AN ANALYSIS OF FACTORS AFFECTING CALVING INTERVALS OF DAIRY COWS

by 5791

ROBERT WAYNE BOZWORTH

B. S., Kansas State University, 1957

A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Dairy and Poultry Science

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

Approved by:

George M. Ward
Major Professor

THIS BOOK CONTAINS NUMEROUS PAGES WITH THE ORIGINAL PRINTING BEING SKEWED DIFFERENTLY FROM THE TOP OF THE PAGE TO THE BOTTOM.

THIS IS AS RECEIVED FROM THE CUSTOMER.

TABLE OF CONTENTS

CHAPTER I. REVIEW OF LITERATURE

Relationship of Calving Interval to Milk Production

Calving intervals have been studied for many years to determine their effect on annual milk production and breeding efficiency. Matson (25) studied the lactations of over 500 Indian cows. He concluded that a calving interval of less than 365 days was desirable for low producers (1591 kg/year), while an interval of approximately 420 days was desirable for high producers (over 2727 kg/year). In this early study, a short calving interval was commonly associated with a short dry period, resulting in less milk production the next lactation.

Gaines (9) suggested that average yearly milk production is influenced by the frequency of calving, the maximum milk flow and the persistency of lactation.

Gaines and Palfrey (10), in a study of 186 Red Dane cows each having 9 lactations, found negative correlation, 0.13, between the length of calving interval and the average daily milk yield. There was positive correlation, 0.14, between the length of calving interval and the milk yield the following lactation. Thus a small gain in the current lactation from a short calving interval was lost in the following lactation.

Shorter calving intervals were associated with higher yearly milk production and greater return over feed cost in a study by Speicher and Meadows (35) involving 4285 Holstein cows.

Calving intervals of less than 12 months, 12 to 13, 13 to 14, and more than 14 months yielded 6351, 6315, 6096, and 5840 kg of milk per cow-year, respectively, with a corresponding return over feed cost of 384, 383, 365, and 350 dollars per cow. The longer calving intervals resulted in more milk per lactation but 1.1 less lactations per cow over a 5-year period.

Miller et al. (28) found a direct relationship between milk production in the first lactation and length of calving interval. This was probably due to longer open periods and the more intense culling of low producers that did not breed back promptly. They concluded that the difference was due mainly to environment since the heritability of calving interval in their study was between 0.02 and 0.04. This is in agreement with Legates (19) who concluded that there was no indication that calving interval length is inherited. In a Pennsylvania study of 58,000 Holstein DHI records, Norman et al. (30) found that calving interval accounted for 5.4 to 14.7% and 4.1 to 13.5% of variance in milk production for the first and fifth lactations, respectively. Length of previous calving interval accounted for an additional 1.7 to 2.1% of the variance in 305-day mature equivalent production. The average calving interval was 385 $\pm$ 65 days. Increasing the calving interval from 340 to 440 days resulted in increases of 365, 572, 587, 712, and 866 kg of milk for the first through fifth lactations respectively.

Rennie (33) reported that intra-herd and yearly regressions of milk and fat production on the length of the current calving interval were 33.4 and 1.08 kg per 10-day increase in calving interval. They were 27.7 and 1.05 kg per 10-day increase in the preceding calving interval. It appeared that a curve-linear association existed for those calving intervals shorter than 400 days.

Morrow et al. (29) found significant correlation, 0.25, between milk production and calving interval. Louca and Legates (23) suggested a 13-month calving interval for first calf heifers and a 12-month calving interval for older cows based on results of their study of the relationship between milk production and time between parturition and conception.

Relationship of Milk Production to Breeding Efficiency

If the goal of a 12- to 13-month calving interval is to be attained, the cow must conceive approximately 80 to 100 days following parturition. For many years investigators have proposed that difficulties in breeding after parturition are due in part to stress of high level milk production.

Hollon et al. (14) reported that milk production during the first 120 days had significant effect on time open and calving interval. Carmen (3) also reported that time open increased as the milk production increased.

Boyd et al. (2) found little indication that high production is incompatible with fertility as indicated by insignificant correlation between milk production and services per conception. Gaines (9) stated that there was no evidence that high milk production interfered with conception in studies of the Guernsey Herd Registry. However, the mean service interval was 174 days and he concluded that this interval was far too long for economical lifetime production.

Everett et al. (7) indicated from their study of 21,000 records that there is no relationship between the 120-day milk and fat production and breeding efficiency. Breeding efficiency increased slightly, but not significantly, as the production increased and as the cows got older.

Early estrus detection is important in getting cows rebred early to maintain 12-month calving intervals. Morrow et al. (29) reported a mean of 15 days from parturition to first ovulation in normal cows and 34 days in abnormal cows. They suggested that estrus detection may become more difficult as milk production increases since they reported that cows producing over 7273 kg of milk per lactation had 83% silent estrus while those producing less than 7273 kg had 49% on the first three ovulations following parturition as determined by rectal palpation. Menge et al. (27) reported 62% silent estrus on the first ovulation with a postpartum interval of 18.9 days to first corpus luteum and 32.4 days to first estrus. Marion and Gier (24) reported 13 to 15 days between parturition and first ovulation and 28.4 to 36.9 days between parturition and first standing estrus depending upon production. Olds and Seath (31) reported 32 $\pm$ 18 days from parturition to first observed estrus with milk production accounting for only 0.9% of the variance. Herman et al. (12) and Menge et al. (27) reported no significant correlation between milk production and interval to first estrus. Trimberger et al. (37) observed 69% of their cows in estrus by 60 days and 93% by 90 days postpartum.

Relationship of Heat Detection to Breeding Efficiency

Hall et al. (11) reported that, using 0600 and 1800 hour checks as the basis, they increased estrus detection by 10% when checking at 1200 and by an additional 20% when checking also at 2400. Such improvement in estrus detection would justify checking more than twice daily, especially during the heavy breeding season.

Johnson (16) reported that by proper training and more careful observation the herdsman can increase estrus detection. In a 5-year study in which the cows were checked 5 times daily for estrus using an index of 1, no visible estrus but estrus determined by rectal palpation, to 4, animal stood to be mounted, estrus scoring less than 4 was reduced from 26% in 1961 to 5% in 1965. This also indicates that estrus is very short in some cows and easily missed. Hall et al. (11) reported that average estrus lasted 11.9 hours in Louisana, which is 5 hours shorter than for estrus reported in cooler regions including Wisconsin and England.

