DROUGHT FEEDING STUDIES WITH CATTLE

8. EARLY WEANING OF BEEF CALVES

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SUMMARY

Two experiments on the early weaning of beef calves as a drought relief measure are described. As the calves had been suckling dams used in studies on drought feeding, they were poorly grown at weaning. The duration of both experiments was 6 weeks.

In one experiment, 19 Hereford calves were weaned at a mean age of 62 days and mean body-weight of 94 lb on to a ration of equal parts of lucerne chaff and crushed sorghum gain *ad lib.* The mean body-weight gain and mean feed intake were 1·1 and 5·07 lb per head per day respectively. There were no deaths.

The calves used in the second experiment had been suckling dams that had received restricted all-grain rations containing negligible carotene for 24 weeks in late pregnancy and early lactation. The calves were weaned on to a ration of crushed sorghum grain *ad lib.* when their mean age was 70 days and mean body-weight 106 lb. The average gain in body-weight was 0·48 lb per head per day, while mean grain consumption was 3·27 lb per head per day. Two deaths occurred. These two calves had low liver vitamin A reserves, and some of the other calves showed nyctalopia and low plasma vitamin A levels at the end of the experiment.

Determination of blood haemoglobin, packed cell volume, glucose, inorganic phosphate; and serum calcium, magnesium, total protein, albumin and globulin were made on calves at the beginning and end of the second experiment. Although there were some differences between initial and final values in some constituents, they were comparable to those obtained in Hereford calves of similar age suckling dams that were grazing the pastures at the Animal Husbandry Research Farm, Rocklea.

I. INTRODUCTION

Previous papers in this series have been concerned with the feeding for survival of maiden yearling heifers (Morris 1958*a*, 1958*b*, 1958*c*; Ryley, Gartner, and Morris 1960) and pregnant and lactating cattle (Ryley 1961; Ryley and Gartner 1962). Another aspect requiring attention in the study of feeding cattle for survival during droughts is the early weaning of calves. This practice would remove the stress of lactation and could minimize losses in the breeding herd. If some grazing is available, this may meet the survival requirements of the dry cows, whereas the calves with their lower total feed intake could be fed separately and more economically.

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It is considered that to be of practical value under the present extensive system of beef cattle management in Queensland, rations to be fed for survival of beef calves would require to be less expensive and less complex than those usually recommended for early-weaned dairy calves.

The results of two experiments on early weaning of beef calves are presented in this paper. The first experiment was designed to evaluate a ration of equal parts of lucerne chaff and crushed sorghum grain fed *ad lib.* and the second experiment was to study the effect of feeding an all-grain ration of crushed sorghum *ad lib.*

II. MATERIALS AND METHODS

(i) *Fodder.*—In Experiment 1 both the lucerne chaff and the crushed sorghum grain were purchased as single lines and used throughout the experimental period. The lucerne chaff was green and leafy. The crushed sorghum grain used in Experiment 2 was from the same batch as that used by Ryley and Gartner (1962).

(ii) *Experimental Animals.*—The 19 calves used in Experiment 1 were those surviving at the conclusion of studies on the feeding of pregnant and lactating cattle for survival on sorghum silage alone and with supplements of urea (Ryley 1961). They were weaned at the conclusion of the experiment, when their mean age was 62 days (range 44–77 days) and mean body-weight was 94 lb (range 64–128 lb). In addition to the dam's milk, each calf was introduced to a creep mixture of equal parts of lucerne chaff and crushed sorghum grain fed *ad lib.* when it was between 4 and 5 weeks of age. The mean period calves had received the supplement prior to weaning was 29 days.

The 20 calves used in Experiment 2 were weaned at the conclusion of an experiment on the feeding of pregnant and lactating cattle for survival on a ration of crushed sorghum grain (Ryley and Gartner 1962). Their mean age was 70 days (range 56–85 days) and mean body-weight was 106 lb (range 57–146 lb) at weaning. For the 28 days immediately prior to weaning all calves had access to crushed sorghum grain available *ad lib.* in a creep.

(iii) *Experimental Yards and Facilities.*—Both experiments were conducted in yards described by Ryley, Gartner, and Morris (1960).

(iv) *Body-weight.*—The body-weights were obtained by individually weighing the calves on a cattle-weighing scale calibrated in 2-lb divisions.

