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THE EFFECTS OF AGE AT FIRST CALVING ON THE PRODUCTIVE AND REPRODUCTIVE PERFORMANCE OF BEEF COWS

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OPSOMMING: DIE INVLOED VAN OUDERDOM MET EERSTE KALWING OP DIE PRODUKSIE EN REPRODUKSIEVERMOË VAN DIE VLEISBEESKOEI

Die invloed van eerste kalwing by verse op 2 of op 3 jaar ouderdom is oor 'n ses-jaar periode bestudeer.

Oor 3 herhalings van die proef was die gemiddelde persent eerste besetting, herbesetting en kalfmortaliteit (distokia) van koeie wat óf as jaar-oud óf as twee-jaar-oud verse gepaar is onderskeidelik 58,6 vs 84,0, 82,0 vs 94,4 en 7,8 vs 3,6. Koeie wat vir die eerste keer op twee-jaar ouderdom gekalf het, het 0,6 meer kalwers geproduseer oor 'n produkteiwe lewe van 5 jaar teenoor koeie wat op drie-jaar ouderdom die eerste keer gekalf het.

Sewe liggaamsmates, nl. borsomtrek, hoogte by skof, hoogte by kruis, diepte van bors, lengte van lyf, wydte van draaibene en wydte van heupe asook liggaamsmassa is jaarliks opgeteken tot die ouderdom van 6 jaar, vir koeie wat óf op 2 óf op 3 jaar vir die eerste keer gekalf het. Slegs liggaamsmassa op 2 jaar en hoogte van skof op 3 jaar ouderdom is betekenisvol beinvloed deur vroeë kalwing. In beide hierdie gevalle het die verskille na een jaar verdwyn. Geen een van die oorblywende mates is betekenisvol beïnvloed nie. Dit dui daarop dat twee-jaar-oud-kalwing geen neerdrukkende invloed op groei tot op die ouderdom van 6 jaar het nie.

Melkproduksie van drie- en vier-jaar-oud koeie is nie beinvloed deur ouderdom van eerste kalwing nie. Ouderdom van die koei het egter melkproduksie betekenisvol beïnvloed. Die gemiddelde totale melkproduksie vir twee-, drie- en vier-jaar-oud koeie by 1, 3 en 5 maande laktasie, was onderskeidelik 8,49 kg, 11,63 kg en 15,20 kg.

SUMMARY:

Over a 6 year period, the effects of mating heifers to calve for the first time at 2 or at 3 years of age were studied.

Over 3 repetitions of the experiment the average per cent first conception, re-conception and calf mortality (dystocia) of females mated either as yearlings or as two-year-olds was 58,6 vs 84,0, 82,0 vs 94,4 and 7,8 vs 3,6 respectively. When calculations were based on a productive life of 5 years, cows calving for the first time as two-year-olds produced 0,6 more calves than those calving for the first time as three-year-olds.

Seven body measurements, viz. heart girt, height at withers, height at rump, depth of chest, length of body, width of thurls and width of hips as well as body mass were recorded at yearly intervals until 6 years of age, for cows that had calved for the first time at 2 or at 3 years of age. Only body mass at 2 years and height of withers at 3 years were significantly affected by early calving. In both these cases the differences had disappeared by the following year. Growth of the cows until 6 years of age was thus not depressed by the early calving.

Age at first calving did not affect the mean milk production of three- and four-year-old cows. However, age of the cow significantly affected milk production. The average total milk production for two, three- and four-year-old cows at 1, 3 and 5 months lactation, was 8,49 kg, 11,63 and 15,20 kg, respectively.

In South Africa many beef heifers are not mated until they are 3 years of age. This is due to the fact that large areas of the Republic have a low and erratic summer rainfall and the consequent limitation of available grazing results in sub-maximal pre- and post-weaning growth. In this environment replacement heifers attain the bodymass which is considered adequate for mating only during the latter stages of their second year of life, hence the delayed age of rist calving. In Northern Natal, however, first mating of three-year-old heifers seldom occurs as the majority of farmers are able to mate their

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heifers at 2 years of age. Mating of yearling heifers is practised by only a few farmers in this area. Besides the fact that the nutritional level which is commonly maintained does not support a growth rate that would allow mating earlier than at 2 years of age, many farmers beleive that mating at too early an age will greatly delay reconception. The possibility of a permanent stunting of the cow is a further factor which may militate against early mating. It is obvious, therefore, that the age at first parturition is highly dependent on the level of nutrition from weaning until first mating (Bernard, Fahmy & Lalande,1973; Carter & Cox, 1973; Gordon, 1976; Varner, Bellows & Christensen, 1977).