The period between parturition and conception was lengthened 17.9 days per cow due to missed estrus, according to Johnson and Ulberg (15), in a study of 7 herds. The range, 9 to 38 days per cow, clearly indicates the value of careful observation for estrus to shorten calving intervals. Zemjanis et al. (41) found that only 10% of all anestrus was due to disorders of the reproductive tract. The remainder was a result of failure to observe estrus due to inadequate observation or variations in the intensity of estrual symptoms.

Relationship of Nutrition to Reproduction

Boyd (1) concluded in his review that there appears to be no evidence that any single nutrient is required specifically for reproduction. In general, if the nutritive requirements for milk production and general health of the cow are met, then the cow's nutritive requirements for reproduction should be adequate.

Energy. Lack of energy is one of the most common causes of nutritional infertility (4). In an English study by King (17), those cows gaining weight at the time of breeding averaged 77% conception at first service while those losing weight averaged only 16% conception. The cows gaining weight averaged 14 kg of milk per day as compared to 21 kg for the cows losing weight on a limited grain, ad lib roughage ration. McClure (26) had similar results in New Zealand in that cows losing weight at breeding time averaged 13% conception compared to 62% conception for cows gaining weight. Cows losing weight were receiving only pasture while the weight gaining group received about 6 kg of hay per cow-day in addition to pasture.

Underfeeding heifers results in delayed sexual maturity, but once sexual maturity is reached, breeding efficiency is not greatly hindered (22, 34). Studies by Wiltbank et al. (40) and Dunn et al. (5) clearly indicated that reproductive performance of beef cows under range conditions was improved by increased energy intake. However, lactating dairy cows in the United States are usually fed more grain than beef cows or dairy cows in other countries and they do not exhibit increased fertility from increased energy. Fuquay et al. (8) found that the level of grain feeding during the first half of lactation did not significantly alter time to first estrus, time open or services per conception. Lamb et al. (18) observed no difference in the reproductive performance of dairy cows fed alfalfa hay and grain versus those fed only alfalfa hay during lactation.

Phosphorus. Limited phosphorus intake is probably the most prevalent mineral deficiency affecting reproduction (34). Hignett and Hignett (13) reported that first service conception rates decreased as the calcium to phosphorus ratio widened in low phosphorus rations. They also reported a greater incidence of silent heat and lower fertility with lower phosphorus intakes. Littlejohn and Lewis (21) could not substantiate these findings as their studies indicated the level or ratio of calcium and/or phosphorus had no effect on fertility of dairy heifers.

Reports (5, 36, 39) have drawn attention to the poor breeding record of cows grazing pasture in phosphorus deficient areas although it was generally accepted that fertility suffered only when other signs of phosphorus deficiency were evident. Palmer et al. (32) observed delayed sexual maturity and high incidence of silent estrus but no effect on ovulation or fertility when heifers were fed rations deficient in both phosphorus and protein.

Ward et al. (38) reported that cows fed a 2:1 calcium: phosphorus ratio ovulated 6 days earlier after parturition than those cows fed a 1:1 ratio. Those cows receiving vitamin-D supplement (3,000,000 I. U./week) showed first estrus 16 days earlier and conceived 37 days earlier than cows not receiving supplemental vitamin D. Services per conception did not vary significantly.

Various studies have been conducted with other nutrients to determine their effect on reproduction. Results have been inconclusive in terms of any one particular nutrient being required for reproduction in excess of that required for normal maintenance and production. However, many areas of nutrition need to be studied in terms of meeting the needs of the high producing dairy cow.

LITERATURE CITED

(1) Boyd, L. J. 1970. Managing dairy cattle for fertility. J. Dairy Sci., 53:969.

(2) Boyd, L. J., D. M. Seath, and D. Olds. 1954. Relationship between level of milk production and breeding efficiency in dairy cattle. J. Animal Sci., 13:89.

(3) Carman, G. M. 1955. Interrelations of milk production and breeding efficiency in dairy cattle. J. Animal Sci., 14:753.

(4) Committee Report. 1968. Prenatal and postnatal mortality in cattle. Natl. Acad. Sci., Washington, D.C., Publ. 1685.

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

(6) Eckles, C. H., R. B. Becker, and L. S. Palmer. 1926. A mineral deficiency in the rations of cattle. Minnesota Agr. Exp. Sta. Bull. 229.

(7) Everett, R. W., D. V. Armstrong, and L. J. Boyd. 1966. Genetic relationship between production and breeding efficiency. J. Dairy Sci., 49:879.

(8) Fuquay, J., A. H. Rakes, L. C. Ulberg, and D. G. Davenport. 1966. Effect of high levels of energy intake during early lactation on the reproductive performance of dairy cows. J. Dairy Sci., 49:447.

(9) Gaines, W. L. 1927. Milk yield in relation to recurrence of conception. J. Dairy Sci., 10:117.

(10) Gaines, W. L., and J. R. Palfrey. 1931. Length of calving interval and average milk yield. J. Dairy Sci., 14:294.

(11) Hall, J. G., C. Branton, and E. J. Stone. 1959. Estrus, estrus cycles, ovulation time, time of service, and fertility in dairy cattle in Louisana. J. Dairy Sci., 42:1086.

(12) Herman, H. A., and J. H. Edmondson. 1950. Factors affecting the interval between parturition and first estrus in dairy cattle. Missouri Agr. Exp. Sta. Bull. 462.

(13) Hignett, S. L., and P. G. Hignett. 1951. The influence of nutrition on reproductive efficiency in cattle. I. The effect of calcium and phosphorus on fertility of cows and heifers. Vet. Rec., 63:603.

(14) Hollon, B. F., C. Branton, R. E. McDowell, and D. C. Meyerhoeffer. 1967. Reproductive performance of purebred versus crossbred dairy cattle. J. Dairy Sci., 50:611.

(15) Johnson, A. D., and L. C. Ulberg. 1967. Heat detection pays big dividends. Hoards Dairyman, 112:1167.

(16) Johnson, K. R. 1966. Estrus intensity in dairy cattle. J. Dairy Sci., 49:731.

(17) King, J. O. L. 1968. The relationship between conception rate and changes in body weight, yield, and solids-not-fat content of milk in dairy cows. Vet. Rec., 83:492.