(v) *Methods of Chemical Analyses.*—Analytical methods employed were as follows: proximate analyses of feed and residues, Association of Official Agricultural Chemists (1955); blood haemoglobin, Donaldson *et al.* (1951); packed cell volume (P.C.V.), Wintrobe (1947), employing heparinised blood and a relative centrifugal force of approximately 2067 *g*; blood glucose, Mendel, Kemp, and

Myers (1954); blood inorganic phosphate, Moir (1954); serum calcium, modification of the method of Clark and Collip (1925); serum magnesium, modification of the method of Holzapfel (1934); serum total protein, albumin and globulin, Gornall, Bardawill, and David (1949) and plasma vitamin A, Peirce (1945). In the determination of blood glucose the blood was added to the trichloracetic acid solution immediately after the sample was drawn. After centrifuging, an aliquot was either analysed within 6 hr or stored in a deep-freeze until analysed. The extraction and determination of vitamin A in liver were as described by Gartner and Ryley (1956).

(vi) *Observations and Recordings.*—The duration of both experiments was six weeks.

In both experiments the calves were weighed at a standard time (8 a.m.–8.30 a.m.) at weekly intervals. Water and feed were available *ad lib.* prior to weighing.

The calves were fed once daily, the previous day's residues being placed on top of the freshly added feed. The amount fed depended on visual observation of the amount of residues left from the previous day. On the weekly weighing day, the residues were removed and weighed. The mean daily consumption for each week was calculated from the amount fed less the residue.

Samples of feed were obtained at the rate of 1 lb per 200 lb fed. These samples were bulked and subsampled for analysis at the end of the experiment. The residues from all groups in Experiment 1 were bulked and subsampled for analyses at the end of the experiment. In Experiment 2, the residues were fed back to the calves, except when they were fouled. No residues were retained for analyses.

In Experiment 2, blood haemoglobin, P.C.V., inorganic phosphate and glucose; and serum calcium, magnesium, total protein, albumin and globulin were determined on samples obtained on the day prior to the commencement of early weaning (initial) and again on the second last day of the experiment (final). Samples for plasma vitamin A were obtained at the final bleeding. Two calves that died were autopsied within 12 hr of death and their livers analysed for vitamin A.

Calves from Experiment 2 were driven through a maze at dusk on the last day of the experiment to obtain information on the incidence of nyctalopia.

Calves in Experiment 2 were observed daily for a period of approximately 10 min for evidence of rumination and geophagia. Regurgitation and subsequent chewing was regarded as rumination, no examination being made to determine whether a bolus was in the buccal cavity.

III. EXPERIMENT 1

(a) Design

All calves were retained in their original groups, and received a ration of equal parts of lucerne chaff and crushed sorghum grain *ad lib.* The grouping was dependent on the treatments received by their dams during late pregnancy and early lactation. These were:—

Group I—sorghum silage *ad lib.*

Group II—sorghum silage *ad lib.* plus 1·5 oz urea and 0·14 oz sodium sulphate per head per day.

Group III—sorghum silage *ad lib.* plus 2·5 oz urea and 0·18 oz sodium sulphate per head per day.

(b) Results

The proximate analyses of the ration and the combined residues from all three groups are shown in Table 1. The residue, which was 2·8 per cent. of the total feed provided, was higher in crude protein, crude fibre and ash and lower in nitrogen-free-extract and ether extract than the feed offered.

All calves survived the experimental period of 6 weeks. The group mean changes in body-weight and mean daily feed consumption per head are shown in Table 2. The mean rate of gain varied from 1·0 lb per head per day for calves in Group I to 1·2 lb for Group II calves. The differences in gain between groups were not significant. There were no significant differences between sexes, although males gained 2·1 ± 5·7 lb more than females.

The feed consumption rose gradually in all groups as the experiment progressed. The mean consumption per head per day for all calves for the duration of the experiment was 5·07 lb.

IV. EXPERIMENT 2

(a) Design

All calves were retained in their original groups, and fed *ad lib.* on a ration of crushed sorghum grain, to which was added 1 per cent. ground limestone. The grouping was dependent on the treatments of their dams during late pregnancy and early lactation. These were:—

Group I—6 lb of crushed sorghum grain per head per day fed daily.