Having defined a management system for Northern Natal for wintering replacement heifers to calve at 3 years (Meaker, 1976a, b), it became necessary to investigate the possibility of calving heifers at 2 years of age. With the existence of a good potential for the production of home-produced roughages in Northern Natal it would seem an easy task to satisfy the nutrient requirements of the yearling heifer during the strategic winter months, i.e. from weaning until first mating (first winter) and during the second winter when the heifer is pregnant and/or lactating.

Although mating of yearlings is not universally accepted there has been a steady increase in the number of heifers calving at 2 years (Martin & Ellis, 1976).

According to Young (1974), mating of yearling heifers results in an increased rate of genetic improvement, early culling of less productive animals, increased total lifetime production and assists in selection for high milk production. Pinney, Pope, van Cotthem & Urban (1962) found that beef females calving first at 2 years of age produced almost 0,8 more calves per cow over their entire production life at 10% less total cost when compared with those females calving first at 3 years of age. The objective of the study to be reported here was to examine the influence of early calving (2 vs 3 years of age) on the productive and reproductive performance of beef females.

Procedure

Animals and treatments

Africander cross Sussex weaner heifers, approximately 8 months old, were used in the experiment which was replicated during 1973, 1974 and 1975. The number of heifers randomly allocated to the 2 treatments each year was 48 (1973), 43 (1974) and 60 (1975), respectively.

Group 1: Heifers fed maize silage *ad lib.* plus protein/mineral supplement during the first winter (High plane) and mated as yearlings.

Group 2: Heifers fed a restricted diet of maize silage plus protein/mineral supplement which ensured body mass daily gains of 0,1 kg to 0,2 kg per heifer over the first winter (Low plane) and then mated at 2 years of age. DM intake of silage for heifers fed the restricted diet was approximately 1,3% of body mass.

The experiment was initiated at the start of the 1973 winter and continued until the end of the winter of 1977. The protein/mineral supplement (CP approximately 42%) comprised of 37,5% maize meal, 25% sodium chloride, 18,8% dicalcium phosphate, 12,5% urea and 6,2% of a 40% high protein concentrate mixture (free of NPN).

During the second winter-feeding period both treatment groups received maize silage and/or *Eragrostis curvula* hay plus a protein/mineral supplement. The supplement consisted of 31% salt, 34% maize meal, 20% dicalcium phosphate and 15% urea (CP content approximately 48%). The quantities of silage and/or hay fed to the cattle were calculated to conform with the minimum DM requirements of beef cattle (NRC, 1970). On the average, the winter feeding treatments commenced in mid July and usually ceased towards the end of October. From approximately November of each year all the animals were allowed to graze veld and were permitted free access to the protein/mineral supplement from approximately mid March until mid November. During the remainder of the year a mineral lick consisting of equal parts of dicalcium phosphate and salt was offered to all the cows.

The heifers on the High and the Low planes of nutrition were exposed to breeding bulls when they were approximately 12 to 13 and 24 to 25 months of age, respectively. Commencing approximately October 10, both groups were exposed to bulls for only 45 days. The heifers that did not conceive and which recieved the High plane of nutrition were joined with the heifers on the Low-plant and mated as two-year-olds. This procedure ensured that the heifers that were too small to conceive as yearlings, were given an opportunity at 2 years of age. After calving for the first time the heifers of both groups were mated for 65 days and this period started approximately December 1. Only Sussex bulls were used. Each group was managed separately, and once they had calved, cows remained within the allotted treatment throughout the experiment. Group feeding was practised throughout the winter months.

In 1976, the 18 calves born to the heifers on the High plane of winter feeding (Group 1) were randomly divided according to sex, into 2 groups and allowed access to a creep ration containing either a High (20% CP) or a Low (12% CP) level of protein. Creep feeding continued until weaning.