(18) Lamb, R. C., C. H. Mickelson, and L. L. Perkes. 1965. Influence of sire and ration on reproductive performance of dairy cows. J. Dairy Sci., 48:823.

(19) Legates, J. E. 1954. Genetic variation in services per conception and calving interval in dairy cattle. J. Animal Sci., 13:81.

(20) Lewis, R. C., and R. E. Horwood. 1949. Breeding efficiency in the Michigan State College dairy herds. Michigan Agr. Exp. Sta. Quart. Bull. 32, 1:152.

(21) Littlejohn, A. I., and G. Lewis. 1960. Experimental studies of the relationship between the calcium-phosphorus ratio of the diet and fertility of heifers. Vet. Rec., 72:1137.

(22) Loosli, J. K., and L. A. Maynard. 1969. Animal Nutrition. McGraw-Hill, New York.

(23) Louca, A., and J. E. Legates. 1968. Production losses in dairy cattle due to days open. J. Dairy Sci., 51:573.

(24) Marion, G. B., and H. T. Gier. 1968. Factors affecting bovine ovarian activity after parturition. J. Animal Sci., 27:1621.

(25) Matson, J. 1929. The effect on lactation of the length of preceding calving interval and its relation to milking capacity, to age, and to other factors of influence. J. Agr. Sci., 19:553.

(26) McClure, T. J. 1965. A nutritional cause of low non-return rates in dairy herds. Australian Vet. J., 41:119.

(27) Menge, A. C., S. E. Mares, W. J. Tyler, and L. E. Casida. 1962. Variation and association among postpartum reproduction and production characteristics in Holstein-Friesen cattle. J. Dairy Sci., 45:233.

(28) Miller, Paul, L. D. VanVleck, and C. R. Henderson. 1967. Relationship among herd life, milk production, and calving interval. J. Dairy Sci., 50:1283.

(29) Morrow, D. A., S. J. Roberts, K. McEntee, and H. G. Gray. 1966. Postpartum ovarian activity and uterine involution in dairy cattle. J. Amer. Vet. Med. Ass., 149:1596.

(30) Norman, H. D., and H. W. Thoele. 1967. Effects of calving interval upon 305-day milk and fat production. J. Dairy Sci., 50:975.

(31) Olds, D., and D. M. Seath. 1953. Repeatability, heritability, and the effect of level of milk production on the occurrence of first estrus after calving in dairy cattle. J. Animal Sci., 12:10.

(32) Palmer, L. S., T. W. Gullickson, W. L. Boyd, C. P. Fitch, and J. W. Nelson. 1941. The effect of rations deficient in phosphorus and protein on ovulation, estrus, and reproduction of dairy heifers. J. Dairy Sci., 24:199.

(33) Rennie, J. C. 1956. Causes of variation in calving intervals of Holstein-Friesen cows. J. Dairy Sci., 39:933.

(34) Salisbury, G. W., and N. L. VanDemark. 1961. Physiology of Reproduction and Artificial Insemination of Cattle. W. H. Freeman and Co., San Francisco.

(35) Speicher, J. A., and C. Meadows. 1967. Milk production and costs associated with length of calving intervals of Holstein cows. J. Dairy Sci., 50:975.

(36) Theiler, A., H. H. Green, and P. J. DuToit. 1928. Studies in mineral metabolism. III. Breeding of cattle on phosphorus deficient pasture. J. Agr. Sci., 18:369.

(37) Trimberger, G. W., and M. G. Fincher. 1956. Regularity of estrus, ovarian function, and conception rates in dairy cattle. Cornell Agr. Exp. Sta. Bull. 911.

(38) Ward, G. M., G. B. Marion, C. W. Campbell, and J. R. Dunham. 1971. Influence of calcium intake and vitamin D supplementation on reproductive performance of dairy cattle. J. Dairy Sci., 54:204.

(39) Wheeler, S. S. 1945. Phosphorus supplements for beef cows and heifers. Wyoming Agr. Exp. Sta. Bull. 269.

(40) Wiltbank, J. N., W. W. Rowden, J. E. Ingalls, and D. R. Zimmerman. 1964. Influence of postpartum energy level on the reproductive performance of Hereford cows restricted in energy intake prior to calving. J. Animal Sci., 23:1049.

(41) Zemjanis, R., M. L. Fahning, and R. H. Schultz. 1969. Anestrus-the practitioners dilemma. Vet. Scope, 14:1.

CHAPTER II. AN ANALYSIS OF FACTORS AFFECTING CALVING INTERVALS OF DAIRY COWS

Abstract

Forty DHI Holstein herds were visited to determine the factors affecting calving intervals and breeding efficiency. Twenty-one herds with calving intervals of 360 to 374 days (S), and 19 herds with calving intervals of more than 405 days (L), based upon the 1969 DHI herd summary, were compared in the two year study.

The L group had a 28-day longer interval ($P < .01$) from parturition to first service. The intervals between services were also longer ($P < .01$) for the L group. Twenty-four per cent of the S group cows had received their first services by 60 days postpartum, 73% by 90 days, and 92% by 120 days post-partum as compared to 13, 50, and 74%, respectively, for the L group. There was no difference in the conception rate of the two groups at first service or after three services.

Cows in the S group received more concentrates, although it is doubtful that this was a factor in their shorter breeding interval since more herds had suboptimal nutrient intake than did the L group. Nutritional deficiencies appeared to affect reproduction adversely in only one herd.

Heat detection was a problem in several herds due to inadequate observation and failure to recognize some heat signs. Reproductive consciousness of the S operators was higher in that they were breeding cows earlier after

parturition and had less problems detecting heat. Many operators need additional training in heat detection and maintenance of complete individual cow health records.

Introduction

Current economic conditions dictate high levels of milk production, breeding efficiency, and management for profitable dairying. Calving interval, the period between calvings, is one measure of breeding efficiency, although it cannot be used by itself to describe a herd's breeding efficiency since it does not account for those cows culled because of failure to conceive. Twelve-month calving intervals are desirable and economically justifiable as indicated by greater return over feed cost than with longer intervals.