Group II—6 lb of crushed sorghum grain per head per day fed twice-weekly.

Group III—10 lb of crushed sorghum grain per head per day fed daily.

TABLE 1

PROXIMATE ANALYSES OF LUCERNE CHAFF/SORGHUM GRAIN RATION AND RESIDUE IN EXPERIMENT 1

Sample	Moisture (%)	Crude Protein (%)	Ether Extract (%)	Crude Fibre (%)	N.F.E. (%)	Ash (%)	Ca (%)	P (%)
Feed—as fed	9·6	13·2	2·8	14·2	55·2	5·0	0·49	0·29
—dry-matter basis		14·6	3·1	15·7	61·1	5·5	0·54	0·32
Residue—as fed	13·6	13·8	1·6	20·1	43·4	7·5	0·48	0·29
—dry-matter basis		15·9	1·9	23·2	50·3	8·7	0·55	0·33

TABLE 2

GROUP MEAN BODY-WEIGHTS, STANDARD ERRORS OF MEANS AND GROUP AVERAGE FEED INTAKES OF HEREFORD CALVES IN EXPERIMENT 1

Group	No. of Calves	Sex Ratio M : F	Initial Mean Age (days)	Mean Body-weight (lb)				Mean Feed Consumption (lb/head/day-air-dry basis)
				Initial	Final	Gain	Gain* Adjusted for Date of birth	
I	5	2 : 3	62·6	85·2	126·4 ± 12·8	41·2	40·8 ± 5·1	4·69
II	7	4 : 3	63·7	100·0	151·1 ± 10·2	51·1	49·7 ± 4·3	5·46
III	7	2 : 5	60·1	94·0	140·9 ± 8·9	46·9	48·6 ± 4·3	4·95

* The regression coefficient of gain on date of birth was significant and gain has been adjusted.

(b) Results

The proximate analysis of the sorghum grain fed expressed as percentages was as follows:—

Moisture	Crude Protein	Ether Extract	Crude Fibre	NFE	Ash	P	Ca
10·3	9·2	2·4	1·4	75·6	1·1	0·23	0·04

Two calves from Group II died during the experimental period. Both calves were similar in age to the mean of all calves, but their body-weight was considerably lower than the mean. One calf was 65 days of age and 60 lb in body-weight at the commencement of the experiment. It gained 2 lb during the first three weeks and died during the fourth week. The main autopsy findings were:—poor condition, nine hairballs 1-3 cm in diameter in the rumen, two hairballs in the pyloric sphincter, causing obstruction, and one hairball 1 cm in diameter in the large intestine. Death was attributed to malnutrition complicated by pyloric obstruction. The other calf was 64 days of age and weighed 69 lb initially. It lost 5 lb during the first two weeks and died during the third week of the experiment. At autopsy, the calf was in poor condition and had one hairball 4 cm in diameter in the rumen. Death was attributed to malnutrition. Both calves had deficient liver vitamin A concentrations of <1 μg/g.

The group mean changes in body-weight of surviving calves and mean daily feed consumption per head are shown in Table 3. The mean rate of gain varied from 0·45 lb per head per day for calves in Group I to 0·51 lb per head per day for Group II calves. The differences in gain between groups were not significant. The grain consumption in all groups rose gradually as the experiment progressed. The mean consumption per head per day for all calves for the duration of the experiment was 3·27 lb.

Some calves in all groups were observed ruminating during the experiment. One calf in Group I showed transient subcutaneous oedema of the sub-maxillary space during the fourth week of the experiment. Geophagia was evident in calves in all groups.

The means of the initial and means and standard errors of final values for blood haemoglobin, P.C.V., glucose and inorganic phosphate; and serum calcium, magnesium, total protein, albumin and globulin are given in Table 4. There were no significant differences among group final values for any determination. The final values for blood haemoglobin, P.C.V. and blood glucose were lower than initial values in all groups. With the exception of blood haemoglobin in Group II, all these differences were significant. The final values for blood inorganic phosphate were lower and for serum globulin were higher than initial values in all groups. The differences were significant only in the case of Group III. The final serum magnesium levels were significantly higher than initial levels in Group III.

