Feeding and Breeding Tests

With Sheep, Swine and Beef Cattle

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CONTENT

Progress reports of research at the Fort Reno Experiment Station include data from experiments conducted in cooperation with USDA-ARS.

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1964 FEEDING AND BREEDING TEST

Continuous vs. Night Breeding in Producing Fall Born Lambs

Joe V. Whiteman, W. L. Basler and Mike B. Gould
U. S. Dept. of Agric.[1]

For many years it has been suggested that the breeding efficiency of flocks of ewes might be improved if rams were turned with the ewes only during the night. Thus, during the day the rams could be given extra feed while the ewes were on pasture. Further, rams are not thought to be quite as fertile nor as aggressive in May and June as during the fall months. In earlier work involving cooling rams during the heat of the day, it was observed that the cooled rams were more comfortable and rested quietly during the day as compared to noncooled rams that tended to be restless. The cooled rams were more aggressive and more efficient breeders.

The authors know of no experiment specifically designed to determine if night breeding is more efficient than continuous breeding. This paper summarizes such a test that has been under way at the Ft. Reno Livestock Research Station during the past four years.

MATERIALS AND METHODS

The study involved 550 ewes and 18 rams. The basic design was a paired arrangement wherein a group of ewes was equally divided into two similar pastures. A pair of similar rams were randomly assigned one to each pasture. One of each pair of rams (chosen at random) was left with his assigned group of ewes continuously throughout the 40-day breeding season. The other ram was removed from his pasture each morning and spent the day (about 8:00 a.m. to 5:00 p.m.) in a lot with feed, water and a shade available. The trial involved nine such pairs of rams and paired groups of ewes as shown in table 1.

The ewes were equally divided on the basis of breed, age and the past years performance (reared 0, 1 or 2 lambs). The number of ewes per group varied by no more than one ewe within pairs but varied from 21 to 35 between pairs. Rams of a pair were of the same age, breeding (usually half brothers), type and in similar condition. Different pairs

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[1] Sheep and Fur Animal Research Branch, Animal Husbandry Research Division Agricultural Research Center, Beltsville, Md.

Table 1. The composition of the breeding groups used during the 1960-1963 seasons.

		Night Only		Continuous	
Year	Pair	Ram (Ident.)	No. of ewes	Ram (Ident.)	No. of ewes
1960	1	30	32	28	32
	2	27	31	29	32
1961	3	32	35	35	35
	4	34	34	33	35
1962	5	46	23	45	23
	6	44	22	47	21
	7	32	33	34	33
1963	8	50	32	49	33
	9	51	32	52	32

of rams were Dorsets, Suffolks or Hampshires and were from one to three years of age. Rams were fitted with marking harnesses and each morning the ewes were examined. Those ewes with fresh marks were recorded as mated.*

The breeding season started each year on the 20th, 21st, or 22nd of May and continued for 40 days. The ewes were left out in the pastures for the entire breeding season. The two groups of ewes that made up a pair were always treated in the same manner so that in their mating and subsequent lambing performance they should have responded alike. Any difference in breeding efficiency between the groups that made up a pair should have been due to the treatment imposed on the assigned ram or due to chance.

If the treatment imposed on the rams had no influence on the breeding efficiency of the groups, the mean performance of all groups bred at night only should be about the same as the mean performance of all groups bred continuously. Also, if one considered which ram treatment performed best within each pair, each treatment would appear better about half of the time if the treatments had equal influences on breeding performance.

RESULTS

An examination of the first two columns of table 2 reveals that relative to the percent of ewes lambing there was little if any treatment effect. In 5 pairs out of 9 more ewes lambed from night breeding only and in the other 4 pairs more ewes lambed from continuous mating. The overall average difference in percent ewes lambing was 2 percent in

* Mating records obtained in this manner are not perfect. Some ewes are mated and not marked and other ewes are marked but not mated.

favor of night breeding. These are the kinds of results that one obtains when there are small or no differences due to the treatments imposed.

The third and fourth columns of table 2 give the lambing rate of the ewes that lambed. This characteristic appears to have been influenced by the treatments. In 7 pairs out of the 9 the ewes that mated only at night had more twins. In one pair the twinning rate was the same and in only one pair of the nine did more twins result from continuous mating. Overall, 40 percent of the ewes that mated at night only had twins as compared to 26 percent for the continuously mated ews. Such results as these would occur rarely due to chance and we would, therefore, conclude that somehow the night breeding treatment caused more twins to be born.

The last two columns of table 2 show the ratio of lambs born per ewe in the breeding flock or if each quantity is multiplied by 100, the percent lamb crop. This, of course, is an overall measure of reproductive performance combining the figures for ewes lambing (columns one and two) and lambing rate (columns three and four). The advantage shown in columns five and six for the night breeding treatment is a reflection of the higher twinning rate previously discussed.

DISCUSSION

It is not normally thought that the ram, provided he is fertile, has much, if any, influence relative to whether a ewe has twins or a single lamb. The number of eggs ovulated by the ewe basically determines the maximum number of embryos that can develop. The ram furnishes millions of sperm, only one of which is necessary to fertilize each egg.

Table 2. The reproductive performance of rams used at night only vs. continuous use (presented by pairs.)

Pair	% ewes lambing		Lambing rate[1]		Lamb/ewe ratio[2]	
	Night	Continuous	Night	Continuous	Night	Continuous
					:1	:1
1	81	91	1.38	1.38	1.12	1.25
2	94	88	1.45	1.39	1.35	1.22
3	89	77	1.39	1.37	1.23	1.06
4	76	77	1.58	1.30	1.21	1.00
5	78	65	1.11	1.13	.87	.74
6	82	95	1.22	1.00	1.00	.95
7	88	82	1.31	1.15	1.15	.94
8	100	91	1.50	1.30	1.50	1.18
9	81	94	1.50	1.13	1.22	1.06
Av.	86	84	1.40	1.26	1.20	1.06

[1] Average number of lambs born per ewe lambing.
[2] Average number of lambs born per ewe in the breeding flock.

These results suggest that the ram may influence (by some unknown mechanism) the number of eggs that are ovulated by the ewe or that there is a differential rate of fertilization of the eggs or of embryo survival. Fertilization rate or embryo survival differences should be reflected in the number of ewes lambing. Either a higher fertilization rate or a higher embryo survival should result in more ewes lambing. The small difference found in this study does not suggest that this is a valid explanation.

In an attempt to determine what influence the rams might have had on other characteristics associated with breeding and subsequent lambing, the records were studied in more detail. Several studies have been conducted by other workers to determine if teaser rams used prior to the breeding season will influence the breeding performance during the breeding season. Many of these trials have yielded inconclusive results but in some instances a modification of the usual breeding pattern has been suggested. Thus, the presence of a ram may alter the breeding pattern of ewes under some conditions. Rams that can rest during the day may be more aggressive while with the ewes at night and thus cause different breeding patterns as compared to rams used continuously. Such an alteration might be reflected in the average date of breeding. The nature of this data is such that breeding dates are not as accurate for all ewes as are lambing dates.

The first two columns of table 3 show the average lambing dates (day of year) for the various breeding groups. Although the difference is only two days with the night bred ewes lambing earlier, the difference is probably real and not due to chance. In 8 of the 9 pairs the night bred ewes lambed earlier. If this is real, it suggests that the rams involved influenced the breeding date.

Table 3. The reproductive performance of rams used at night only vs. continuous use (presented by pairs.)

Pair	Av. lambing date[1] Night da.	Av. lambing date[1] Cont. da.	s lambing date[2] Night da.	s lambing date[2] Cont. da.	First Sv. concep.[3] Night %	First Sv. concep.[3] Cont. %
1	304.1	305.5	9.9	7.7	73	59
2	304.5	306.4	8.6	8.1	81	80
3	306.0	308.5	7.9	7.2	68	74
4	302.0	303.6	7.1	7.8	70	85
5	307.6	312.7	6.7	6.3	50	43
6	307.9	309.3	8.4	6.8	67	45
7	306.1	305.8	7.6	8.4	58	53
8	302.8	303.2	7.2	7.8	94	78
9	299.1	302.6	6.6	5.6	87	81
Av.	304	306	7.8	7.4	73	68

[1] Day of the year.
[2] s is a measure of variation. Smaller values indicate more uniformity.
[3] Percent of the ewes conceiving during their first recorded estrus (heat).