While much progress has been made in the last three decades in the improvement of dairy cattle fertility through disease control, infertility or breeding problems still rank second as cause for culling, accounting for 16 to 19% of all culled cows. Infertility is also one of the most important economic losses in high-producing herds. Modern feeding and management practices in large herds may have accentuated this problem. We still must recognize management as a significant factor if we are to achieve fertility in our dairy herds. Regular reproduction requires individual attention to each cow from parturition until she has conceived. Mass handling of cows in large herds does not appear to be as conducive to efficient reproductive management as to other functions, such as feeding and housing. This study was conducted to determine some of the factors affecting calving intervals and breeding efficiency in Kansas dairy herds.

Procedure

Forty Kansas DHI Holstein herds were studied from each of two groups, 21 with calving intervals between 360 to 374 days (S), and 19 with intervals more than 405 days (L), based on the 1969 DHI herd summary. Dates of individual calvings, breedings, and estrus not bred for the period, September, 1968, to August, 1970, were obtained during a visit to each farm. Incomplete herd health records prevented the collection of data on other factors affecting reproductive efficiency such as milk fever, ketosis, and abnormal calving.

Data were collected on kinds and amounts of feed fed during the period to determine possible relationship of nutritional status to breeding efficiency. Crude protein, estimated net energy, calcium and phosphorus contents of the ration were calculated from these data. Each ration, based upon reported roughage, and 20 pounds of concentrates per cow, was compared to the NRC (13) standards for a 650 kg cow producing 23 kg of 3.5% milk. Interviews with the owner-operator were used to evaluate his managerial ability and goals in terms of heat detection and reproductive consciousness. An index of 10-excellent, 1-poor, was used to rate their management ability.

Results and Discussion

The herds visited were one- or two-man family operations of 16 to 115 cows, averaging 46 cows. The two year study included 3634 gestations. The typical ration consisted of alfalfa or brome-alfalfa hay, corn or sorghum silage, and usually brome and/or sudan grass pasture. Thirty-one herds used some pasture; 15 used limited pasture in addition to their regular ration of hay, silage and concentrates, while 16 used pasture to replace hay and/or silage in their summer rations. The concentrate mixtures consisted of corn, sorghum, wheat, barley, and soybean-oil meal or commercial protein supplement plus vitamins and minerals. The average production and ration are shown in Table 1.

Table 1. Average production and ration per cow.

Group	Cows	Milk	Fat	Conc.	Hay	Succ.	Pasture
	No./herd	(kg/year)					(days)
Short	44	6201	225	3005	1850	5130	69
Long	47	6069	223	2520	1848	5986	89

Herds in the S group received more ($P < .01$) concentrates, although it is doubtful that this was a factor in their shorter breeding interval since they had more nutritional deficiencies that the other group.

Five rations (4S, 1L) were low in crude protein, six (5S, 1L) were low in energy, four (3S, 1L) were low in calcium with 3 of the 4 offering a calcium supplement free choice in addition to the calculated ration, and fourteen (9S, 5L) were low in phosphorus with 11 of the 14 offering a phosphorus supplement free choice. Nutritional deficiencies appeared to be affecting reproduction in only one herd. In this herd, first calf heifers apparently were not cycling after calving until treated with hormones. The heifers were grazed on native bluestem pasture during the summer and wintered on dry bluestem plus alfalfa hay from 8 months of age until calving. They received no mineral supplement other than salt and no grain during this period. This ration was deficient in phosphorus since bluestem pastures in this area are known to be low in phosphorus. Drake (3) reported that feeding moderate amounts of dicalcium phosphate on similar pasture seemed to improve the reproductive performance of beef heifers. Several authors (2, 4, 17, 21) have reported reduced reproductive efficiency in animals grazing phosphorus deficient range. Hignett and Hignett (7) reported lowered fertility and high incidence of silent heat in dairy heifers receiving less than 40 g of phosphorus daily.

The primary factor affecting the calving interval was longer intervals from parturition to first service ($P < .01$) for the L, than for the S group as indicated in Table 2.

Table 2. Herd breeding efficiency evaluation.

Criterion	Short	Long
Calving to first service (days)	79	107*
First to second service (days)	36	57*
Second to third service (days)	33	52*
Conception after first service (%)	56	56
Conception after second service (%)	80	80
Conception after third service (%)	91	90
Services per conception	1.8	1.8

* Significantly different from short group, ($P < .01$)

The intervals between services were also longer ($P < .01$). Not only was breeding started earlier in the S group but also these operators were detecting estrus earlier on those cows not settled and getting them rebred quicker.

Touchberry (18) reported that service interval alone accounted for 16.8% of the variance among intervals from parturition to conception. This increased at an increasing rate as the service interval increased to 50 days then increased nearly linearly as the service interval increased. Olds and Cooper (15) reported that cows in their study were bred 82 ± 33 days after calving and that each day sooner, down to 35 days postpartum, resulted in shortening the calving interval 0.9 day.

There was no difference in the conception rate between the two groups. The 56% first service conception is comparable to 58.8% reported by Morrow et al. (12) and 50.8% reported by VanDemark and Salisbury (20), but is lower than the 65 to 70% first service conception rates that are commonly discussed.

Conception after 3 services or less was 90%, higher than the 75% reported by Pelissier (16). Trimberger (19) reported conception after 3 services varying between 73 and 87% depending upon the service interval.

Services per conception is another widely used index of fertility. The 1.8 services per conception found in this study are comparable to those reported respectively by Boyd (1)-1.68, Hollon (8)-1.73, Morrow (12)-1.84, VanDemark (20)-1.97, and Pelissier (16)-2.55.

There was considerable variance between the groups in cows bred by respective days after calving. In general, most dairymen breed cows 60 days or more postpartum, although in this study 24% of the cows in the S group had received their first services by 60 days after calving (Figure 1).

The service interval did not affect the conception rate in this study between groups or between periods (Table 3).

Table 3. Affect of service interval on first service conception.

	Service interval (days)					
Group	0-45	46-60	61-90	91-120	121-180	>180
			%			
Short	38	47	55	59	59	41
Long	47	44	55	58	57	62

Early studies by VanDemark et al. (20), Trimberger (19), and Touchberry et al. (18) indicate low conception rates when breeding before 50 to 60 days postpartum. Several authors including Olds and Cooper (15) and Nilsson (14) have suggested that commercial dairymen begin breeding their cows 40 to 60 days postpartum.