Puberty

Within a week after weaning, i.e. at the start of the winter feeding period, three vasectomised bulls equipped with marking harnesses were placed in a pen which was separate from, but adjacent to, that in which the groups of heifers were run. The bulls were introduced to the heifers in the late afternoon and removed again the following morning. In addition to those heifers marked during the night a heifer was also considered to be in oestrus if she stood to be mounted by the bull or another heifer. Puberty was then defined as the age at which the heifer exhibited first oestrus and the body mass at puberty was interpolated from the recordings prior to, and subsequent to, first oestrus. Observations for puberty were not conducted while the heifers were on summer grazing.

Body measurements

The growth and development of the experimental females was quantified in terms of bodymass and body measurements, the latter being measured at 10, 22, 34, 46, 58 and 70 months of age. The measurements taken were circumference of heart girth, height at withers, height at rump, depth of chest, width at hooks, width at thurls and length of body (brisket to pin bones). At 22 months only the pregnant heifers on the High plane (Group 1) and non pregnant females on the Low plane (Group 2) were measured. Thereafter, measurements were confined to pregnant cows.

Milk production

During the summer of 1976/77 the milk production of cows that calved for the first, second or third time, was determined. These recordings were performed when the calves were approximately 40, 100 and 160 days of age. The milk production was estimated by the "calf nursing" method which involved separating the calves from their mothers at 12h00 the day preceding the actual test. The calves were penned while the cows returned to their grazing camps. At 18h00 the calves were allowed to suckle and thereafter penned again until 05h30 the following day. The calves were then weighed, allowed to suckle until the first calf stopped suckling and immediately thereafter all the calves were reweighed to the nearest 0,5 kg. The same procedure was repeated at 11h30 and 17h30. The change in mass at each suckling was assumed to equal the quantity of milk consumed by the calf and the total obtained for the 3 recordings was regarded as the total milk production by the cow for that day.

Statistical analysis

Mean differences in data were compared by means of Student's t-test, analysis of variance with samples of unequal size and by least-squares analysis of variance. Enumerative data was compared using Chi-square.

Results

The average daily intake of lick, maize silage and *E. curvula* hay per cow during the relevant winter-feeding periods for cows calving for the first time at either 2 or 3 years of age are summarised in Table 1.

The average percentage conception for yearlings and two-year-old heifers, (Table 2) calculated over 3 years, was 58,6% and 84,0%, respectively ($P < 0,10$). Only 70% of the yearlings exhibited oestrus by the start of the breeding season (average for 3 years) idicating that not all the heifers showing oestrus conceived. As first-calvers the average reconception percentages of the two-year-olds was 82,0% and that of the three-year-olds was 94,4%. The calf losses due to dystocia were higher amongst the heifers calving at 2 years of age (7,8% – average over 3 years) compared with those heifers calving at 3 years of age (3,6% – average over 3 years). Assistance at the first parturition was necessary for an average of 9,8 % of the two-year-old heifers while none of the heifers calving for the first time at 3 years of age had to be assisted (Table 2).

When the heifers were fed either a high or a low plane of nutrition after weaning, the mean body mass at puberty was 241,2 ± 31,1 kg ($n = 68$) and 226,5 ± 25,1 kg ($n = 27$), respectively. The mean difference of 14,7 ± 6,7 kg in favour of the heifers fed a high plane of nutrition had no significant effect on the mean age at which the 2 groups of heifers attained puberty (High: 337,5 ± 52,3 days vs Low: 351,3 ± 50,0 days). In addition, plane of nutrition had no significant effect on the length of the oestus cycle (High: 21,01 ± 4,07 days, $n = 67$ vs Low: 21,43 ± 5,87 days, $n = 14$). Age at first calving also had no significant effect on the interval to post partum oestrus. The mean interval for the cows calving for the first time at either 2 or 3 years of age was 73,1 ± 12,9 days (range 43 to 95, $n = 18$) and 69,9 ± 15,3 days (range 44 to 111, $n = 20$), respectively.

