13 (2) | 10 |
| 5 | 19 | 12 (2) | 7 |
| 6 | 20 | 12 (1) | 8 |
| 7 | 8 | 6 | 2 |
| Total | 127 | 68 | 59 |
| Percent | | 54 | 46 |

[a]Number in parenthesis indicated number of cows having a corpus luteum but were not nursing a calf. If these animals are removed then the frequency of corpora lutea is 45 percent.

The relationship between the presence of a corpus luteum at the beginning of the breeding season and the interval to conception is summarized in Table VI. A significantly higher percentage (64 vs 49) of the animals having a corpus luteum conceived during the first 21 days as compared with the second 21 days of the breeding season ($X^2 = 5.02$; $P = .025$). If the conception rates during the first and second 21 day periods are combined, 62 percent of the cows having a corpus luteum conceived during this period as compared to 38 percent of those animals not having a corpus luteum at the beginning of the breeding season. During this 42 day period 81 percent of the cows conceived. These results emphasize the importance of having cows cycling at the beginning of the breeding season in order to increase the rate of early conceptions.

The data are summarized in Table VII to show the conception rate within age groups by successive 21 day periods of breeding season. Comparison of conception rates of 1- and 2-year old females with older aged cows shows that only 38 percent of the younger cows as compared with 58 percent of the older cows had a corpus luteum at the beginning of the breeding season. This difference was statistically significant ($X^2 = 3.99$; $P < .05$). However, the conception rate was 72 percent and 87 percent, respectively, during the first 42 days of the breeding season. Although this difference is not significant ($X^2 = 2.11$; $P < .1$) it does suggest the possibility of a higher conception rage among the older cows during the first 42 days of the breeding season.

TABLE VI

RELATIONSHIP OF PRESENCE OF A CORPUS LUTEUM AT THE BEGINNING OF THE BREEDING SEASON AND SUBSEQUENT CONCEPTION RATE BY 21 DAY INTERVALS DURING THE 1976 BREEDING SEASON, TOBACCO EXPERIMENT STATION HERD, 1976

| Interval from Beginning of the Breeding Season to Conception (Days)[a] | Total | Number of Cows With Corpus Luteum | Number of Cows Without Corpus Luteum | Percent Conceiving |
|---|---|---|---|---|
| 1-20 | 42 | 27 | 15 | 38 |
| 21-40 | 49 | 24 | 25 | 44 |
| 41-60 | 11 | 4 | 7 | 10 |
| 61+ | 9 | 2 | 7 | 8 |
| Total | 111 | 57 | 54 | |

[a]The date of conception in 1976 was estimated by substracting 282 days from date of birth of the calf in 1977.

TABLE VII

RELATIONSHIP BETWEEN AGE OF FEMALES, PRESENCE OF A CORPUS LUTEUM, AND TIME OF CONCEPTION DURING 1976 BREEDING SEASON, TOBACCO EXPERIMENT STATION HERD, 1976

| Age of Females (Years) | Total | Conception by 21 Day Intervals | | | |
|---|---|---|---|---|---|
| | | 1st | 2nd | 3rd | 4th |
| 1 | 20 (8)[a] | 5 (3)[a] | 9 (3) | 4 (2) | 2 (0) |
| 2 | 19 (7) | 7 (4) | 7 (2) | 3 (1) | 2 (0) |
| 3 | 15 (8) | 6 (3) | 8 (4) | -- | 1 (1) |
| 4 | 19 (12) | 9 (7) | 6 (4) | 1 (0) | 3 (1) |
| 5 | 19 (11) | 8 (5) | 9 (6) | 2 (0) | -- |
| 6 | 19 (11) | 7 (5) | 10 (5) | 1 (0) | 1 (1) |
| Total | 111 (57) | 42 (27) | 49 (24) | 11 (3) | 9 (3) |

[a]The first number is the number of cows per subgroup and the number in parenthesis is the number having a corpus luteum at the beginning of the breeding season.

1977 Breeding Season

The ovaries of 61 females in the TES herd were palpated on 3-30-77. The results showing age of animals and frequency of corpora lutea are summarized in Table VIII. Only 33 percent of the females had a corpus luteum. The frequency of corpora lutea relative to the length of the postpartum interval are shown in Table IX. Only 36 percent (16 of 45) cows were cycling in this herd at this time.

