Relationship of Energy, Cow Size and Sire to Calving Difficulty

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Bellows (1971), in a previous paper, has indicated that 50% of the calf losses at or near birth could be prevented by improved management. He also indicated that age of dam had a marked effect on calving difficulty and this was related to the cow size. Bellows (1971) and Rice and Wiltbank (1970) have reported that birth weight of calf is the most important cause of calving difficulty in 2-year-old heifers.

Methods for decreasing calf birth weight or calf size at calving time, increasing or predicting size of the pelvic opening of the cow at calving time could be useful in decreasing calving difficulty and consequently losses at or near calving. This paper will explore several methods for predicting or altering calf size, the relationship between pelvic size and calving difficulty and methods of predicting pelvic size.

Energy

Most producers feel that decreasing the level of energy fed a heifer prior to calving will decrease losses at or near calving time. Heifers which are extremely fat do have more calving problems and losses at calving are higher (Wiltbank, et al., 1965). The data shown in Table 1 point this out. Heifers received either a high, medium, or low level of energy from the time they were weaned until calving time at approximately two years of age. It can be seen that heifers on the high level of feed weighed 1085 pounds after calving. Heifers fed the moderate level of feed weighed 862 pounds and those on the low level of feed 609 pounds. These heifers differed markedly in condition at this time. Heifers on the high level were extremely fat, heifers on medium level of feed were in good flesh and those on low level were thin. Losses at or near calving were high in the heifers on the high level of feed. Four calves out of 22 were dead at birth (18%), six more died within 24 hours (27%) and two more died before two weeks of age. This is in contrast to a loss of one calf in the heifers receiving medium level of feed and one calf in the heifers receiving the low level of feed. The cause of this high loss in the heifers fed the high levels of feed was not because birth weight was increased. The birth weight was 61

TABLE 1

Level of Energy and Calf Losses
(2-Year-Old Cows)

	Level of Energy[a]		
	High	Medium	Low
Heifer weight after calving (lb.)	1085	862	609
No. cows calving	22	22	18
Calves living at			
Birth	18	21	17
24 hour	12	21	17
2 weeks	10	21	17
Calf birth weight (lb.)	61	61	46
Gestation length (days)	278	277	280

[a]Fed from weaning to calving.

pounds for heifers receiving a high level of feed and 61 pounds for heifers receiving a medium level of feed while the birth weight of calves from heifers receiving the low level of feed was 46 pounds. These data make an important point. Birth weight is not increased by feeding high levels of feed, however, it is decreased if heifers do not receive adequate levels of feed. An increased birth weight was not the cause of the high losses encountered near calving time in this experiment. Two other factors appear to be responsible for these losses. Most of the calves born to the heifers being fed the high level of feed were presented backwards and most heifers appeared to have large amounts of fat in the pelvic region which could have decreased the size of the pelvic opening. Thus, calving losses are increased in heifers that receive high levels of feed for long periods of time and become extremely fat. However, calving losses were not decreased when heifers were put on low levels of feed even though birth weight was markedly decreased.

The effect of two levels of energy on calving difficulty and calving losses was determined at Fort Robinson Beef Cattle Research Station (U.S.D.A. and University of Nebraska cooperating). Details of the rations used were reported by Dunn, et al., (1969). In general, the heifers received two levels of feed. One supplied 8 pounds TDN and the other 4.3 pounds of TDN. Heifers on the moderate level of TDN (8 pounds) gained 120 to 150 pounds the 120 days prior to calving; in contrast, the heifers fed the low level of energy (4.3 pounds TDN) gained only 13 or 35 pounds during this same period of time. It should be noted that the losses in weight at calving time reduced the heifers on the moderate level of feed to approximately the same weight they were at the start of the experiment. While heifers on the low level of feed averaged 125 to 130 pounds less after calving than they did 120 days prior to calving (Table 2). The average birth weight of the calves from

TABLE 2

Level of Energy, Calving Difficulty and Calf Losses
(2-Year-Old Angus and Hereford Cows)