The middle two columns of table 3 show the variability in lambing date for the groups. (s is a mathematical symbol for a measure of variation. The smaller the value the more uniform the characteristic measured.) The night bred ewes were more variable (overall) for lambing date but this may have been due to chance. In 6 pairs the night bred ewes were more variable and in 3 pairs the continuous bred ewes were more variable.

The last two columns give the first service conception rate (percent of ewes settling during their first recorded estrus) for the various groups. In 7 of 9 pairs the night bred ewes exhibited a higher conception rate. Such results would occur less than one time in fifty due to chance if there were truly no treatment effect. Therefore, the night breeding treatment probably results in a higher first service conception than does continuous breeding under conditions similar to these. Such results would be expected if the higher twinning rate shown in table 2 resulted from a higher ovulation rate for the night bred ewes. If other factors are equal, a higher ovulation rate automatically leads to higher conception rate.

The higher first service conception rate should have led to an earlier average lambing date. If a higher percentage of the ewes in a group conceive at their first estrus, this will automatically cause the group to have an earlier average lambing date than a group where more of the ewes conceive at a second or later estrus as did the continuously bred ewes in these trials. The records (such as they are) indicate that there was essentially no difference between the treatment groups in the first mating date.

The higher conception rate at first estrus should have led to a higher percent of the ewes lambing among the night breeding ewes if all ewes were in a proper physiological condition to conceive. There was essentially no difference in percent ewes lambing because more continuous bred ewes conceived to later services. It may be that there were about equal numbers of ewes in each treatment group that were not in a proper physiological condition to conceive and the imposed treatment had no beneficial effect on these conditions.

The mating records of the ewes not lambing were studied. There were 82 ewes of the 550 that did not lamb. This included 39 night mated and 43 continuously mated ewes. These ewes that mated but did not lamb had a later average first mating date than did the ewes that conceived and lambed. Ten ewes of the night mated group and 11 of the continuously mated ewes did not show any matings. There was nothing in the records to explain why these ewes did not mate and/or lamb.

SUMMARY

A trial has been conducted during the 1960-63 May-June breeding seasons to determine if mating at night only results in any improvement in breeding efficiency as compared to continuous mating. A total of 550 ewes and 18 rams were involved in a paired design involving 9 pairs of rams and 9 paired pasture mating groups.

There was little difference in the percent of the ewes lambing. The ewes that were mated at night only lambed two days earlier and produced more twins than the ewes that were mated continuously. It is believed that resting the rams during the day caused them to be more aggressive while they were with the ewes. The increased twinning of ewes bred to rested rams could have resulted from a higher ovulation rate by the ewes or a higher fertilization and/or embryo survival rate. The data is not adequate to determine which explanation is correct, but irrespective of how it happens, the evidence is very conclusive that resting rams during the day is a beneficial practice when the breeding season is during late May and June.

Effect of Feed Level Before and After Calving on The Performance of Two-Year-Old Heifers

E. J. Turman, L. Smithson, L. S. Pope, R. E. Renbarger and D. F. Stephens.

The vital importance of properly developing the beef heifer intended to be a replacement in the herd has long been recognized. However, considerable differences of opinion still exist among producers in regard to the best nutritional level for this development. Extremes in levels used have ranged from the creep-fed heifer that is placed on full feed following weaning, to the poorly mothered, non-creep fed heifer that is provided a mere survival ration following weaning.

A number of experiments have been conducted at several experiment stations to study the effect of nutrition on the development and subsequent performance of beef heifers. While many of these studies are still in progress, the evidence that has been obtained shows fairly conclusively that either extreme is undesirable. Extremely high levels reduce the life span and impair the milking ability of the beef female as well as being excessively costly. Extremely low levels results in poor reproductive performance, poor milking and light weaning weights.

Extensive studies at the Ft. Reno Station have been reported in earlier Feeder's Day reports and provide some basis for making recommendations as to the proper winter feed level for developing heifers. These studies have indicated that best reproductive function and performance have been obtained by feeding the amount of supplemental feed necessary to secure gains of 1 lb. per day in the weaner heifer and maintain the fall weight through calving in bred yearlings. However, satisfactory performance has been obtained from a moderate level which permitted gain of 0.5 lb. per day in the weaner heifer and a loss of 10% of the fall weight through calving in the bred yearling. Because of the excessive cost of the high level, the moderate level has been recommended as the best practical level even though performance is not as desirable as that obtained on the high level.

Although recommendations have been made on the basis of earlier studies, many questions still remain unanswered. There is the question as to whether the improved performance of the high level could be obtained more economically by feeding this level only part of the winter. If so, which period during the winter is most critical in feeding the bred yearling who is to calve in the early spring? In an effort to determine this, a study was set up to feed four different sequences of high and/or low levels before and after calving. The results of this study are reported in this paper.

EXPERIMENTAL PROCEDURES

Eighty bred yearling Hereford heifers were started on two different winter feed levels in the fall of 1962 at the Ft. Reno Beef Cattle Research Station. These heifers were selected from a group of 105 heifers that had been carried on four levels of feeding as weaner calves the previous winter. The effects of the first winter trial have been reported previously[1]

The heifers, weighing approximately 800 lb., were allotted to four groups of 20 each on the basis of body weight, previous winters feed level, bull to which they were bred and expected date of calving. The heifers, grazing dry native grass pasture, were fed supplemental feed as needed to obtain the desired weight change from early November to mid April.

Two levels of supplemental feeding (milo and cottonseed meal) were used. The amount of feed to be fed on each level was determined by how much was needed to produce the following weight changes:

> Low—Loss of 20% or more of fall weight through calving (including calving loss).
>
> High—Loss less than 5% of fall weight through calving.

[1] 1963 Feeders Day Report, MP-70, p28-35

It was estimated that heifers of this age would lose approximately 100 lb. at calving. Therefore, heifers on the low level weighing 800 lb. should lose 60 lb. up to calving time. The high level heifers should gain approximately 100 lb. to calving.

Two lots were started on each level on November 14. At calving time one lot on each level was switched to the opposite level. The four lots and treatments were as follows:

Lot 1 (Low-Low) —Low level prior to calving and continued on low level after calving.

Lot 2 (Low-High)—Low level prior to calving and high level after calving.

Lot 3 (High-Low)—High level prior to calving and low level after calving.

Lot 4 (High-High)—High level throughout the entire winter feeding period.

The total amount of supplemental feed that was required is shown in table 1. No milo was needed for the Low level and cottonseed meal was not started until early January. In contrast two lb. cottonseed meal per day, starting November 14, was required for the High level plus some milo. During the early part of the winter period only 2.0 lb. milo was required, but from February on the daily feeding of milo was 7.0 lb. It should be remembered that these were the levels required on the dry range forage on the Ft. Reno Station. More or less may be required at other locations depending on the quality of the dry grass available.

The heifers in lots 2 and 3 were changed individually to the opposite regime as they calved. The amount of feed they were fed after being placed on the opposite level was determined by the amount fed to the heifers on the respective level just prior to calving.

After calving, the heifers were checked for occurrence of first post-partum heat. Vasectomized bulls were placed with the heifers from calving until May 1, whereupon the heifers were exposed to fertile bulls until August 15. The bulls were equipped with a special marking harness with a grease-filled pad covering the brisket. The heifers were checked daily, and those with grease marks on their rumps were recorded as being in heat on that day. All heifers were checked for pregnancy by rectal palpation approximately 45 days after the end of the breeding season.

The calves were weighed at birth and permanently identified by ear tattoos. A score was given each cow for difficulty of calving ranging from 1 for no help necessary to 6 for a very difficult birth in which both cow and calf were lost. Calves were weighed at intervals of 3 months. All calves were weaned on October 12 and weaning weights were corrected for sex and adjusted to 210 days of age.

Estimates of daily milk production were obtained on each heifer once each month by measuring the differences in body weight of suckling calves before and after nursing. Briefly the procedure involved separating the cows and calves 12 hours before the initial nursing and during the next 12-hour period before the second nursing. The calves were weighed before and immediately after nursing, as rapidly as possible, on scales graduated to the nearest ¼ lb. Data on any calf that showed excretory loss were discarded. The gain in weight of the calf after suckling was taken as the estimate of milk produced by the cow during that period.