TABLE 3

GROUP MEAN BODY-WEIGHTS, STANDARD ERRORS OF MEANS AND GROUP AVERAGE FEED INTAKE OF HEREFORD CALVES IN EXPERIMENT 2

Group	No. of Calves	Sex Ratio M : F	Initial Mean Age (days)	Mean Body-weight (lb)			Mean Feed Consumption (lb/head/day-air-dry basis)
				Initial	Final	Gain	
I	5	2 : 3	71	95·8	114·8 ± 19	19	3·24
II	6*	3 : 3	75	94·3	115·8 ± 10	21·5	2·89
III	7	4 : 3	67	136·3	156·4 ± 4·3	20·1	3·61

*There were originally 8 calves in this group, but 2 died during the course of the experiment.

TABLE 4

GROUP MEANS AND THEIR STANDARD ERRORS FOR BLOOD AND SERUM ANALYSES OF HEREFORD CALVES IN EXPERIMENT 2

Group	I		II		III	
Period	Initial	Final	Initial	Final	Initial	Final
Determination :—						
Blood haemoglobin (g/100 ml)	13·5	11·0 ± 0·7 *	13·5	11·7 ± 0·6	14·0	12·2 ± 0·6 *
P.C.V. (%)	43·0	33·8 ± 1·8 ***	41·4	35·8 ± 1·7 **	46·5	38·7 ± 1·6 ***
Blood glucose (mg/100 ml)	55·8	43·2 ± 2·1 ***	48·8	43·7 ± 1·9 *	52·7	47·8 ± 1·9 **
Blood inorganic P (mg/100 ml)	6·7	6·3 ± 0·3	5·8	5·4 ± 0·3	6·6	5·6 ± 0·2 **
Serum Ca (mg/100 ml)	10·7	11·0 ± 0·3	11·2	11·6 ± 0·2	11·0	11·0 ± 0·2
Serum Mg (mg/100 ml)	2·7	2·7 ± 0·12	2·7	2·9 ± 0·11	2·7	2·9 ± 0·1 *
Total serum protein (g/100 ml)	5·6	5·6 ± 0·2	5·5	5·8 ± 0·2	5·7	6·0 ± 0·2
Serum albumin (g/100 ml)	3·2	3·0 ± 0·11	3·2	3·1 ± 0·1	3·4	3·2 ± 0·09
Serum globulin (g/100 ml)	2·4	2·6 ± 0·2	2·3	2·7 ± 0·1	2·2	2·8 ± 0·1 **

* Significantly lower or higher than initial value at 5% probability level.
** Significantly lower or higher than initial value at 1% probability level.
*** Significantly lower or higher than initial value at 0·1% probability level.

The plasma vitamin A levels and presence or absence of nyctalopia for the individual calves are shown in Table 5. The plasma vitamin A levels ranged from <4 to 23μg/100 ml. Night blindness was evident in 5 of the 7 calves with levels of 8 μg/100 ml or less and was most marked in the two calves with <4 μg of vitamin A/100 ml of plasma. Both these calves were scouring, while the consistency of the faeces of the remaining 16 calves was considered to be normal.

TABLE 5

PLASMA VITAMIN A LEVELS AND OCCURRENCE OF NYCTALOPIA IN HEREFORD CALVES IN EXPERIMENT 2

Group	Plasma Vitamin A (μg/100 ml)	Nyctalopia
I	13·0	−
	13·0	−
	8·5	−
	8·5	−
	8·0	+
II	15·0	−
	10·0	−
	7·0	+
	5·5	+
	17·0	−
	17·0	−
III	7·0	−
	23·0	−
	13·0	−
	9·5	−
	<4·0	+
	<4·0	+
	8·0	−

V. DISCUSSION

The early weaning of calves to milk substitutes fed either as a liquid or as dry meals has received considerable attention in recent years. Some aspects have been reviewed by Roy (1956) and Preston (1957). These findings are more directly related to the rearing of dairy calves where complex rations are fed to maintain a satisfactory growth rate. Because of their nature, cost and availability, such early-weaning rations are unlikely to be fed to beef calves in Queensland as a drought relief measure.

In the two experiments reported in this paper, Hereford calves were weaned at mean ages of 62 days (Experiment 1) and 70 days (Experiment 2). In both experiments, the calves were the progeny of cows that were being used in drought feeding experiments. Despite supplementation of the calves with a creep feed for approximately four weeks prior to weaning, calves from most groups were poorly grown and were considered to be comparable with calves which graziers would contemplate weaning and feeding in droughts.