If a 12-month calving interval is ideal, a cow must conceive approximately 80 to 90 days after calving. Touchberry et al. (18) calculated that with 60% first service conception, a herd would need a service interval of 47 to 60 days in order to maintain a 365-day calving interval. Figure 1 shows that only 50% of the cows in the L group had received their first services by 90 days and 74% by 120 days postpartum in comparison to 73 and 92%, respectively, for the S group. Pelissier (16) reported that 60.1% of the cows had received their first services by 90 days and 87.9% by 120 days after calving. Olds and Cooper (15) reported 23.3% of the cows received their first services by 60 days after calving, 69.5% by 90 days, and 89.9% by 120 days.

The importance of timely heat detection has been indicated by several authors. Johnson (10) reported that difficulty in detecting heat is one of the common causes of long calving intervals. He indicated that heat detection can be improved by proper training and more careful observation. Johnson and Ulberg (9), comparing reproductive efficiency of seven herds, found that the days lost per cow-year due to missed heats ranged from 9 to 38 days, clearly indicating the importance of heat detection. Hall et al. (5) reported 30% more heats detected by checking cows 4 times daily as compared to twice daily. Zemjanis et al. (22) indicated that only 10% of all anestrus was due to disorders of the reproductive tract. The

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

THIS IS AS RECEIVED FROM CUSTOMER.

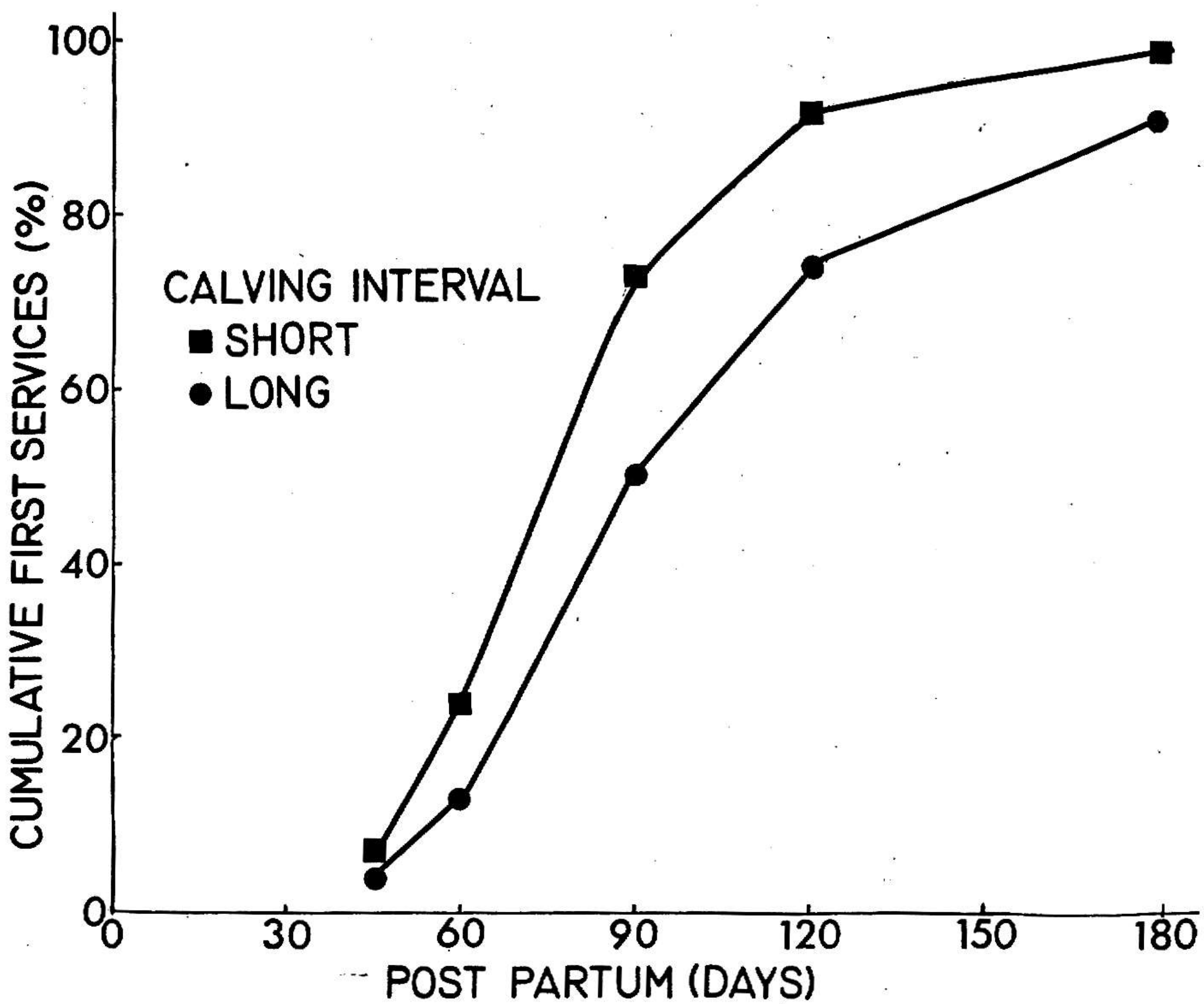

FIG. 1. Cumulative first services by postpartum interval.

remaining 90% was a result of failure to observe estrus due to inadequate observation or variations in the intensity of estrus symptoms.

In the study several dairymen reported problems in detecting heat. They observed the cows only when driving them into the holding pen for milking and at feeding time, thus indicating a management problem since neither time is favorable for careful observation of heat by the man or expression of heat by the cow.

The importance of early heat detection in getting cows bred can also be demonstrated by comparison of the groups on interval of repeat services. Only 30% of the L group's repeat services occurred 17 to 24 days after a previous service as compared to 48% for the S group (Table 4).

Table 4. Interval of repeat services from previous service.

	Interval (days)					
Group	<17	17-24	25-50	51-90	91-120	>120
			%			
Short	5	48	30	13	3	2
Long	3	30	31	24	6	6

These differences appear to be due primarily to heat detection as there was no evidence of more disease or abnormal heat in the L group. No doubt some embryonic abortions are represented in the repeat intervals longer than 25 days; however, the number would be expected to be about equal in each group.