RESULTS AND DISCUSSION

The performance of the heifers is presented in table 1. In this study the nutritional level of the heifer during gestation had a marked effect on birth weight. There was a highly significant difference ($P<.01$) of 14 lb. in the birth weights of calves from heifers fed on the two different levels up to calving time.

Table 1. Performance of two year old heifers fed different levels of supplemental feed before and after calving.

Item	Winter Feed Level Lot 1 Low-Low	 Lot 2 Low-High	 Lot 3 High-Low	 Lot 4 High-High
No. Heifers	20	20	20	20
No. Weaning Calves	16	13	15	14
Heifer Weights (lbs.)				
Nov. 1, 1962	797	804	796	798
Apr. 16, 1963	586	649	701	762
Nov. 13, 1963	868	921	928	961
Winter weight loss as percent of Fall Wt. (%)	26.4	19.2	11.9	4.5
Summer gain as percent of Spring Wt. (%)	46.1	41.4	31.3	24.8
Calving Data:				
Avg. Calving Date	3/11	3/17	3/18	3/15
Avg. Birth Wt. (lb.)[1]	62	63	77	75
% Heifers Requiring Assistance	58	60	84	58
Breeding Data:				
Post-partum interval Calving to 1st heat (days)	92.6	70.4	63.6	55.6
Avg. Breeding Date	6/12	5/29	5/22	5/17
% Pregnant	53	75	100	93
Weaning Wt. (lb.)[2 3]	358	376	408	432
Supplemental Winter Feed per heifer (lb.)				
CSM	161	203	284	313
Milo	0	249	651	891

[1] HL and HH heavier than LL and LH ($P<.01$)
[2] Corrected for Sex and adjusted to 210 days
[3] HL and HH heavier than LL and LH ($P<.01$)

It might be expected that larger calves at birth would result in more calving difficulty. This was true in the case of one lot (lot 3) of heifers carried on the high level. However, there was no difference in the percent of heifers in the other lots that required assistance. While the cause of calving difficulty cannot be determined from this data, it does indicate that the low feed levels in this study did reduce birth weights but the lower birth weights were not necessarily associated with less calving difficulty. This is not proof, however, that, other factors being equal, birth weight is not an important factor in calving difficulty. The heifers in this study with the lowest birth weights may have had more difficulty calving because of a generally weaker body condition resulting from the low feed level.

The average calving date of the heifers in each lot is about a month before green grass is normally available. It is apparent from the weaning weights that providing additional feed during this month has a beneficial effect. This is evident from a comparison of lot 1 (Low-Low) with lot 2 (Low-High), and lot 3 (High-Low) with lot 4 (High-High). However, it is likewise apparent that the level of feeding prior to calving also has an important effect on the subsequent mothering ability of the heifer. If the amount of feed fed after calving was the most important factor influencing mothering ability, the heifers of lot 2 (Low-High) should have weaned heavier calves than did those of lot 3 (High-Low). When these two lots are compared, the heifers of lot 3 (High-Low) weaned calves that averaged 32 lbs. heavier than those of lot 2 (Low-High), and only 14 lb. of this difference could be explained by a heavier birth weight.

This improved mothering ability is largely milk production, as shown by the average daily milk production data of heifers in the four lots (figure 1). In general they agree with the weaning weights. Although the Low-High lot had higher average production initially and in April, the heifers of the High-Low lot were higher producers from May until August. It is interesting to compare the two extremes, Low-Low and High-High. Even during their period of greatest production in May and June, the Low-Low heifers did not produce as much milk as the High-High heifers were producing as late as July.

The most marked differences between the treatments is in the rebreeding performance of the heifers (table 1). It is apparent that in this trial the level fed before calving was more important than that fed after calving. Nearly all of the heifers in lots 3 and 4 fed high prior to calving conceived. This compares to only 53% of the heifers fed on the low level continuously and 75% of those fed low to calving then raised to high (lot 2).

An increased conception rate was not the only advantage of the high level over the low level. High level heifers had an earlier breeding date and, thus, will have an earlier calving date. When the two extremes (lots 1 and 4) are compared, heifers fed on the high level continuously (lot 4) should calve, on the average, nearly one month earlier than those fed low continuously (lot 1).

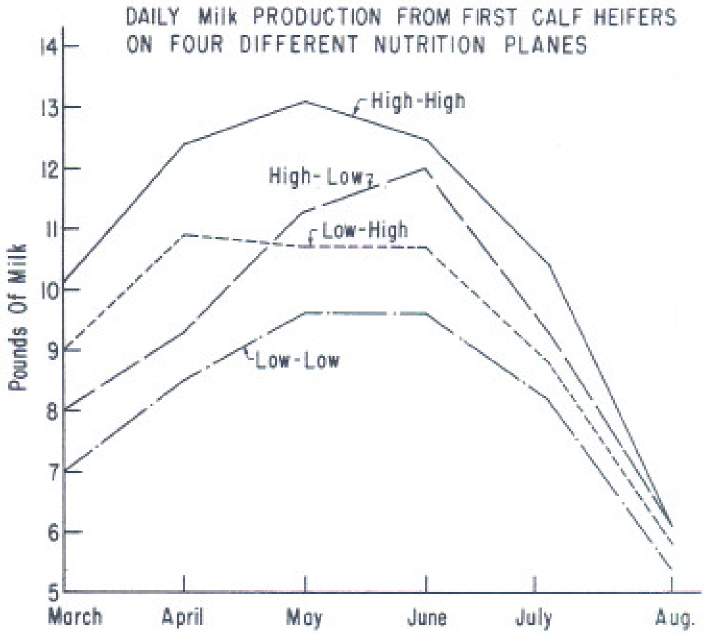

Figure 1.

Most of the difference in average breeding date can be explained by the post-partum interval from calving to first estrus. Again comparing the extremes, the heifers fed high continuously (lot 4) returned to heat, on the average, in 56 days, while those fed low (lot 1) required 93 days. These data point out the practical importance of reducing this post-partum interval since it is closely associated with earlier rebreeding. The earlier the average breeding date, the earlier the average calving date the next year, and the older, and heavier, the calves will be at weaning time in the fall.

As mentioned previously, the level of feeding prior to calving seemed to be more critical than the level fed after calving in this study. This would probably be true in any situation where the heifers are calving in the spring within a month of grass. However, it is very doubtful if this would be the case if they were forced to nurse calves for several months before grass came. Under such a situation the response to the Low-High and High-Low levels might be reversed from what they were in this trial.

Although this study was directly concerned with winter feed levels for bred yearling heifers, it is interesting to consider possible "carryover" effects of their first winter's treatment. The data presented in table 2 suggests the first winter's treatment can have a big influence on rebreeding. Heifers fed on a high level (1 lb. day gain) during their winter as a weaner heifer had a satisfactory conception rate regardless of their second winter treatment. Only one heifer out of nine fed low until calving was open at the end of the breeding season. Likewise, if the heifers were fed at the high level prior to calving during their winter as bred yearlings their conception rate was good regardless of their level of feeding as weaner heifers. The rebreeding performance of heifers fed at a moderate level (.5 lb. per day gain) or a low level (no gain) during their first winter, and carried on a low level prior to calving as bred yearlings suggests more study is needed. Fifty-three percent of the moderate level group and 33% of the low level group were open. Admittedly the numbers are small and further work is needed on this important point.

Earlier studies with weaner heifers have indicated that the low level was not to be recommended because of poor breeding performance. However, although the best performance was obtained with the high level, satisfactory performance was obtained with the moderate level. Because of the costs involved the moderate level has been recommended as the best practical level. These data suggest that the moderate level may be borderline, and may be too low for weaner heifers if they must also be fed at a low during the winter they are bred yearlings.