The birth mass of the calves born to two-year-old cows was lower in all replications of the experiment when compared with calves born to three- and four-year-old cows. Only the difference between calves produced by two-vs three-year-old cows (cows born in 1972) was significant ($P < 0,05$). Age of the cow at first calving had no significant effect on birth mass of the calves which were produced at subsequent calving (Table 3).

Exceptionally poor weaning masses were recorded for calves born to the two-year-old cows (Table 3). The creep ration provided to the calves from dams born in 1974 resulted in a significantly ($P < 0,01$) improved average weaning mass. The results also indicated that the weaning masses of the calves improved as the age of the cows increased. For example, the cows born in 1972 produced calves with average weaning masses of 129,5 kg, 147,0 kg and 155,1 kg when the cows were 2, 3 and 4 years of age.

Table 1

Average daily intakes (kg) of lick, maize silage and E. curvula per cow during the respective winters for cows bred to calve for the first time either at 2 or 3 years of age

		Age of cows at first calving							
		2 years				3 years			
		W1	W2	W3	W4	W1	W2	W3	W4
Cows born in 1972:									
Average intake of	lick (kg/cow/day)	0,656	0,726	0,267	0,379	0,307	0,595	0,262	0,379
Average intake of	silage (kg/cow/day)	15,0	–	–	–	7,5	15,0	–	–
	pre partum	–	15,0	5,3	12,0	–	–	5,4	12,4
	post partum	–	20,0	11,9	27,0	–	–	11,5	27,0
Average intake of	*E. curvula* hay (kg/cow/day)								
	pre partum	–	–	4,7	3,3	–	–	4,8	3,4
	post partum	–	–	6,6	–	–	–	6,4	–
Cows born in 1973:									
Average intake of	lick (kg/cow/day)	0,826	0,294	0,354	–	0,656	0,258	0,354	–
Average intake of	silage (kg/cow/day)	12,5	–	–	–	7,5	7,4	–	–
	pre partum	–	4,8	13,0	–	–	–	14,1	–
	post partum	–	9,5	25,0	–	–	–	25,0	–
Average intake of	*E. curvula* hay (kg/cow/day)	–	–	–	–	–	4,8	–	–
	pre partum	–	4,2	3,6	–	–	–	3,9	–
	post partum	–	5,2	–	–	–	–	–	–
Cows born in 1974:									
Average intake of	lick (kg/cow/day)	0,484	0,798	–	–	0,502	0,561	–	–
Average intake of	silage (kg/cow/day)	14,7	–	–	–	8,4	23,1	–	–
	pre partum	–	20,9	–	–	–	–	–	–
	post partum	–	22,4	–	–	–	–	–	–

W1, W2, etc. = First winter, second winter, etc. after weaning

Table 2

Calving rate, incidence of dystocia and cows assisted at calving, for cows born in 1972, 1973 and 1974 and bred to calve forthe first time at 2 or 3 years of age

		Females bred to calve for the frist time at: 2 years				3 years		
		Annual calvings				Annual calvings		
		1	2	3	4	1	2	3
Cows born in 1972:								
No. of cows mated		24	15	15	14	32	29	29
Cows calved	(%)	62,5	86,7	80,0	92,8	93,7	96,5	72,4
Dystocia	(%)	6,7	–	–	–	10,0	–	–
Assisted at calving	(%)	20,0	–	–	–	–	–	–
Cows born in 1973:								
No. of cows mated		22	16	16	–	27	25	–
Cows calved	(%)	72,7	68,7	100,0	–	92,6	92,0	–
Dystocia	(%)	12,5	–	–	–	–	–	–
Assisted at calving	(%)	12,5	–	–	–	–	–	–
Cows born in 1974:								
No. of cows mated		41	19	–	–	41	–	–
Cows calved	(%)	48,8	89,5	–	–	70	–	–
Dystocia	(%)	5,0	–	–	–	–	–	–
Assisted at calving	(%)	–	–	–	–	–	–	–

Table 3

Birth mass and corrected weaning mass at 205 days of calves born to cows of different ages (kg)