It seems that taking additional time at intervals throughout the day for observing the cows would help to improve heat detection. Hall (5) reported that 54.8% of the cows came into heat during the night indicating the importance of early morning check for heat. Dairymen may also need training on symptoms of estrus, other than standing heat, to improve heat detection.

The management ability in terms of reproductive consciousness of the S operators was higher ($P<.01$) than of the L operators as evidenced by indices of 5.9 and 4.7 respectively. These operators, in general, were breeding on the first heat after 60 days postpartum, while two of the L operators delayed breeding until 90 days postpartum "to improve conception" and three reported delaying breeding to preclude calving during cold weather or during the summer harvest season.

Regression accounted for 58% of the variance between calving intervals in two consecutive years for 426 Kansas Holstein herds. This indicates that a herd with a long calving interval is very likely to have a similar interval the following year whether due to factors influenced by man, animal or both.

Morrow (11) reported that a Michigan dairyman was able to reduce the forced culling due to disease from 55% to 19% during 4 years of a systematic herd health program. This permitted him to double selective culling for low production and poor type. The calving interval was maintained within the goal of 12 to 13 months, and breeding efficiency was maintained at 1.6 services per conception. Herschler et al. (6) reported calving interval reduction from 433 to 386 days over 3 years with a complete herd health program. Culling due to reproductive failure was reduced from 14 to 5 cows per year in a 55-cow herd.

In conclusion, it appears that the calving interval is primarily a management decision, with the length of calving interval depending on the reproductive goals and attitudes of the operator. The calving interval in many herds could be reduced by breeding cows on the first heat after 45 days postpartum, provided the cow has been examined and her reproductive tract normal. Many operators need additional training in heat detection. Some also need to develop an awareness of the economic importance of early heat detection, routine reproductive tract examinations, and maintenance of complete individual health records. Less than 25% of the herds involved had complete herd health records and records of estrus occurring before breeding.

More time spent observing the cows for heat would greatly reduce the breeding problems in many herds. Perhaps large herds could benefit by grouping their cows according to reproductive status for better observation of those cows requiring attention. Estrus synchronization may become a useful tool in heat detection in the future.

References

(1) Black, W. H., T. H. Lash, J. M. Jones, and R. J. Kleburg, Jr. 1943. Effects of phosphorus supplements on cattle grazing on range deficient in the mineral. Tech. Bull. 856, USDA, Washington, D.C.

(2) Boyd, L. J., D. M. Seath, and D. Olds. 1954. Relationship between level of milk production and breeding efficiency in dairy cattle. J. Animal Sci., 13:89.

(3) Drake, C. L., E. F. Smith, H. G. Spies, D. Richardson, and D. L. Good. 1964. The effects of feeding different levels of dicalcium phosphate to heifers on bluestem pasture. Kansas Agr. Exp. Sta. Bull. 473.

(4) Eckles, C. H., R. B. Becker, and L. S. Palmer. 1926. A mineral deficiency in the rations of cattle. Minnesota Agr. Exp. Sta. Bull. 229.

(5) Hall, J. G., C. Branton, and E. J. Stone. 1959. Estrus, estrus cycles, ovulation time, time of service, and fertility in dairy cattle in Louisana. J. Dairy Sci., 42:1086.

(6) Herschler, R. C., C. Miracle, B. Crowl, T. Dunlap, and J. W. Judy. 1964. The economic impact of a fertility control and herd management program on a dairy farm. J. Amer. Vet. Med. Ass., 145:672.

(7) Hignett, S. L., and P. G. Hignett. 1952. The influence of nutrition on reproductive efficiency in cattle. II. The effect of phosphorus intake on ovarian activity and fertility in heifers. Vet. Rec., 64:203.

(8) Hollon, B. F., C. Branton, R. E. McDowell, and D. C. Meyerhoeffer. 1967. Reproductive performance of purebred versus crossbred dairy cattle. J. Dairy Sci., 50:611.

(9) Johnson, A.D., and L. C. Ulberg. 1967. Heat detection pays big dividends. Hoards Dairyman, 112:1167.

(10) Johnson, K. R., 1966. Estrus intensity in dairy cattle. J. Dairy Sci., 49:731.

(11) Morrow, D. A. 1970. Diagnosis and prevention of infertility in cattle. J. Dairy Sci., 53:961.

(12) Morrow, D. A., S. J. Roberts, K. McEntee, and H. G. Gray. 1966. Postpartum ovarian activity and uterine involution in dairy cattle. J. Amer. Vet. Med. Ass., 149:1596.

(13) National Research Council. 1966. Nutrient Requirements of Dairy Cattle. Natl. Acad. Sci., Washington, D.C., Publ. 1349:5.

(14) Nilsson, L. S. Jr. 1965. What's magic about 60 days. Hoards Dairyman, 110:142.

(15) Olds, D., and T. Cooper. 1970. Effect of postpartum rest period in dairy cattle on the occurrence of breeding abnormalities and on calving intervals. J. Amer. Vet. Med. Ass., 157:92.

(16) Pelissier, C. L. 1970. Factors contributing to low breeding efficiency in dairy herds. J. Dairy Sci., 53:684.

(17) Theiler, A., H. H. Green, and P. J. DuToit. 1928. Studies in mineral metabolism, III. Breeding of cattle on phosphorus deficient pasture. J. Agr. Sci., 18:369.

(18) Touchberry, R. W., K. Rottensten, and H. Andersen. 1959. Association between service interval, interval from first service to conception, number of services per conception, and level of butterfat production. J. Dairy Sci., 42:1157.

(19) Trimberger, G. W. 1954. Conception rates in dairy cattle from services at various intervals after parturition. J. Dairy Sci., 37:1042.

(20) VanDemark, N. L., and G. W. Salisbury. 1950. The relations of postpartum breeding interval to reproductive efficiency in the dairy cow. J. Animal Sci., 9:307.

(21) Wheeler, S. S. 1945. Phosphorus supplements for beef cows and heifers. Wyoming Agr. Exp. Sta. Bull. 269.

(22) Zemjanis, R., M. L. Fahning, and R. H. Schultz. 1969. Anestrus-the practitioners dilemma. Vet. Scope, 14:1.