The economics of these four winter feeding levels must be considered. It is obvious that the High-High level costs more than any other level. However, it seems hardly fair to charge the full cost against the calf weaned in the year concerned. It is obvious that the returns from the next calf crop will be greatly influenced by the breeding performance of the heifers as shown in table 1. Comparing again the two extremes, 40% fewer open heifers would be wintered in the High-High group than the Low-Low group, they would calve, on the average, 25 days earlier and, thus, if all were weaned at the same time, would be approximately 50 lb. heavier. If we assume that the heifers were checked for pregnancy after the breeding season and all open heifers removed

Table 2. Rebreeding performance of 2-year-old heifers fed three different levels their first winter as weaner calves and four different levels the second winter as bred yearlings.

Feed Level	Item	Second Winter Feed Level			
		Low-Low	Low-High	High-Low	High-High
High	No. Heifers	6	3	6	4
	No. Open	1	0	0	0
Moderate	No. Heifers	5	7	4	5
	No. Open	4	4	0	0
Low	No. Heifers	4	5	5	5
	No. Open	2	1	0	1

so no open heifers would be wintered, a replacement rate of 47% would be required for this reason alone for the Low-Low group, compared to 7% for the High-High.

Since the winter feed bill is one of the largest "out-of-pocket" costs to the cattleman this study relates to an annual problem facing the cattleman. No set answer can be given to the question, "How much supplemental feed must I provide?" The amount varies from year to year on the same ranch, and certainly from area to area and even between ranches in the same area. The results reported from this study, combined with data from previous studies at Ft. Reno, suggests that *a low level for heifers up to two years may be a false economy.* It is in variably associated with (a) delayed breeding of yearling heifers, (b) lighter weaning weights of calves, and (c) delayed rebreeding of two-year old heifers, with a higher percent of open heifers at both ages. There is a real need for additional information as to what is the best level of winter feeding consistent with maximum production at the most economical cost.

SUMMARY

Eighty bred yearling Hereford heifers were fed four different levels of winter supplemental feed (milo and cottonseed meal) while grazing dry native grass pastures. Two groups were fed at a low level prior to calving and two groups were fed at a high level prior to calving. The heifers of one group on each level were switched to the opposite feed level at calving time. Thus, the four treatments were: Low-Low, Low-High, High-Low and High-High, indicating, respectively, the feed levels before and after calving. The low level was the amount of feed necessary to establish a loss of more than 20% of the fall weight through calving. The high level was the amount necessary to maintain the fall weight through calving.

Heifers fed at the High level prior to calving dropped calves that averaged 14 lbs. heavier at birth than did the Low level heifers. Heifers fed High prior to calving returned to heat earlier, bred back earlier and had a higher conception rate (93% and 100% vs 53% and 75%) than did heifers fed low up to calving. Raising the Low level heifers to High at calving resulted in a 2 weeks earlier breeding date, a higher conception rate (75% vs 53%) and an 18 lb. heavier average weaning weight. Average weaning weights followed amount of winter feed fed and were as follows: High-High, 432 lbs.; High-Low, 408 lbs.; Low-High, 376 lbs.; and Low-Low, 358 lbs. The heifers of the High-High lot had the highest average milk production, the heifers of the Low-Low lot had the lowest, and the other two lots were intermediate between the two extremes.

These data do not permit specific recommendation as to the best practical level for wintering bred yearling heifers. They do suggest that low levels, while costing less at the time, may be false economy. They eventually are costly in terms of more open heifers, later breeding and calving, and reduced calf crop percentages.

Growth and Development of Beef Heifers From Weaning to 18 Months of Age

L. A. Malkus and R. L. Henrickson
Oklahoma Agricultural Experiment Station

INTRODUCTION

The proportion of fat, lean, and bone, in the carcass are important to the producer, packer, retailer, and particularly the consumer. Current trend in consumer demand reflect emphasis on smaller, leaner cuts of beef.

An important factor affecting carcass composition is animal maturity. The producer has shown an interest in marketing cattle at an earlier age to meet demand for retail cuts which possess an absolute minimum of external fat and to provide meat cuts that will meet price competition. Because of this aversion to fat and the need for economic production, it becomes increasingly important to obtain fundamental information on the growth and development of the major carcass issues. The ultimate goal would be to establish a point during the growth cycle where maximum muscle development and a minimum of fat deposition is obtained for the least cost of production. A current investigation at the Oklahoma State Agricultural Experiment Station provides some information relative to these production goals.

PROCEDURE

Twenty-four Hereford heifers were used to investigate the effects of advancing age on the changes in carcass composition. Six heifers were assigned at weaning to each of four groups. The first group was slaughtered when the animals in the group averaged 9 months of age and was used as the basis to study subsequent changes in carcass composition. The remaining animals were group-fed a fattening ration consisting of shelled corn, cotton seed meal & hulls, alfalfa hay and molasses until the assigned slaughter age was reached (12, 15, & 18 months).

Slaughter and carcass data included; weight of offal products, yield of wholesale cuts, carcass measurements, dressing percent, grade, marbling score, physical separation of one side, and a chemical analysis of the boneless tissue.

RESULTS

Trends in consumer demands emphasize the importance of the relative proportion of fat and lean in the carcass. While specie, age, and plane of nutrition are of fundamental importance, breed, sex, exercise, and other factors may also influence the kind and amount of the major tissue components in the carcass. The main aspect considered in this investigation was that of age.

It is evident from table 1 that the slaughter weight at 9 months of age was light. This may well be expected in Fall dropped calves from cows on a low plane of nutrition. Consequently, the calves grew more slowly than what would seem desirable. It is also of interest to note the small change in carcass weight which took place during the first three month period. After the recovery period all tissues appeared to make normal growth. Consequently, these data should be interpreted as the minimum growth which would occur rather than maximum.

Carcass grade and marbling scores reflect that only a small amount of fat was present in the muscle tissue. It may also be noted that animals slaughtered at 15 months of age possessed equally as much marbling as those slaughtered at 18 months of age. The outside fat cover on these carcasses increased independently of marbling.

Table 1. Changes in Carcass Measurements as Influenced By Animal Age at the Time of Slaughter

	9 Mo.	12 Mo.	15 Mo.	18 Mo.
Slaughter wt. (lb)	451.8	519.7	712.2	844.3
Carcass wt. (lb)	257.2	305.4	440.9	549.3
Dressing (%)	56.8	58.7	61.9	65.1
Carcass grade	Std.	G—	G+	G+
Marbling score	Traces	Traces	Sm. Amt.	Sm. Amt.
Rib eye area (sq. in.)	6.1	6.6	8.5	9.7
Fat area (sq. in.)	1.3	1.8	2.8	4.5
Fat thickness (in.)	0.2	0.4	0.6	0.9

Table 2. Percentage Yield of Wholesale Cuts as Influenced by Animal Maturity

	9 Mo.	12 Mo.	15 Mo.	18 Mo.
Major Cuts				
Chuck	24.9	24.2	24.0	23.3
Rib	7.9	7.7	8.2	8.4
Loin	14.2	14.3	14.2	14.5
Rump	5.3	5.7	6.1	5.4
Round cushion	15.8	15.1	13.4	12.4
Minor Cuts				
Hind shank	4.8	4.7	4.2	4.0
Flank	6.9	7.4	8.3	8.9
Kidney knob	3.4	3.6	4.1	5.0
Plate	7.2	7.4	8.6	9.5
Brisket	5.0	5.2	5.2	5.1
Foreshank	4.6	4.8	3.8	3.6

A study of the wholesale cuts as influenced by animal age tended to point out where some of the tissues changes occur. When the carcass is sectioned into major and minor cuts (table 2) one quickly observes that the rib and chuck increased with advanced age. This is in part due to the more rapid deposition of fat in these cuts. Note on the other hand a decrease in the cushion round. The deposition of fat in and on these cuts is much more slower than is true for the other wholesale cuts. A consideration of the minor cuts reflect much the same composition. Lean cuts such as the foreshank and hindshank decrease on a percentage basis while fat cuts as the flank, plate, and kidney knob increase rapidly. It is readily evident from these data that care must be taken when evaluating an animal totally on the weight of its major or minor wholesale cuts.