	Cows calving for the first time at: 2 years		3 years	
	Birth mass	Weaning mass	Birth mass	Weaning mass
Cows born in 1972 and calving at:				
2 years	27,4 ± 4,6	129,5 ± 22,7	–	–
3 years	34,1 ± 1,7	147,0 ± 18,2	31,1 ± 3,5	151,1 ± 18,2
4 years	32,1 ± 3,2	155,1 ± 22,7	31,1 ± 4,0	148,8 ± 18,5
Cows born in 1973 and claving at:				
2 years	28,2 ± 3,8	123,1 ± 17,4	–	–
3 years	30,1 ± 3,1	131,8 ± 18,2	30,2 ± 2,7	133,4 ± 12,7
Cows born in 1974 and calving at:				
2 years	26,1 ± 4,1	151,4 ± 22,9		–

Table 4

Intake of the creep ration by the calves, change in mass of the cows over the creep feeding period and 205 day corrected weaning mass of the calves

	CP content of the creep ration: 20%	12%
Intake of creep ration over 153 days (kg/calf/day)	1,056	0,877
Gain in mass of cows over creep feeding period (kg)	16,4	23,1
205 day corrected weaning mass of calves (kg)	161,6	149,3

respectively. The differences between consecutive years were significant ($P < 0,05$). In addition, calving for the first time at either 2 or 3 years of age had no significant effect on the average weaning mass of the calves by the time the cows calved as three- and four-year olds (Table 3). The generally poor weaning weights obtained during the course of the experiment may have been due to *Chlamydia* infection. The CP content of the creep rations had no significant effect on the 205 day corrected weaning mass of the calves (Table 4). However, it would appear that the weaning mass of the calves was favoured by the 20% creep ration, hence a difference of 12,3 kg in weaning mass between the 2 groups of calves. In addition, the 2 creep rations had no significant indirect effect on the gain in mass of the cows over the experimental period (Table 4).

The level of CP in the creep ration had no significant effect on the milk production of two-year-old cows (Table 5). Furthermore, early calving had no significant effect on the average milk production of either three- or four-year-old cows, but four-year-old cows were found to produce significantly ($P < 0,05$) more milk than three-year-old cows and three-year-old cows in turn produced significantly more milk than two-year-olds ($P < 0,05$, Table 5).

When the effect of age of first calving, and of calving annually thereafter on the growth and development of the cow from one year until 6 years of age was evaluated it was evident that early calving had no major effect on the 8 growth variables recorded. Only in 2 instances were significant differences ($P < 0,05$) noted in the growth and development of the cow viz. body mass at 2 years and height of withers at 3 years (Fig. 1). It would appear from the graphs that no meaningful growth was recorded after 4 years of age and the cows reached their maximum mass at 6 years of age.

Discussion

The results of this trial clearly showed the beneficial effects which early calving had on the productive and reproductive performance of beef cows. After 5 years, the average cow that had calved first at 2 years of age had produced 0,6 more calves and 129,8 kg more weaner mass than those that calved first at 3 years. Pittaluga, Rovira & Madalena (1967) recorded 0,71 more calves from early calvers after 4 years, while Pinney *et al.* (1962) reported 0,8 more calf per cow over their entire production life. The difference in weaner production between cows calving for the first time at 2 years and those at 3 years ranged from about 140 kg to 107 kg up to 7 years (Bernard *et al.*, 1973), and 154 kg over approximately 12 years (Pinney *et al.*, 1972). Yearling mating therefore resulted in increased total lifetime production.

Table 5

Effect of 2 levels of protein in the creep ration of the calves, age of cows and age of cows at first calving on the mean daily milk production of cows at 1, 3 and 5 months of lactation period (kg)

	Age of cows (years): 2		3		4	
	CP content of creep		Age of cows at first calving (years)			
	20%	12%	2	3	2	3
Milk production of cows at:						
1 month	3,83	4.11	5,24	4,49	5,43	5,06
3 months	2,44	2,72	4,29	3,34	5,46	5,00
5 months	1,81	2,06	2,74	2,74	5,00	4,44
Total	8,08[a]	8,89[a]	12,26[b]	11,00[b]	15,89[c]	14,50[c]