The calves in Experiment 1, fed a mixture of equal parts of lucerne chaff and crushed sorghum grain, gained weight at a satisfactory rate (mean 1·1 lb per head per day) and all survived. The slightly older calves of slightly higher initial mean body-weight fed crushed sorghum grain in Experiment 2 for the same period of time gained weight at a much slower rate (0·48 lb per head per day). Two calves died in the latter experiment. These differences can be explained on nutritional grounds. The mean intake per head per day of the lucerne chaff/crushed sorghum grain mixture fed in Experiment 1 was 5·07 lb. The calculated intake of nitrogen, based on figures obtained by proximate analysis, was 48·6 g per head per day and the total digestible nutrients (T.D.N.) intake based on T.D.N. content of lucerne chaff and sorghum (milo) as given by the National Research Council (1958 *b*) was 3·3–3·4 lb per head per day. The comparable figures for Experiment 2 were total intake of crushed sorghum grain 3·27 lb, calculated nitrogen intake 21·9 g, and calculated T.D.N. intake 2·6 lb per head per day. The figures quoted by the National Research Council (1958 *a*) for normal growth of dairy heifers (0·8 lb daily gain) in large breeds are 0·62 lb protein (44·9 g N) and 2 lb T.D.N. It would thus appear that nitrogen intake rather than energy intake was limiting growth of calves in Experiment 2. The subsequent findings of Gartner and Ryley (1962 *a*) suggest that the low vitamin A status in some calves in Experiment 2 could also have adversely affected their growth rate and feed consumption.

In both experiments, observations were restricted to six weeks as it was considered that this would include the critical period after early weaning. In practice, where high survival but not maximum growth is the objective, it should be possible to restrict the amounts fed provided reasonable weight gains, such as those recorded in Experiment 1, are obtained in the initial stages of early weaning.

The calves in these experiments had a possible advantage in that they had access to the feed, subsequently used for early weaning, in creeps for approximately four weeks before weaning. Such a procedure may not be convenient in practice and further work is necessary on the effect of abrupt early weaning of beef calves to non-complex rations. However, Quayle (1958) found no significant differences in the performance of dairy calves weaned from milk abruptly at three weeks compared with that of calves weaned gradually.

The occurrence of vitamin A deficiency in calves in Experiment 2, as indicated by low liver reserves in the two calves that died and by the presence of nyctalopia and low plasma vitamin A levels in some of the calves at the conclusion of early weaning, was not unexpected. Prior to early weaning the calves were suckling dams with low milk production in which the butterfat was low in vitamin A (Gartner and Ryley 1962 *b*). In addition, the sorghum grain fed as a creep feed for four weeks prior to weaning and during the early weaning experiment contained negligible carotene. The relationship between the plasma vitamin A levels and nyctalopia is discussed by Gartner and Ryley (1962 *a*).

The analytical data for constituents in blood and serum are comparable to those obtained in Hereford calves, of similar age, suckling their dams and grazing the predominantly *Paspalum dilatatum* pastures at the Animal Husbandry Research Farm, Rocklea (unpublished data). The globulin/albumin ratio increase, from an initial mean of 0·71 to a mean of 0·87 six weeks later, is apparently a normal change in serum proteins in calves with increasing age.

Hairballs were present in both calves that died in Experiment 2, and in one calf one of these caused an obstruction. It appears that in all-grain feeding of calves, fatal obstruction due to hairballs is a possibility.

The occurrence of rumination in the calves fed all-grain rations is difficult to explain, in view of the finding by Ryley, Gartner, and Morris (1960) of cessation of rumination in maiden heifers fed all-grain rations. Perhaps the excessive ingestion of soil and hair was sufficient to initiate rumination in the younger animals. Wilson (1961) in the discussion of his paper suggested that calves reared intensively in the United Kingdom for veal and baby beef ruminated because they ate small quantities of straw or sacking, gnawed the wood of their pens, or licked hair from their own bodies.

These preliminary experiments indicate that young calves can be fed for survival on non-complex mixtures. It would appear that the inclusion of some good-quality roughage in the ration would be an advantage. If all-grain rations are fed, the possibility of the occurrence of vitamin A deficiency should be considered.

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