Another approach to the evaluation of a carcass has been to determine its total composition of lean, fat, and bone. A glance at table 3 will reflect the changes in total tissue composition as it is influenced by age. Bone changes little on a percentage basis, but on a weight basis it almost doubles during the last 9 month period. Fat on the other hand increased slowly for the first 3 months than quite rapidly during the last 6 months. (figure 1) This provides ample evidence that fat is a late maturing tissue in relation to lean or bone. At 9 months of age the carcass possessed 71 pounds of lean or lean made up 55.7 per cent of the carcass. Even though lean growth increased during the following 9 month period, fat was deposited at a more rapid rate. These facts indicate that if economy of production is tied closely to quality lean production, one would expect to produce beef most economically at an early age. Now turn to figure 2, and note the change when quantity of tissue is expressed in terms of percent. Bone varies slightly while fat increases and lean decreases as fat deposition becomes rapid.

Changes in growth as reflected by various chemical measurements further substantiate the early growth of muscle. Table 4.

Table 3. Changes in Composition of Fat, Lean, and Bone as Influenced by Animal Age

Age Mo.	Lean lb	Fat lb	Bone lb	Lean %	Fat %	Bone %
9	71.0	32.5	24.5	55.7	25.0	19.3
12	80.0	43 8	26.9	53.1	28.9	18.0
15	104.1	74.8	41.2	47.3	34.0	18.7
18	124.6	102.6	45.8	45.9	37.3	16.9

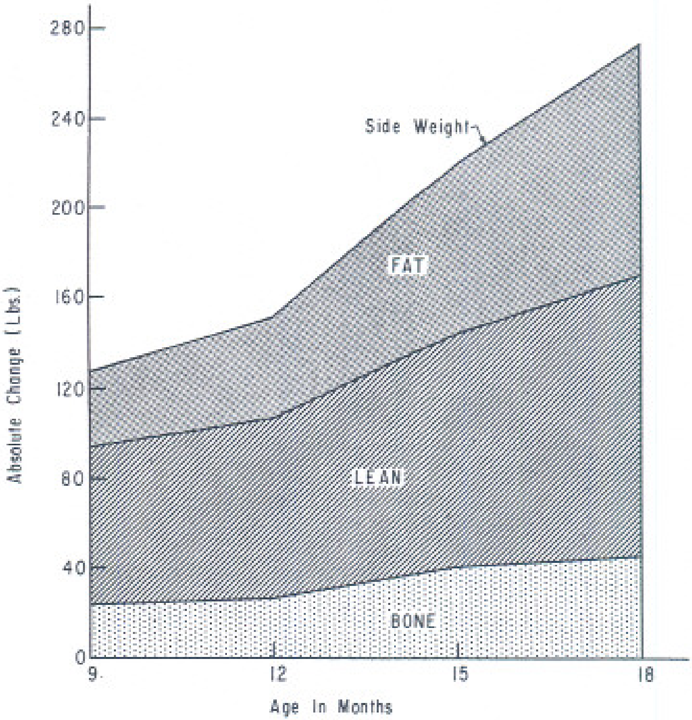

Figure 1. Influence of age on the Bone, Lean and Fat Weights of the side.

Table 4. Changes Due to Growth as Influenced By Various Chemical Components

Age Mo.	Protein lb.	Ether Extract lb.	Moisture lb.	Ash lb	Protein %	Ether Extract %	Moisture %	Ash %
9	17.3	23.4	56.9	0.8	17.6	23.1	57.8	0.9
12	20.7	30.5	66.6	1.0	17.5	25.6	56.2	0.8
15	26.2	54.8	88.6	1.1	15.4	32.3	52.2	0.7
18	30.0	79.3	103.3	1.4	14.2	36.8	48.6	0.6

SUMMARY

Hereford heifers were used to reflect the change in major tissue growth and development from 9 to 18 months of age. Bone is an early maturing tissue and made only a small change during the 9 month

period. Lean on the other hand made up 71 pounds of the carcass at 9 months of age and increased by 53 pounds during a following 9 month period. Fat, a late maturing tissue, increased rapidly throughout the fattening period.

When the quantities of fat, lean and bone are expressed in terms of percent, lean and bone in the carcass decreased while fat increased. The percent lean in a carcass from animals slaughtered at 18 months of age was approximately 10 percent less than at 9 months. Fat increased by 12.3 percent and bone decreased 2.4 percent.

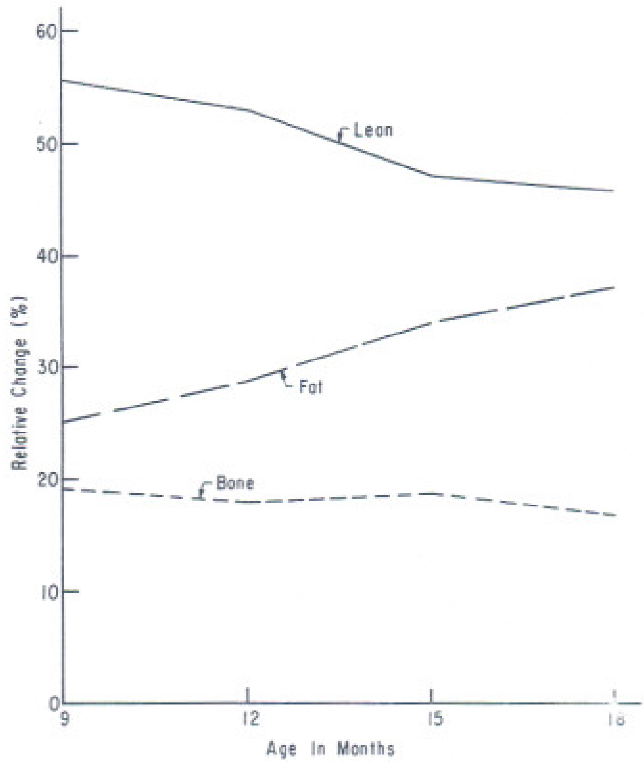

Figure 2. Influence of age on the weight of bone, lean and fat expressed as a percentage of the side weight.

Observations on the Use of 6-methyl-17-acetoxyprogesterone (Provera[1]) for the synchronization of estrus in ewes

Charles W. Nichols and Joe V. Whiteman
U. S. Dept. of Agric.[2]

Individual open ewes exhibit estrus (heat) about every 16-17 days during those seasons of the year when they are sexually active. Among a large flock of open ewes, there will be ewes exhibiting estrus every day. There are reasons why it would be desirable to have all ewes exhibit estrus on the same day or during a very few days.

For about twenty-five years it has been known that small injections of the pregnancy hormone, progesterone, would prevent ewes from exhibiting estrus. More recently progresterone-like compounds that can be fed have been developed. Research workers have shown that when these compounds are fed during the regular breeding season, the ewes will stop exhibiting estrus during the feeding period. When feeding of the drug is halted, most if not all ewes will exhibit estrus on the 2nd or 3rd day thereafter.

A series of trials have been conducted using one of these compounds (6-methyl-17-acetoxy progesterone or Provera) to test its possible use in relation to the spring breeding of ewes or for speeding up the rebreeding of lactating ewes. This report summarizes these trials.

MATERIALS AND METHODS

The procedure for the administration of Provera has been essentially the same in all trials. The drug is mixed into the feed at a rate such that each one-half pound of feed will contain the daily dosage for one ewe. The feed must be highly palatable so that all ewes will eat it. It should be fed at a time of day when all ewes are hungry. Enough trough space must be provided to allow all ewes to eat at once. In these trials the feed used was a mixture of 50% ground alfalfa, 45% ground sorghum grain and 5% molasses. The drug must be fed to the ewes for about 15 days.

Various observations were made during one or more of the trials as follows:

Mating records—either teaser or fully fertile rams were equipped with marking harnesses and the ewes observed once or twice daily to

[1] Provera is the trade name of the compound used in these trials. It is manufactured and was furnished by the Upjohn Co., Kalamazoo, Michigan.

[2] Sheep and Fur Animal Research Branch, Animal Husbandry Research Division, Agricultural Research Center, Beltsville, Maryland.

record all ewes with fresh marks. (This system is not perfect as some mated ewes are not marked and some marked ewes are not mated but about 90% of the records are correct).

Laparotomies—some ewes were anesthetized a few days following mating, a surgical incision was made into the abdominal cavity and the ovaries examined to determine whether an ovulation had occurred. This is an exact method of determining ovulation rate or ovulation failures.