	1963		1964	
	Moderate 8 lb. TDN	Low 4.3 lb. TDN	Moderate 8 lb. TDN	Low 4.3 lb. TDN
No. cows	140	94	123	111
Heifer weight				
120 days before calving (lb.)	774	794	762	760
7 days before calving (lb.)	924	829	882	773
1 day after calving (lb.)	780	664	752	635
Birth weight of calf (lb.)	70	63	70	64
Calves alive at				
Birth (%)	96	97	97	96
24 hrs after birth (%)	95	97	96	95
2 weeks after birth (%)	94	96	93	94
Cows experiencing calving difficulty (%)	37	34	36	20
Cows experiencing calving difficulty in which calf was presented abnormally (%)	13	16	5	5
Cows experiencing calving difficulty in which calf was presented normally				
Total (%)	24	18	31	15
Very difficult birth (%)	1	2	5	1
Pullers needed (%)	18	15	23	14
Slight difficulty (%)	5	1	3	1

cows fed the low level of feed was 63 pounds one year and 64 pounds the next year, compared to 70 pounds from heifers fed the high level of feed. The losses at or near calving were similar for the two groups with 96 or 97% of the calves living at birth and 95 to 97% alive at 24 hours after birth. For calves born in 1963, 3% more calves born to heifers receiving the moderate level of feed had to be assisted (37% vs. 34%) and there were 6% more of the calves from these heifers that had to be assisted when the calf was presented normally at the time of birth (24% vs. 18%). The difference in calves that had to be assisted between the two levels of feed for calves born in 1964 was larger (36% vs. 20%). In heifers in which the calf was presented normally, 4% more calves from the heifers on a moderate level of feed had a very difficult birth and 9% more had to have pullers used when compared to heifers receiving a low level of feed. It should be noted, however, that this did not lead to an increase in losses at or near birth. From these data, I would conclude that losses at or near calving cannot be decreased markedly by placing

heifers on low levels of feed prior to calving. In other words, you cannot starve calving losses out of a group of heifers. It should also be noted that the low level of feed used here has a detrimental effect on reproductive performance such that heifers receiving this low level of feed do not return to heat and conceive as readily as heifers on the moderate level of feed (Wilbank, 1970). Consequently, it is recommended that heifers be placed on the moderate level of feed for 120 days prior to calving for optimum reproductive performance. This moderate level of feed would cause heifers to gain approximately one pound per head per day for the last 100 to 120 days prior to calving and heifers would be fed approximately 8 pounds of TDN.

Pelvic Opening

Measurement of the pelvic opening can be accomplished either with a pelvimeter (Rice and Wiltbank, 1970) or a pair of sliding calipers (LaFever and Wiltbank, 1961). The method of accomplishing this with the pelvimeter is shown in Figures 1, 2 and 3. The two measurements (height and width) are multiplied by each other and the pelvic area is obtained. The relationship between pelvic area obtained approximately 100 to 120 days prior to calving and calving difficulty has been determined.

In 3-year-old heifers calving for the first time, the size of the pelvic area ranged from 210 sq. cm. to over 280 sq. cm. Forty percent of the heifers had a pelvic area between 240-259 sq. cm. (Table 3). Sixty-one

TABLE 3

Calving Difficulty and Pelvic Opening in 3-Year-Old Cows Calving First Time

	Pelvic Area (Sq. Cm.)					
	210-219	220-239	240-259	260-279	Over 279	Total
No. heifers	18	69	121	82	16	306
% heifers having this size pelvic opening	6	22	40	27	5	
Cows experiencing calving difficulty (%)	61	30	20	15	12	
Cows experiencing calving difficulty in which calf was presented abnormally (%)	11	7	7	7	12	
Cows experiencing calving difficulty in which calf was presented normally						
Total (%)	50	23	13	8	0	
Very difficult birth (%)	11	0	0	0	0	
Pullers needed (%)	11	13	3	–	–	
Slight difficulty (%)	28	10	9	7	0	