ACKNOWLEDGMENTS

The author wishes to express his sincere thanks to Dr. G. M. Ward, major advisor, and to Dr. E. P. Call for their help, advice, and valuable suggestions during this study and the preparation of this manuscript. Thanks is also extended to Dr. C. L. Norton and Dr. D. Richardson for their suggestions during the study. Appreciation is expressed to Ralph Bonewitz for his assistance with the DHI data. Gratitude is expressed to the Franklin County Extension Council and staff, as well as to Dr. R. A. Bohannon, Extension Director, for making this program of study possible.

A special thanks is expressed to the author's wife, Helen, and family for their patience and understanding during this study period.

APPENDIX

APPENDIX Table I. Gestations and calving intervals by group.

Herd no.	Short: Gestations	Short: 1969 C I	Short: 1970 C I	Long: Gestations	Long: 1969 C I	Long: 1970 C I
	(no.)	(days)		(no.)	(days)	
1	49	365	361	69	435	382
2	136	368	384	120	408	393
3	112	373	377	52	443	477
4	67	371	368	151	427	420
5	79	366	363	61	412	462
6	29	361	389	27	431	396
7	51	370	386	51	422	370
8	121	373	391	66	414	431
9	80	374	372	191	410	406
10	101	369	401	29	416	423
11	86	372	406	110	406	419
12	40	369	377	64	419	435
13	130	370	382	61	405	421
14	169	360	360	160	412	390
15	104	371	373	88	405	389
16	177	362	380	103	413	409
17	119	367	382	52	449	490
18	76	365	366	46	422	438
19	108	371	372	86	411	430
20	53	374	389			
21	160	374	383			
Mean	97	369	379	84	419	420

APPENDIX Table II. Interval between services by group.

Herd no.	Short: Calv.-first	Short: First second	Short: Second third	Long: Calv.-first	Long: First-second	Long: Second-third
	(days)					
1	71	36	37	102	62	76
2	86	31	31	94	38	43
3	80	35	40	107	67	48
4	76	29	42	105	51	40
5	50	25	22	97	59	88
6	84	36	36	116	74	24
7	70	23	26	59	43	41
8	68	37	32	113	60	57
9	77	38	33	109	45	39
10	87	36	32	91	51	48
11	92	33	29	135	63	47
12	90	37	44	97	46	51
13	88	47	31	92	49	44
14	87	39	29	79	44	55
15	66	47	39	99	53	42
16	79	37	36	109	56	48
17	84	42	39	169	71	41
18	91	47	27	122	53	67
19	81	30	25	140	106	45
20	93	41	30			
21	76	33	41			
Mean	79	36	33	107	57	52

APPENDIX Table III. Conception after three services, or less, by group.

Herd no.	Short: Service First	Short: Service Second	Short: Service Third	Long: Service First	Long: Service Second	Long: Service Third
	(%)					
1	65	86	96	59	81	94
2	50	76	89	46	74	89
3	54	79	90	48	73	84
4	46	76	89	43	63	81
5	67	85	91	63	87	93
6	67	79	96	77	96	96
7	46	65	88	53	86	92
8	40	62	73	61	77	89
9	66	84	94	50	80	90
10	43	78	92	48	76	86
11	59	78	92	56	86	94
12	55	88	100	44	58	78
13	65	87	97	41	76	93
14	73	91	96	49	75	92
15	45	72	88	69	94	98
16	53	81	92	65	83	94
17	49	81	91	69	83	88
18	67	88	95	67	82	91
19	55	85	99	67	91	95
20	66	85	88			
21	44	68	86			
Mean	56	80	91	56	80	90

APPENDIX Table IV. Services per conception and management index by group.

Herd no.	Short: Services/ conception	Short: Mgt. index [a]	Long: Services/ conception	Long: Mgt. index [a]
1	1.6	7	1.7	5
2	1.9	7	1.9	5
3	1.7	6	2.2	6
4	1.9	6	2.3	5
5	1.7	4	1.6	6
6	1.7	5	1.4	5
7	2.5	5	1.6	4
8	2.7	5	1.8	4
9	1.7	7	1.9	6
10	1.9	6	2.3	5
11	1.7	5	2.0	2
12	1.6	5	2.5	4
13	1.5	7	1.9	5
14	1.4	7	1.9	4
15	2.1	6	1.3	6
16	1.8	4	1.5	6
17	1.9	5	1.6	3
18	1.5	6	1.9	5
19	1.6	7	1.6	3
20	1.6	7		
21	1.9	6		
Mean	1.8	5.9	1.8	4.7

a 10 excellent, 1 poor

APPENDIX Table V. First service conception by postpartum interval of short group.

Herd no.	0-45 B[a]	0-45 C[b]	46-60 B	46-60 C	61-90 B	61-90 C	91-120 B	91-120 C	121-180 B	121-180 C	>180 B	>180 C
1	1	0	15	9	27	19	5	3	1	1	-	-
2	5	1	18	9	39	19	22	9	12	6	1	1
3	-	-	26	11	55	33	16	10	5	2	1	0
4	1	0	4	1	37	18	6	4	1	0	-	-
5	28	16	15	11	23	17	9	5	3	2	3	3
6	2	1	1	1	10	7	8	3	1	1	-	-
7	1	0	10	6	33	13	4	3	1	1	-	-
8	19	7	35	14	35	12	15	9	6	3	1	0
9	1	1	9	8	43	25	11	6	2	0	-	-
10	1	0	6	2	53	23	30	11	7	5	1	0
11	-	-	3	3	47	28	23	12	12	5	-	-
12	5	2	2	1	12	8	2	1	5	4	1	1
13	6	1	9	3	38	22	18	13	7	6	3	2
14	4	1	11	7	64	49	33	21	10	9	2	0
15	26	8	27	11	33	19	11	5	6	3	-	-
16	1	1	25	11	111	58	28	17	12	6	-	-
17	3	1	33	16	48	24	18	12	12	6	3	0
18	1	0	9	2	32	22	10	10	8	6	2	1
19	10	5	12	5	42	23	28	17	5	4	1	0
20	-	-	-	-	31	18	16	13	4	3	2	1
21	5	1	41	16	76	33	32	20	5	1	1	0
Tot.	120	46	311	147	889	490	345	204	125	74	22	9
Conception (%)	38		47		55		59		59		41	

a No. bred
b No. conceived

APPENDIX Table VI. First service conception by postpartum interval of long group.