Lambing records—all ewes were allowed to lamb if a fertile male was used at breeding time. Some ewes died and thus their lambing records could not be compared to their mating records. The lambing records included the date of lambing and the number of lambs born.

TRIAL I

This trial was conducted to determine the effectiveness of estrus synchronization by feeding Provera, and to compare the conception and lambing rate of ewes that received Provera to like ewes that did not receive Provera.

During the 1962 spring breeding season 23 ewes, 12 Dorset X Western and 11 Merino X Rambouillet, were fed 60 mg. Provera per head per day for the first 15 days of the breeding season. Twenty-three ewes of like breeding were maintained on the same feed ration without the Provera. Both groups of ewes were together on pasture except at feeding time. The Provera feeding period was from May 20 to June 3. The ram was with the ewes from May 22 to June 30.

Seven of the 12 Dorset X Western ewes mated during the Provera feeding period indicating that the 60 mg. level was not sufficient to suppress estrus in all of these ewes during this time of the year. One of the ewes that mated was laparotomized and she had not ovulated. None of the Merino X Rambouillet ewes mated during the Provera feeding period.

The breeding and lambing performance of the Provera fed group and the group that received no Provera (the control group) is summarized in Table 1.

The Dorset X Western ewes that received Provera all mated during a three day period from the third to the fifth day after the last day of Provera feeding. The Merino X Rambouillet ewes that received Provera all mated during a four day period from the third to the sixth day after the last day of Provera feeding. The first estruses of the ewes of the control group were scattered over a 24 day period. Two of the control group ewes, one of each breed group, did not mate during the breeding season.

Laparotomies were performed on all the Dorset X Western ewes approximately five days after they mated to determine if the ewes had

Table 1. Breeding and Lambing Results from Trial I

	Dorset X Western ewes[1]		Merino X Rambouillet ewes	
	Provera group	Control group	Provera group	Control group
No. of ewes at beginning of trial	12	12	11	11
Range of first estruses in days[2]	3	24	4	24
First estrus conceptions	5	2	5	6
No. of lambs from first estrus conceptions	7	2	5	8
Second estrus conceptions	1	6	4	3
No. of lambs from second estrus conceptions	1	8	4	4
No. of ewes not mating during breeding season	0	1	0	1
No. of ewes not lambing	3	3	2	2
No. of ewe alive at lambing[3]	9	11	11	11

[1] The Dorset X Western ewes of both groups were laparotomized after their first estrus.

[2] For the Provera groups the ranges in days refer to the first synchronized estruses following the 15 day Provera feeding period.

[3] Three of the Dorset X Western ewes from the Provera group and one from the control group died as a result of the laparotomies.

ovulated and how many ova were shed. The control ewes were laparotomized after their first recorded mating, but ewes receiving Provera were laparotomized only after the first mating that occurred after Provera feeding had ended. Two of the Dorset X Western ewes that had mated during the Provera feeding period had not ovulated at the synchronized estrus mating. Ovulation rate for the Dorset X Western ewes that had received Provera and had ovulated was 1.33 ova per ewe and for the Dorset X Western control ewes was 1.55 ova per ewe.

Five of the 11 Merino X Rambouillet ewes that received Provera conceived at the first estrus after Provera feeding ended and produced five lambs. Four of the remaining Provera fed ewes lambed from return estruses and produced four lambs. Two of the Provera fed ewes did not lamb. Six of the 11 control ewes conceived at their first estrus and produced eight lambs. Three of the control ewes conceived at their next return estrus and produced four lambs, leaving two control ewes that did not lamb.

The effect of the laparotmy operations upon subsequent lambing performance is not known, but it is possible that the operation will increase embryonic mortality in the ewes that have conceived. This is indicated by the low first estrus conception shown by the Dorset X Western ewes, particularly the control group ewes. Five of the Dorset X Western ewes that received Provera conceived at the first synchronized estrus and produced seven lambs. Two of the control group ewes conceived at their first estrus and produced two lambs. Three of the Provera fed ewes and one of the control ewes died as a result of the laparotomies. Information on conception was not obtained on these ewes. Of the remaining four Provera group ewes that did not conceive at their first estrus one conceived at the next return estrus and produced a single lamb, leaving three ewes that did not lamb. Of the remaining control group ewes six conceived at their first return estrus and produced eight lambs and three ewes did not lamb.

Even though the level of Provera was not high enough to block apparent estrus, these results indicated that with May and June breeding the product would definitely control the time of first estrus. The information on conception and ovulation rate was not extensive enough to draw firm conclusions.

TRIAL II

The purpose of this trial was to compare the effectiveness of estrus synchronization by feeding Provera both with and without PMS[1] injection at the end of the Provera feeding period.

Thirty-seven head of yearling ewes, twenty Dorset X Western and seventeen Rambouillet, were fed 60 mg. Provera per head per day for 15 days, from October 5 to October 20, 1962.

One-half of each of the above breed groups was injected with 500 I. U. PMS 36 hours after the last feeding of Provera. PMS stimulates the development of ovarian follicles and should cause an increased ovulation rate. With an increased ovulation rate the potential for multiple births should be increased, also the number of ewes conceiving at the first estrus should be increased.

Two fertile rams were alternated, one during the day and one at night, with the ewes for 25 days beginning the last day that Provera was fed. All 18 of the ewes that received Provera but no PMS mated within five days after the last day that Provera was fed. Eighteen of the 19 ewes that received both Provera and PMS mated within the same five day period, one ewe mated 20 days after the last day that Provera was fed.

Eight of the 10 Dorset X Western ewes in both the Provera feeding group and Provera feeding plus PMS injection group conceived at the first synchronized estrus following the end of the Provera feeding period. Eleven lambs were produced by the above eight ewes in each group. The remaining two ewes in each group conceived at the second estrus after the end of the Provera feeding period and each ewe produced a single lamb.

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[1] Pregnant Mare Serum (PMS) is a commercial product that when injected in adequate dosages will cause ovulation. PMS has in the past been used with varying results in an attempt to initiate and synchronize estrus.

Six of the nine Rambouillet ewes that received only Provera conceived at the first synchronized estrus and produced six lambs. The remaining three ewes of this group did not lamb. Four of the eight Rambouillet ewes that received both Provera and PMS conceived at the first synchronized estrus and produced six lambs. One ewe conceived at her second estrus and produced a single lamb, and the remaining three ewes did not lamb.

Estrus synchronization was effective in this trial with 36 of the 37 ewes mating within five days after the Provera feeding period ended. In this trial PMS did not greatly increase the total number of lambs born as the group of ewes that received PMS produced only one more lamb than the group receiving no PMS. All the Dorset X Western ewes from both the Provera fed group and the Provera plus PMS group lambed. Three Rambouillet ewes from each group (PMS or no PMS) did not lamb.

TRIAL III

Rebreeding ewes shortly after lambing and during lactation may be necessary in some types of intensive sheep production. This trial was conducted to study the possible effects of Provera feeding upon lactation and the subsequent breeding performance of ewes that had recently lambed.

Forty-eight mature ewes, 24 Dorset X Western and 24 Western, that had lambed within a six day period, November 4 to 10, were allotted to two groups. The 24 ewes in one of these groups were fed 70 mg. Provera per head per day for 17 days, beginning when their lambs were an average of 15 days of age. The other group served as a control and was maintained under similar conditions without receiving Provera in their feed. Vasectomized teaser rams were run with the ewes and matings were recorded for 69 days, beginning the first day of the Provera feeding period.

Milk production of the ewes in both groups was measured three times, one day before the Provera feeding began, during the first week of Provera feeding and during the second week of Provera feeding. Provera feeding apparently had no effect on milk production.

None of the ewes that were fed Provera mated at the time Provera feeding ended but 14 of the 24 ewes of this group mated 17 to 24 days following the last day of the Provera feeding period. Three other ewes mated 35, 38 and 44 days after the last day of the Provera feeding period. The ewes not mating until about three weeks after the Provera feeding period can be explained since ewes usually have a silent heat period, and do not breed, at their first ovulation following lambing. In this case the first ewe mated 46 days after lambing and the last ewe 81 days after lambing. The average interval from lambing to first mating was 55 days. Eleven of the control ewes mated from 39 to 69 days after lambing and there was an average interval from lambing to first mating of 53 days.