percent of the heifers having a pelvic area of 210-219 sq. cm. needed assistance at calving time. As the pelvic area increased in size, less assistance was needed. Thirty percent of the heifers needed assistance when pelvic area was 220-239 sq. cm., 20% when pelvic area was 240-259 sq. cm., 15% when pelvic area was 260-279 sq. cm. and 12% when the pelvic area was over 279 sq. cm. The relationship is even more apparent if you consider only those births in which the calf was presented normally. This appears justified because pelvic opening did not appear to affect the incidence of abnormal presentations as it varied from 7% to 12% in heifers with different size pelvic openings. All of the heifers experiencing very difficult births were found in the heifers having a pelvic area of less than 220 sq. cm. Pullers were needed in 11% of the heifers having openings of between 210-219 sq. cm. and in 13% of the heifers having a pelvic opening between 220-239 sq. cm. while in the other three groups the incidence was 3% or 0. Thus there definitely appears to be a relationship between pelvic area and calving difficulty in 3-year-old heifers.

An attempt was made then to predict calving difficulty (LeFever and Wiltbank, 1961) in heifers calving first at three years of age utilizing size of the pelvic opening. The pelvic opening was measured in the fall, approximately 120 days before heifers were expected to start calving. It was predicted that heifers having a pelvic area of less than 230 sq. cm. would experience calving difficulty while little or no calving difficulty was expected in heifers having a pelvic area greater than 230 sq. cm. The results in these heifers were encouraging. Seventy percent of the heifers having a pelvic area of less than 230 sq. cm. experienced calving difficulty compared to 15% in heifers having a pelvic area greater than 230 sq. cm. Abnormal presentations accounted for 20% of the births in heifers having pelvic areas of less than 230 sq. cm. and 10% of the births in heifers having a pelvic area greater than 230 sq. cm. As pointed out previously, abnormal presentations appear to have little or no relationship to size of the pelvic opening. It can be seen then that in heifers in which the calf was presented normally 10% of the heifers having a pelvic area less than 230 sq. cm. had a very difficult birth and 40% experienced slight difficulty. This is compared to 2% in heifers having a pelvic opening greater than 230 sq. cm.

The relationship between calving difficulty and pelvic size is not as predictable in heifers calving first at two years of age. The pelvis in 2-year-old heifers is smaller than the pelvis in 3-year-old heifers. This can be seen by comparing pelvic size in Tables 3 and 5. The smallest pelvis in the 3-year-old heifers was 210-219 sq. cm. while only 29% of the 2-year-old heifers had a pelvis larger than this. Using the criteria for a prediction of calving difficulty in 3-year-old heifers, all 2-year-old heifers had a pelvis smaller than 230 sq. cm. so we would predict a lot of calving problems. Therefore, it is not surprising that the relationship between pelvic area and calving difficulty is not as consistent in 2-year-old heifers. However, even here as shown in Table 5, there

TABLE 4

Prediction of Calving Difficulty in Heifers
Calving First at 3 Years of Age

	Pelvic Area	
	190-229 (Sq. Cm.)	230-289 (Sq. Cm.)
Prediction	Likely Calving difficulty	Probably no Calving difficulty
No. heifers	10	41
Cows experiencing calving difficulty (%)	70	12
Cows experiencing calving difficulty in which calf was presented abnormally (%)	20	10
Cows experiencing calving difficulty in which calf was presented normally		
Total (%)	50	2
Very difficult birth (%)	10	0
Pullers needed (%)	0	2
Slight difficulty (%)	40	0

TABLE 5

Calving Difficulty and Pelvic Opening
in 2-Year-Old Cows

	Pelvic Area (Sq. Cm.)					
	150-189	190-199	200-209	210-219	Over 220	Total
No. Heifers	26	51	66	38	20	203
% heifers having this size pelvic opening	13	25	33	19	10	
Cows experiencing calving difficulty (%)	50	33	36	47	25	
Cows experiencing calving difficulty in which calf was presented abnormally (%)	15	10	12	21	10	
Cows experiencing calving difficulty in which calf waspresented normally						
Total (%)	35	23	24	26	15	
Very difficult birth (%)	4	0	1	3	5	
Pullers needed (%)	31	17	20	18	10	
Slight difficulty (%)	0	6	3	5	0	

TABLE 6

Pelvic Opening and Calving Difficulty
(Cooperative Ranchers)