Herd no.	0-45 B[a]	0-45 C[b]	46-60 B	46-60 C	61-90 B	61-90 C	91-120 B	91-120 C	121-180 B	121-180 C	>180 B	>180 C
1	6	2	9	4	20	12	15	12	10	4	7	6
2	1	0	8	2	39	21	32	18	11	7	1	1
3	-	-	1	1	14	9	23	10	12	4	1	1
4	1	0	14	5	60	29	33	12	30	14	11	3
5	7	4	9	8	14	9	21	15	5	2	4	2
6	4	3	2	2	5	2	5	4	5	4	4	4
7	27	13	9	5	11	6	2	1	3	2	2	2
8	-	-	2	1	19	12	16	8	12	10	2	0
9	2	1	3	1	64	32	43	18	34	17	12	7
10	2	1	2	0	15	8	5	2	3	2	1	1
11	6	1	15	4	35	24	15	11	21	11	21	11
12	1	0	7	3	26	13	21	10	4	1	5	1
13	-	-	7	3	40	13	10	6	2	1	5	5
14	2	1	36	14	80	42	24	14	16	7	-	-
15	1	1	2	2	31	21	30	22	18	12	2	2
16	1	1	9	4	39	27	17	15	25	13	9	5
17	1	1	1	1	8	2	12	6	10	9	20	17
18	-	-	1	1	13	9	15	7	10	8	7	5
19	-	-	5	2	15	10	20	17	25	17	11	5
Tot.	62	29	142	63	548	301	359	208	256	145	125	78
Conception (%)		47		44		55		58		57		62

a No. bred
b No. conceived

APPENDIX Table VII. Average annual production and ration of the short group.

Herd no.	Cows	Milk	Fat	Conc.	Hay	Succulents	Pasture
	(no.)	(kg)					(days)
1	34	6603	237	3273	1704	4975	---
2	55	6589	246	2793	1918	3902	167
3	58	5934	232	3380	1745	6527	---
4	24	5937	231	2705	1675	5098	61
5	51	6360	230	2755	1859	5387	89
6	23	6296	223	2668	3520	---	138
7	42	5930	185	3639	2036	657	153
8 a	39	5490	196	2100	2045	4009	91
9	25	4416	165	2598	2199	---	164
10	46	6653	236	3661	1975	4245	---
11	47	6554	204	2870	2541	4209	32
12	48	7078	260	2898	526	7062	168
13	43	6844	245	3391	2416	5136	---
14	55	6337	235	3180	305	6236	75
15	43	6403	238	2018	2839	8984	---
16	101	5738	212	3295	884	5686	16
17	45	6236	223	2898	1857	7911	96
18	26	5928	222	2548	4502	591	119
19	35	5990	204	2493	2148	8793	47
20	29	5864	213	1916	1724	5454	173
21	66	6530	223	3323	2093	3125	61
Mean	44.5	6201	225	3005	1850	5130	69

a 1969 only

APPENDIX Table VIII. Average annual production and ration of the long group.

Herd no.	Cows	Milk	Fat	Conc.	Hay	Succulents	Pasture
	(no.)	(kg)					(days)
1	26	6700	223	2695	2200	3158	184
2	52	6262	240	2868	1986	5236	87
3	31	6706	245	3141	2018	2718	179
4	115	5882	215	2032	1173	10168	92
5	37	6170	220	2595	1439	5920	172
6	16	5313	197	2107	2620	---	214
7	43	6129	220	2173	1414	5470	111
8	34	5461	209	1818	943	5934	104
9	56	6116	228	2584	1477	6000	---
10	28	6725	246	2652	1323	3316	186
11	62	5777	194	2441	1866	4132	74
12	40	6935	260	3034	1441	6639	---
13	50	6166	224	1966	1498	4875	128
14	63	6683	256	2643	2116	4793	200
15	44	6849	246	2732	1161	7289	115
16	85	5391	204	2648	4130	5102	15
17	29	4851	179	3334	3014	7800	73
18	35	5834	235	2629	1161	8345	---
19	52	5844	246	2607	1600	6820	---
Mean	47.3	6069	223	2520	1848	5986	89

AN ANALYSIS OF FACTORS AFFECTING CALVING INTERVALS OF DAIRY COWS

by

ROBERT WAYNE BOZWORTH

B. S., Kansas State University, 1957

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Dairy and Poultry Science

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1971

Calving intervals have been studied for many years to determine their effect on annual milk production and breeding efficiency. Calving intervals have been reduced to average less than 13 months in the last two decades from an average of about 14 months during the 1920's and 1930's, due to economic conditions and increased emphasis on 305-day lactations rather than 365 days. In earlier studies, a short calving interval was commonly associated with a short dry period, resulting in less milk production the next lactation. Later studies indicate that a 12-month calving interval is desirable from the standpoint of increased income over feed cost and more calves for replacement or expansion.

Forty DHI Holstein herds were visited to determine the factors affecting calving intervals and breeding efficiency. Twenty-one herds with calving intervals of 360 to 374 days (S), and 19 herds with calving intervals of more than 405 days (L), based upon the 1969 DHI herd summary, were compared in the two year study.

The L group had a 28-day longer interval ($P < .01$) from parturition to first service. The intervals between services were also longer ($P < .01$) for the L group. Twenty-four per cent of the S group cows had received their first services by 60 days postpartum, 73% by 90 days, and 92% by 120 days postpartum as compared to 13, 50, and 74%, respectively, for the L group. With 60% first service conception, cows must be bred at 45 to 60 days postpartum in order to maintain a 365-day calving interval. There was no difference in the conception rate of the two groups at first service or after three services.

In general, if the nutritive requirements for milk production and general health of the cow are met, then the cow's nutritive requirements for reproduction should be adequate. Cows in the S group received more concentrates, although it is doubtful that this was a factor in their shorter breeding interval since more herds had suboptimal nutrient intake than did the L group. Nutritional deficiencies appeared to affect reproduction adversely in only one herd.

Heat detection difficulties are one of the common causes of long calving intervals. Heat detection was a problem in several herds due to inadequate observation and failure to recognize some heat signs. Reproductive consciousness of the S operators was greater in that they were breeding cows earlier after parturition and had less problems detecting heat. Some operators need additional training in heat detection and maintenance of complete individual cow health records. Some herds could reduce their calving interval by having all cows examined 30 days postpartum and by breeding all normal cows on the first heat following 45 days postpartum.