Since none of the ewes were allowed to mate to fertile rams no information was obtained on conception and lambing.

In this trial the feeding of Provera did not influence the amount of milk produced. A 17 day Provera feeding period was not followed immediately by the exhibition of estrus, but did tend to synchronize the exhibition of the estrus which occurred about three weeks after the end of the Provera feeding period.

TRIAL IV

As shown in Trial III Provera feeding apparently had no adverse effect upon lactation and did tend to synchronize the first estrus exhibited by ewes with young lambs. This trial was conducted to further study the influence of Provera feeding, with and without PMS injections, upon the breeding performance of lactating ewes and the effect upon their subsequent lambing performance.

The 37 ewes that were previously discussed in Trial II were all fed 60 mg. per head per day of Provera for 13 days, April 1 to 13, beginning when the oldest lambs were 17 days of age. When Provera feeding began three of the ewes had not lambed, and were added to the group receiving Provera when their lambs were two days old. The six dry ewes remained with the group and received Provera the full 13 day period. At the end of the Provera feeding period the ewes were equally divided into two groups, the groups being as equal as possible as to breed, age of lambs, number of ewes having twins or singles and number of dry ewes. The ewes of one group were injected with 500 I.U. PMS 24 hours after the last feeding of Provera, the other group received no injection. A ram was put with the ewes on the first day of the Provera feeding period and ran with the ewes continuously for 90 days.

All the Rambouillet ewes were laparotomized one week after the end of the Provera feeding period. Of all the ewes that received PMS at the end of the Provera feeding period, three dry ewes and six with lambs, ovulated. Only one of the ewes, a dry ewe, that did not receive PMS ovulated.

Four ewes, three Dorset X Western and one Rambouillet, mated between 22 and 25 days after the last day of the Provera feeding. One of the three Dorset X Western ewes lambed from this mating and produced a single lamb. All four of the ewes that mated had lambed and were lactating. These were the only matings recorded during the 90 day breeding season, although one Rambouillet ewe lambed from a mating about 90 days after the beginning of the Provera feeding period.

There are several possible reasons why breeding performance was not good with this group of ewes. They were young ewes raising their first lamb crop, consequently it was difficult to keep the ewes in good condition during lactation. The breeding season began in April which is usually a relatively inactive breeding period, which might explain the failure of the six dry Rambouillet ewes to mate.

As was observed in Trial III, the Provera feeding period during early lactation was not followed by the immediate initiation of estrus.

The Rombouillet ewes that had lambed, and had not received PMS, had not ovulated when examined by laparotomy one week after the Provera feeding period. All ewes that received PMS injections had ovulated but in no case did a ewe exhibit estrus until about three weeks after the Provera feeding period.

TRIAL V

In this trial a large group of spring bred ewes were bred at the second estrus after feeding Provera. The factors in reproduction that were studied including the effectiveness of estrus synchronization, conception rate and lambing rate.

Two-hundred and five mature ewes were allotted to two groups before the spring breeding season in 1963. The two groups were balanced as to bred and age of the ewes. One-hundred and three of the ewes, 48 Dorset X Western and 55 Western ewes, were fed 70 mg. Provera per head per day for 16 days, beginning 32 days before the regular spring breeding season (May 20 to June 29). The other group of 102 ewes, 50 Dorset X Western and 52 Western ewes, were fed the same feed ration without the Provera.

The objective in having the Provera feeding period end 16 days before the beginning of the breeding season was to allow the ewes to mate to fertile rams at their second synchronized estrus. Other research workers have, in some cases, reported a lowered conception rate from breeding at the first synchronized estrus. By breeding at the second synchronized estrus it was anticipated that the conception rate of the ewes receiving Provera would be about the same as that of the ewes receiving no Provera.

Although no attempt was made to completely record individual matings, vasectomized teaser rams were run with both groups of ewes during the time after the Provera feeding period and before the regular breeding season. These observations confirmed that many of the Provera group ewes mated at the first synchronized estrus to the teaser rams.

At the beginning of the regular breeding season all the ewes were allotted at random into four breeding groups. Each breeding group was composed of approximately one-half Provera fed ewes and one-half control group ewes. Two rams were assigned to each breeding group. One Dorset ram and one Hampshire ram were assigned to each of two groups and one Dorset and one Suffolk ram were assigned to each of the other two groups. The rams were rotated every day, each ram being with the ewes every other day.

The number of matings for each week of the breeding season and the number of resulting conceptions are shown in Table 2. Estrus synchronization was very effective in the Provera fed group as 95 of the 103 ewes mated during the first week of the breeding season. An additional four Provera group ewes mated the second week, making a total of 99 of the 103 Provera fed ewes mating the first two weeks. Three more ewes of this group mated the fourth week and one ewe did not mate. It is possible that the ewes that mated the fourth week had mated, but were not recorded, during the first two weeks.

Thirty-seven of the 102 control group ewes mated the first week and 49 more mated the second week for a total of 86 of the 102 ewes the first two weeks of the breeding season. Judging from past years performance the control group ewes mated unusually well at the beginning of the breeding season. Since all the ewes were fed for the 16 day Provera feeding period it is possible that this supplemental feed in some way contributed to the better than expected breeding performance of the control group ewes early in the breeding season. No ewes mated for the first time during the last 12 days of the breeding season and few return matings were recorded during this period. This is difficult to explain since eleven of the Provera fed ewes did not lamb and nine of the control group ewes did not lamb.

Table 2. Matings and Conceptions for Trial V

	Provera Group	Control Group
No. of ewes	103	102
First week:[1]		
No. first estrus matings	95	37
No. first estrus conceptions	77	34
Second week:[1]		
No. first estrus matings	4	49
No. first estrus conceptions	3	44
Third week:[1]		
No. first estrus matings	0	9
No. first estrus conceptions	0	8
Fourth week:[1]		
No. first estrus matings	3	3
No. first estrus conceptions	3	2
Last 12 days:[1]		
No. first estrus matings	0	0
Total no. first estrus matings	102	98
Total no. first estrus conceptions	83	88
No. second estrus conceptions	8	4
No. third estrus conceptions	1	1
Total No. conceptions	92	93
No. ewes not lambing	11	9
No. ewes not mating	1	4

[1] Periods of the forty day breeding season May 20-June 29.

The number of first estrus conceptions for each week of the breeding season and the number of second and third estrus conceptions, with the number of lambs resulting from each are given in Table 3. The corresponding number of matings, as previously discussed, are shown in Table 2.

Although only eight rams were used with the 205 ewes, conception rates were very acceptable. Of the 95 Provera group ewes that mated the first week 77 or 81 percent conceived. Thirty-seven control group ewes mated the first week and 34 or 92 percent of these conceived. Over the whole breeding season first service conception rate was 81 percent for the Provera fed ewes and 90 percent for the control group ewes. Eight of the Provera group ewes conceived to second estrus matings and one to a third estrus mating. Four of the control group ewes conceived to second estrus matings and one to a third estrus mating. One Provera group ewe and four control group ewes did not mate during the breeding season.

Lambing rates were very comparable between the Provera group and the control group. The 103 Provera fed ewes produced 133 lambs from 92 conceptions and the 102 control group ewes produced 137 lambs from 93 conceptions. Eleven of the Provera fed ewes and nine of the control group ewes did not lamb.

The lambing results by breed of ewe within the Provera fed group and the control group are given in Table 4. The 48 Dorset X Western ewes that received Provera produced 64 lambs and the 50 Dorset X Western ewes that received no Provera produced 77 lambs. The 55 Western ewes that received Provera produced 69 lambs and the 52 ewes that received no Provera produced 60 lambs. These results indicate that feeding Provera may have reduced the lambing rate of the Dorset X Western ewes and increased the lambing rate of the Western ewes. However, the differences that were observed are not large and may have

Table 3. Conceptions and number of lambs born for Trial V

	Provera Group		Control Group	
	No. Conceptions	No. Lambs Born	No. Conceptions	No. Lambs Born
First Estruses				
1st Week	77	113	34	52
2nd Week	3	4	44	65
3rd Week	0	0	8	11
4th Week	3	5	2	2
Last 12 days	0	0	0	0
Total 1st Estruses	83	121	88	131
Second Estruses	8	10	4	6
Third Estrus	1	1	1	1
Group Totals	92	133	93	137

Table 4. Lambing rate of the Dorset X Western and Western ewes on Trial V.