	Pelvic Area (Sq. Cm.)				
	150-169	170-189	190-209	210-229	Over 229
No. heifers	29	157	148	57	15
% heifers having this size pelvic opening	7	39	37	14	4
Cows experiencing calving difficulty (%)	76	64	49	40	27
Cows experiencing calving difficulty in which calf was presented abnormally (%)	3	3	2	2	0
Cows experiencing calving difficulty in which calf was presented normally					
Total (%)	73	61	47	38	27
Very difficult birth (%)	14	5	3	0	0
Pullers needed (%)	25	28	23	16	7
Slight difficulty (%)	36	29	21	23	20

appeared to be some relationship. Fifty percent of the heifers having a pelvic opening between 150-189 sq. cm. required assistance while fewer heifers having larger pelvic openings required assistance. Again this relationship is somewhat more apparent if we consider only those heifers having a normal presentation. The heifers having the very difficult births were not confined to the heifers with the small pelvic openings but were found even in heifers having the largest pelvic openings. This points out that even though a heifer had a large pelvis for a 2-year-old heifer and gave birth to a calf with a heavy birth weight she still ran into difficulties because the pelvis wasn't big enough when compared to 3-year-old heifers.

A group of heifers calving first at two years were measured on some cooperating ranches. The result from these ranches appear somewhat more promising than those just noted. Pelvic opening in these heifers were somewhat smaller than those noted in the previous study. It can be seen in the heifers with a pelvic area less than 170 sq. cm., 76% required assistance and they steadily decreased as the pelvis increased in size. Also, most of the difficult births were encountered in heifers with the small pelvic openings. It would therefore appear possible to do some predicting in heifers calving first at two years of age. This was attempted in 224 heifers. It can be seen from Table 7 that much of the calving difficulty occurred where it had been predicted. However, it should be noted that over half the heifers were included in the heifers having less than 190 sq. cm. So most heifers calving first at two years of age have too small a pelvis to calve without assistance. Our

TABLE 7

Predicting Calving Difficulty in Heifers
Calving First at 2 Years of Age

	Pelvic Area	
	Less than 190 Sq. Cm.	Greater than 190 Sq. Cm.
Prediction	Calving difficulty likely	Probably no calving problems
No. heifers	114	110
Cows experiencing calving difficulty (%)	74	25

data would indicate as Bellows (1971) has also indicated that calf size needs to be decreased if we are going to decrease calving difficulty in 2-year-old heifers.

The effect of birth weight and pelvic opening on calving difficulty is shown in Table 8. It can be seen that when a heifer gave birth to a calf weighing 70-79 pounds she had calving difficulty even when she had a pelvis of 210-219 sq. cm. This indicates that either the pelvic area needs to be increased or birth weight decreased. Fifty percent of the heifers that gave birth to a calf weighing between 60-69 pounds experienced calving difficulty if they had a pelvic opening from 150-169 sq. cm. Thus it appears that a combination of two things, birth weight and pelvic area, are important in decreasing calving difficulty. We cannot have a real small pelvis and birth weights must not be excessive if we are to decrease calving difficulty.

Decreasing Birth Weight

We have already discussed the effect of nutrition on birth weight and indicated although there was some decrease in birth weight when heifers were fed low levels of feed, there was not a marked decrease in calving difficulty.

One other method that has been suggested for decreasing birth weight and calving difficulty is to breed Hereford heifers to Angus bulls. The data in Table 9 indicate no decrease in calving difficulty as a result of using Angus bulls on Hereford heifers, in fact, there was an increase from 24% when Hereford bulls were bred to Hereford heifers to 30% when Angus bulls were bred to Hereford heifers in 1963 and in

TABLE 8

Birth Weight and Pelvic Opening

Birth Weight	50-59 lbs.	60-69 lbs.	70-79 lbs.
	% Calving diff.	% Calving diff.	% Calving diff.
Pelvic area			
150-169	0	50	100
170-189	18	10	50
190-209	0	0	25
210-229	0	0	60

TABLE 9

Effect of Crossbreeding on Calving Difficulty
(2-Year-Old Heifers)

		1963		1964	
		No. Calves Born	% Calving Difficulty	No. Calves Born	% Calving Difficulty
Hereford	Hereford	84	24	64	52
Angus	Hereford	71	30	61	56
Hereford	Angus	67	29	56	64
Angus	Angus	55	26	55	59

the following year an increase from 52% to 56% was noted, so indiscriminate crossing of this type does not lead to a decrease in calving difficulty.