Although the three herds included in this study are widely separated geographically within the state and management of each herd differs, the physiological readiness of the females to resume reproductive activity at the beginning of the breeding season is quite similar. Of the total of 364 females palpated 169 (46 percent) had a corpus luteum. The estimated conception rate during the first 21 days of the breeding season in the Tobacco Experiment herd was 38 percent (42 of 111 females). However, 27 of the 42 females conceiving during the first 21 day period had a corpus luteum prior to initiation of breeding. Using this as the basis and applying it to all females (364 head) in this study 138 cows would be expected to conceive during the first 21 days of the breeding season. However, 64 percent of the cows which conceived during the first 21 day period had a corpus luteum prior to beginning of the breeding season (Table VII). Thus if one applies the same reasoning to all three herds then one would expect 233 (64 percent of 364) rather than 138 (38 percent of 364) conceptions during this period.

TABLE VIII

AGE OF FEMALES AND FREQUENCY OF CORPORA LUTEA IN HEIFERS AND POSTPARTUM COWS AT THE BEGINNING OF THE 1977 BREEDING SEASON, TOBACCO EXPERIMENT STATION HERD, 1977

| Age of Females (Years) | Total | Number of Females With Corpora Lutea | Number of Females Without Corpora Lutea |
|---|---|---|---|
| 1 | 13 | 3 | 10 |
| 2 | 7 | 2 | 5 |
| 3 | 10 | 4 | 6 |
| 4 | 11 | 3 | 8 |
| 5 | 11 | 6 | 5 |
| 6 | 9 | 2 | 7 |
| Total | 61 | 20 | 41 |
| Percent | | 33 | 67 |

TABLE IX

RELATIONSHIP BETWEEN POSTPARTUM INTERVAL AND FREQUENCY OF CORPORA LUTEA, TOBACCO EXPERIMENT STATION HERD, 1977

| Interval from Parturition to Palpation (Days) | Total | Number of Cows[a] With Corpus Luteum | Number of Cows[a] Without Corpus Luteum |
|---|---|---|---|
| <40 | 5 (20)[b] | 1 | 4 |
| 41- 60 | 23 (35) | 8 | 15 |
| 61 - + | 17 (41) | 7 | 10 |
| Total | 45 | 16 | 29 |
| Percent | | 36 | 64 |

[a]Three open cows, of which one had a corpus luteum, and 13 yearling heifers, of which only three had a corpus luteum, are not included in the table.

[b]First number indicated number of females per subgroup and number in parenthesis is the percent of animals with a corpus luteum.

While the above extrapolations are crude, they do emphasize the importance of the physiological status of the cow at the beginning of the breeding season on her ability to become pregnant early in the breeding season.

## IV. SUMMARY AND CONCLUSIONS

The ovaries of a total of 364 cows in three University of Tennessee Agricultural Experiment Station herds were palpated within one week prior to the beginning of the breeding season, to determine if the females had resumed postpartum ovarian activity. The numbers and ages of animals within the three herds were: (1) Alcoa herd-78 head, 2- to 4-years, (2) Ames Plantation herd-106 head, 2- to 13-years, and (3) Tobacco Experiment Station herd-172 head, 1- to 7 years of age. Overall the ovaries of only 46 percent of the females contained a corpus luteum.

In the Alcoa herd, presence of a sterile bull with the cows for 45 days prior to the beginning season did not influence the numbers of cows with corpora lutea.

Estimated conception rates in the Tobacco Experiment Station herd, by 21 day periods of the breeding season, indicated that 38 percent of the females conceived during the first 21 day interval of the breeding season. However, 64 percent of the cows which became pregnant during this period had a corpus luteum at the beginning of the breeding season. Extrapolation of these results to all three herds suggests that had all cows been cycling at the beginning of the breeding season, about 67 percent more calves would have been born during the first three weeks of the calving season. This emphasizes the importance of the reproductive status of the cow at the beginning of the breeding season on her subsequent reproductive performance.

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