Means have the same superscript are not significantly different from one another

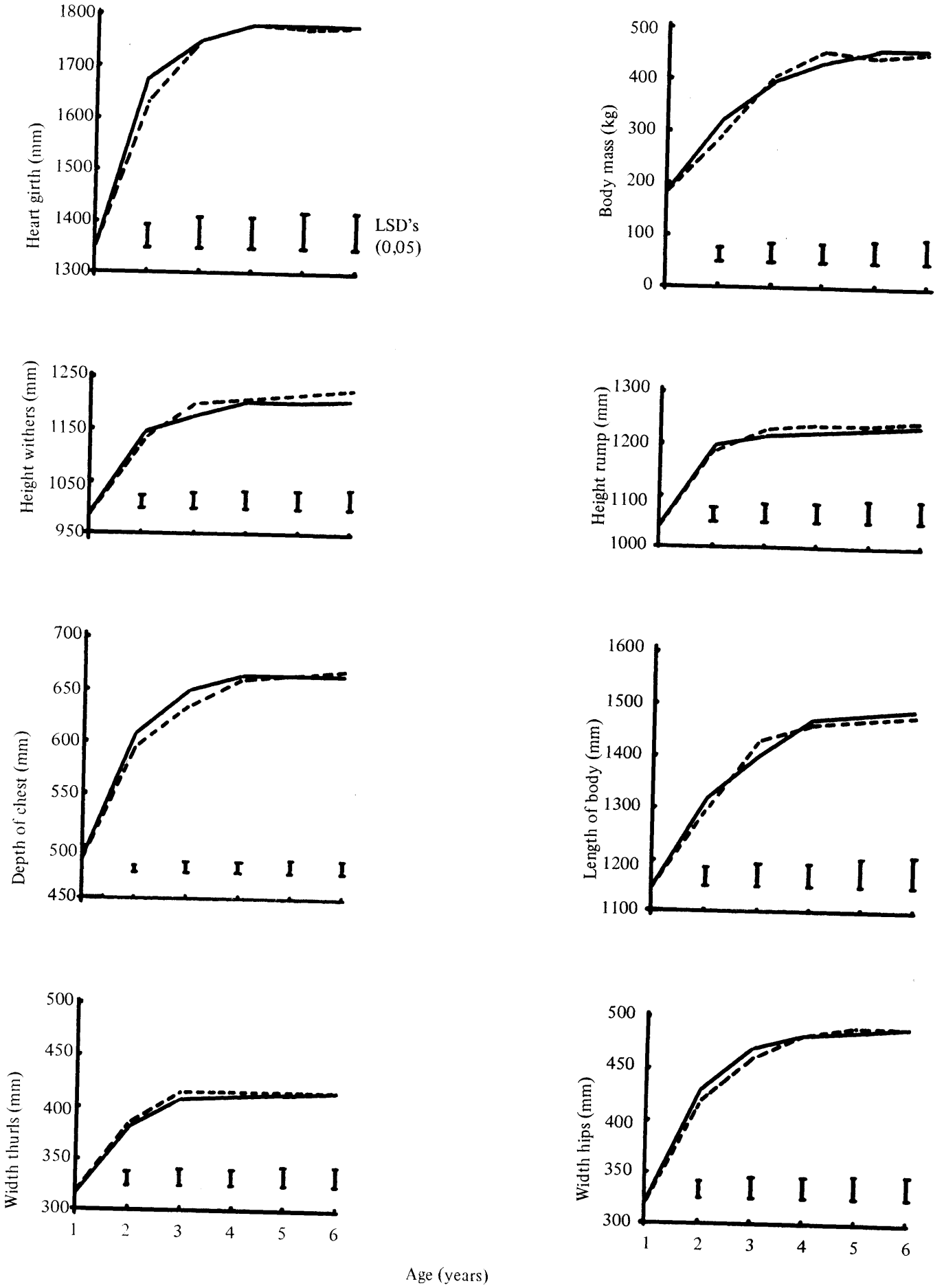

Fig. 1 The effect of calving at 2 (— —) or 3 (- - - -) years of age on body measurements over 6 years

The loss of calves at birth was due to calving difficulty or dystocia. The exact reasons for these losses are difficult to assess. Factors such as high birth mass of the calves, heifers which were not well grown and extremes of nutrition (Stachan & Wythes, 1976) may have contributed to the high incidence of dystocia. The incidence recorded in this trial was markedly similar to the 12% reported by Wythes, Strachan & Durand (1976), although Short (1976) obtained a figure of 6% when heifers were mated as yearlings. If calf losses could be reduced by judicious selection of heifers to be mated and of sires likely to produce calves that do not cause problems at parturition, then the lifetime production of herds in which early calving is practised is likely to be considerably improved.