There are bulls, however, that can be used on heifers in both Angus and Hereford breeds that will decrease calving difficulty. The information in Table 10 points this out. There were two Angus bulls, 602 and 611, and three Hereford bulls, 702, 705 and 750, which sired calves where a lot of difficulty was encountered while only a little difficulty was encountered in heifers bred to Angus bulls 609 and 610 and Hereford bull 753. Consequently, selecting a bull to breed to heifers could be profitable. It should be noted that while the birth weight was decreased somewhat in bulls where calving difficulty was

TABLE 10

Effect of Sire on Calving Difficulty
in 2-Year-Old Heifers (1964)

	Angus Sires				Hereford Sires			
	602	609	610	611	702	705	750	753
No. calves born	30	30	29	25	29	34	35	22
Birth Weight (lbs.)	68	64	62	70	69	68	71	66
Cows experiencing calving difficulty (%)	44	13	20	36	31	40	23	13
Cows experiencing calving difficulty in which calf was presented abnormally (%)	3	3	7	4	3	8	3	9
Cows experiencing calving difficulty in which calf was presented normally								
Total (%)	41	10	13	32	28	32	20	4
Very difficult birth (%)	7	0	0	8	7	3	0	0
Pullers needed (%)	27	10	10	24	21	29	17	4
Slight difficulty (%)	7	0	3	0	0	0	3	0
Live calves at 24 hours (%)	87	100	93	96	96	100	94	100

less, this was not a marked decrease. It should also be stated that this type of bull cannot be determined by "eyeballing" but must be chosen on the basis of his performance.

Predicting Pelvic Opening

The relationships between size of the pelvis and calving difficulty noted here resulted from measurements taken on the pelvis approximately 100-120 days before expected calving. If a heifer has a small pelvis at this time, it is difficult to cull her and consequently about all that can be done is to watch the heifer at calving time and anticipate the calving difficulty. A better time to measure would be before the start of breeding season and then the heifers with a small pelvis would not be bred and could be sold for slaughter. In order to accomplish this effectively, the rate of growth of the pelvis from breeding to calving must be linear or the heifers which have a small pelvis at breeding must also be the ones with the small pelvis at calving.

A group of Angus heifers were measured at the time of breeding in May, again in November and again one to two weeks prior to calving and a few hours before calving (Rice and Wiltbank, 1970). The results indicate that the growth of the pelvis is not linear. The pelvis grew more rapidly from the November measurement to calving than it did from the measurement in May to the November measurement (Figure 1). Thus pregnancy appears to have a marked effect on growth of the pelvis. The pelvis also grew at a faster rate from two weeks prior to calving than it did prior to this time (Figure 2). Thus prediction of pelvic size at calving from a measurement taken at breeding would appear to be difficult. These heifers were ranked on the basis of pelvic

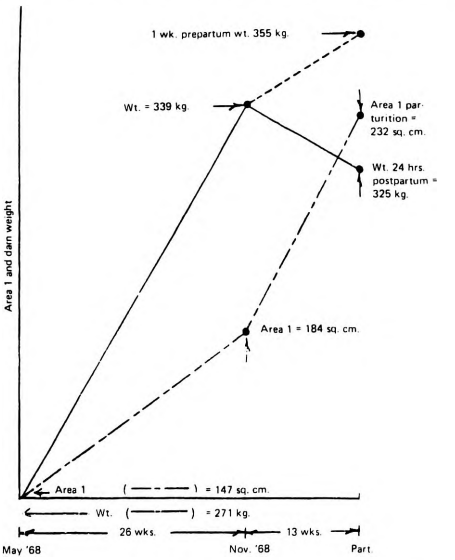

Figure 1: Rate of pelvic Area 1 expansion from breeding (May 1968) to parturition, 1969.

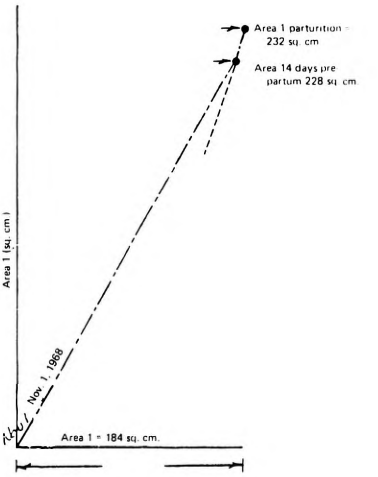

Figure 2: Rate of pelvic Area 1 expansion between Nov. 1968 and parturition, 1969.

size at breeding and then compared again 90 days before calving and at calving. To determine if heifers stayed ranked approximately the same, the heifers having the smallest pelvis at the first measurement were chosen. An arbitrary 15% were chosen and the number still in the bottom 15% and 20% at the next two measurements were determined.

It can be seen that 45% of the heifers having the smaller pelvis at breeding time were still in the bottom 15% when measured in November and 45% were still in the bottom 15% at calving. So, heifers

TABLE 11

Repeatability of Measurements in May and at Calving

No. heifers measured	74
15% with smallest pelvis (No.)	11
No. in bottom 15% at breeding	
in bottom 15% in November	5 (45%)
in bottom 20% in November	5 (45%)
No. in bottom 15% at breeding	
in bottom 15% at calving	5 (45%)
in bottom 20% at calving	6 (54%)
No. in bottom 15% in November	
in bottom 15% at calving	6 (54%)
in bottom 20% at calving	7 (64%)

TABLE 12

Repeatability of Measurements in
2-Year-Old Angus and Hereford Heifers
140 Days Before Calving and Near Calving

	Moderate	Low
No. heifers measured	138	85
Range in size at 140 days before calving	152-270	161-260
No. in 15% having smallest pelvis	21	13
No. in bottom 15% at 140 days before calving in 15% 1 week before calving	14 (67%)	9 (69%)
No. in bottom 15% 140 days before calving in bottom 20% 1 week before calving	18 (86%)	11 (85%)
No. in bottom 15% 140 days before calving in bottom 15% 2 weeks after calving	15 (75%)[a]	5 (56%)[b]
No. in bottom 15% 140 days before calving in bottom 20% 2 weeks after calving	17 (85%)[a]	6 (67%)[b]

[a]Measurements not available on 1 heifer 2 weeks after calving.
[b]Measurements not available on 4 heifers 2 weeks after calving.

tended to rank the same from one measurement to the next but it certainly leaves something to be desired. Data were available from two other groups, one group was measured 140 days before calving and again at calving time and the other has been measured every 28 days starting at breeding to approximately 90 days before calving. The results are shown in Tables 12 and 13. Again there is some repeatability but it certainly is not ideal.

TABLE 13

Repeatability of Measurements in Hereford Heifers from Breeding to 90 days before Calving

No. heifers measured	42
No. heifers in 15% having smallest pelvis	6
No. in bottom 15% at breeding in bottom 15% 90 days prior to calving	3 (50%)
No. in bottom 15% at breeding in bottom 20% 90 days prior to calving	4 (67%)

Pelvic Area in Older Cows

With the increasing use of exotic bulls, an increase in calving difficulty in older cows has been noted. This undoubtedly is a result of an increase in birth weight. With an increase in size of the calf at birth, the size of pelvis in mature cows becomes more important. The variation in pelvic size in mature cows can be seen in Table 14. Pelvic size varied from 230 sq. cm. to 409 sq. cm. Most of the cows have a pelvis greater than 300 sq. cm. Much of the calving difficulty encountered when mature cows are bred to exotic bulls might be related to pelvic size. The relationship between size of the pelvis and calving difficulty when cows are bred to bulls might give us a useful way to decrease calving difficulty.

TABLE 14

Pelvic Area in Cows 4-8 Years Old

Pelvic Area (Sq. Cm.)	No. Cows	% Cows Having This Size Pelvis
230-259	1	0.01
260-289	10	4
290-319	60	23
320-349	110	42
350-379	64	25
380-409	15	6
Total	260	

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