Contrary to the belief that mating at too early an age would result in permanent stunting of the female animal, the results from this experiment showed that two-year-old calving had no depressing effect on the 8 growth variables measured from one until 6 years of age. Although in certain instances (height at withers and rump height) the trend favoured three-year-old calving, this was not significant. These findings are therefore contrary to the belief held by some, viz. that mating at too early an age results in permanent stunting of the female animal. Other deterrents to early breeding mentioned by Carter & Cox (1973), are the expectation of calving difficulties, the fear of physical damage to lightweight heifers joined with mature herd bulls and the smaller size at birth and weaning of calves born to two-year-old dams. Although increased calving difficulties and smaller calves at birth and at weaning were recorded with the two-year-old heifers, the advantages overwhelmingly favoured the mating of yearling heifers.

It is obvious that if high calving percentages are to be obtained with two-year-old heifers, they must attain puberty at least before the mating period is terminated. Age at puberty, therefore becomes increasingly critical if management demands that heifers be mated as yearlings. When mated at such an early age, a delayed onset of puberty can very often lead to a reduced reproductive performance of the group as a whole. Martin (1976) suggests that, given good conditions, there is no reason why calving percentages among yearling-mated heifers cannot be in the region of 95 per cent. Although the average mass of the heifers at puberty was 236 kg, the highest conception (81%) was recorded when the average mass at joining was 285 kg. There was no justification for a further increase in the body mass at joining. According to the results obtained here it seems unlikely that conception rates as high as 95% can be achieved. Swanson, Hafs & Morrow (1972), presented data on pituitary and ovarian hormones in post-puberal cattle which showed that maturation of the reproductive system continued well beyond the first heat. This means that breeding a heifer after several oestrous cycles may result in a higher conception rate than after the first heat period. This type of response has been observed in gilts mated at either the first, second or third oestus after puberty (MacPherson, Hovell & Hones, 1977). The data recorded in this trial suggest that around the time of puberty the reproductive mechanisms are still developing and the possibility exists that a fair proportion of the heifers may not have ovulated at the first standing heat.

The data on milk production indicated that the milk yield of three and four-year-old cows was not influenced by age at first calving (Table 5). Cowan, O'Grady & Moss (1974) found livemass at calving to be related to milk production, and not age at first calving. In the present investigation the milk yield was significantly influenced by the age of the animal. Four-year-old cows produced significantly ($P < 0,05$) more milk than three-year-old cows, while the latter in turn yielded significantly ($P < 0,05$) more than two-year-old cows. The reduction in milk yield from the first until the fifth month of lactation was more marked among the two- and three-year-old cows than the four-year-olds. The difference in milk production, expressed as a percentage of milk yield at one month, for the two- and the four-year-old cows, was 51% and 10% respectively. The decline in milk production over the lactation period under discussion, was therefore more rapid among the two-year-old cows than for the four-year-olds. When Cummins & Kroker (unpublished data) used two-year-old Hereford heifers they observed a peak yield of 4 kg milk per day which had declined to 2 kg by the seventh month of lactation (Bishop, Cummins & Morgan, 1975). Very similar milk yields were recorded in this trial after one and 5 months of lactation.

An economic assessment of this trial revealed a margin above winter feed costs (total weaner mass produced less total winter feed costs over 4 winters) of R140,12 and R42,74 for cows calving for the first time at 2 and 3 years, respectively. The difference in margins was due to the greater weaner mass produced by the cows calving for the first time at 2 years. Although total winter feed costs were higher for these cows, primarily due to higher feed cost during the first winter, the income from total calf production was such that it more than offset the increased feed costs. Obviously, the relative difference would narrow if the assessment was made over the entire productive life of a cow. It is doubtful, however, whether cows calving for the first time at 3 years would ever offset the extra fraction of one weanling calf produced by the cows calving at 2 years.

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