	Provera Group	Control Group	Total by Breed of ewe
Dorset X Western ewes			
No. of ewes	48	50	98
No. of lambs	64	77	141
Western ewes			
No. of ewes	55	52	107
No. of lambs	69	60	129
Total of both breeds			
No. of ewes	103	102	205
No. of lambs	133	137	270

been due to chance variation in lambing rates. As can be observed from Table 4 the overall lambing rate for the Dorset X Western ewes was considerably higher than for the Western ewes.

In this trial estrus was very effectively synchronized by feeding Provera for 16 days beginning 32 days before the beginning of the breeding season and allowing the ewes to breed at the second synchronized estrus. First estrus conception rate was lower for the Provera fed group than for the control group, but it appears that the first estrus conception rate of the control group ewes was unusually high. The lambing rate for the Provera fed group was only slightly less than that for the group not fed Provera. However, the Provera feeding may have reduced the lambing rate of the Dorset X Western ewes and increased the lambing rate of the Western ewes.

TRIAL VI

This trial was conducted to determine if a Provera feeding period would aid in increasing the number of fall born ewe lambs that would mate and conceive during the regular 30 day late summer breeding season.

Beginning July 30, 1963, 20 head of ewe lambs, born the previous fall, were fed 50 mg. Provera per head per day for 12 days. Twenty head of ewe lambs of like age and breed were fed the same ration without the Provera. Twenty of the 40 head of ewes were Dorset X Western, 10 head were ¾ Dorset-¼ Western and 10 head were ¾ Rambouillet-¼ Dorset.

Two vasectomized teaser rams were put with the 40 ewes for three weeks before the Provera feeding period began. Twelve of the 20 control group ewes and 17 of the 20 Provera group ewes mated to the teaser rams during this period. The ewe lambs that did not mate may not have been sexually active at this time.

A fertile ram was put with both groups of ewes 10 days after the end of the Provera feeding period, on August 20 and remained for a 30 day breeding period. This allowed the Provera fed ewes to mate to the fertile ram at their second synchronized estrus.

All of the Provera group ewes mated but synchronization of estrus was rather ineffective. The first estrus matings of the Provera fed group were spread over a 19 day period with six of the 20 ewes mating the first week, 13 mating the second week and one ewe mating the third week of the breeding season.

All of the control group ewes mated over a 29 day period, six during the first week of the breeding season, 10 during the second week, and four during the third week.

The second synchronized estrus of the Provera fed group should have occurred during the second week of the breeding season. Since 13 of the 20 Provera fed ewes mated during the second week of the breeding season there was a tendency for the ewes to remain synchronized. But, in comparison, 10 of the 20 control group ewes mated during the same period.

Fifteen of the Provera group ewes lambed, ten from first estrus conceptions and five from second estrus conceptions. Thirteen of the control group ewes lambed, eight from first estrus conceptions and five from second estrus conceptions. All the ewes that lambed, in both the Provera fed group and the control group, produced single lambs.

The failure of effective estrus synchronization in this trial might have been contributed to by several factors. Past experiences has shown that conception rate is not high in ewe lambs and it is possible that some of the ewes were not having regular estrual cycles when the Provera feeding period began. If the ewes were having estrual cycles of very irregular length much of the synchronization effect might have been lost by waiting until the second estrus to breed the ewes.

SUMMARY

Estrus was effectively synchronized in three of four trials with non-lactating ewes. In one trial with late summer breeding of ten month old ewe lambs estrus was not well synchronized when the ewes were allowed to mate at the second estrus after the end of the Provera feeding period. In these trials lambing rate of ewes that had received Provera was about equal to that of ewes receiving no Provera.

In two trials in which Provera was fed to lactating ewes it was found that the ewes did not exhibit estrus and mate immediately after the end of the Provera feeding period. However, estruses that occurred about three weeks after the end of the Provera feeding period tended to be synchronized. In one trial with lactating ewes the injection of PMS at the end of the Provera feeding period caused ovulation but not estrus. Provera feeding, either with or without PMS injection, did not appear to hasten the occurrence of estrus in lactating ewes. The feeding of Provera to lactating ewes was found to have no effect on milk production.

Restricting Feed Intake To Growing-Finishing Swine

J. C. Hillier, Marvin Heeney, L. E. Walters and Lynn Bryam

The practice of restricting the feed intake of growing-finishing pigs has been followed by European producers for many years. This is done to tailor the carcasses produced to the exacting requirements of their pork carcass standards for Wiltshire sides and for very lean cured pork cuts, such as ham. It is also claimed that some improvement in feed efficiency is accomplished by limiting the feed intake to 80-85 percent of the amount that would be consumed if the same ration was self-fed.

Much interest has been shown in the limited feeding of growing-finishing pigs in this country in recent years. Several mechanical devices have been developed and placed on the market to deliver measured quantities of feed to groups of pigs at variable intervals. The results of research in this country on the limiting of feed to growing-finishing pigs vary a great deal. Some report favorable results both from the standpoint of improved carcass leanness and improved feed efficiency. Others report increased feed requirements per unit of grain as well as unfavorable results from a carcass standpoint, particularly in terms of dressing percentage.

It is visualized that a successful scheme to limit the feed intake of growing-finishing pigs must meet the following requirements.

1. It must limit the feed intake of pigs in relation to the need for limitation, that is the tendency to fatten. Those that tend to become excessively fat should be restricted most.

2. It must become more restrictive as the pigs become older and heavier and tend to lay on more finish.

3. It must permit some variation in daily feed intake in relation to the pig's desire to eat and to his need for body heat. This point applies particularly under conditions where environmental temperatures are subject to considerable variation.

4. It must permit each pig in a pen an opportunity to eat without having to fight the others to get his share. If this requirement is not met the boss pigs are limited only to a slight degree and the weaker ones too much. Under such conditions the pigs in a group become less uniform in size and finish as they approach market weights. The goal should be to make the pigs in a group more uniform by limiting the finish on those with the greatest tendency to fatten.

5. The degree of restriction and the ration formulation should be such that the necessary nutrients for maximum bone and muscle growth will be provided with little excess energy for storage as body fat.

6. It must be aninexpensive piece of equipment that requires very little daily attention.

To meet the above requirements a simple arrangement was made by placing regular two-hole self-feeders at the top of a series of steps in such a way that the pigs had to stand in an inclining position to eat. The steps used in this study required the pigs to stand at an angle of about 56 degrees. This is about as steep an angle as a market weight pig can stand on long enough to eat a reasonable amount. It was thought that this arrangement would require a certain relationship between physical strength and the weight of the animal. This might be interpreted as being between muscle and finish. It was hoped that the small framed pig with a strong tendency to fatten would become tired and retreat from the feeder before consuming as much as he would have if standing on a level floor. On the other hand it was hoped that the "athletic type" pig could hold himself in this position long enough to eat nearly as much as he would have if standing on a level floor. The relationship between strength and weight should bring about greater restriction of feed as the animal became heavier. A sketch of the equipment used appears below.

PROCEDURE

Pigs of Hampshire and Yorkshire breeding were used on these trials. Those on test from July through October were fed three to the pen. In the second trial (November-February) the pigs were fed in pairs. Within replicates the pigs were allotted on the basis of breed, sex, weight, sire and general appearance. Weight differences within each replicate were small, while sex and sire differences were balanced as well as possible. There were, however, considerable weight differences among replicates. Water was supplied by an automatic system.

The pens were about 7 X 7 feet and were located in a large barn which was relatively cool in summer and not real cold in winter. Temperature conditions were not recorded.

The same type-two-hole self-feeders were used in all pens. In the one case it was placed on the floor in the ordinary position, in the other it was placed at the top of a set of stair steps as indicated above.

The platform on which the feeder was placed was perforated with a series of one-half inch holes to allow all of the spilled feed to drop into a drawer below. Feed collected in the drawer was returned to the feeder. By this means feed wastage was held to a minimum.

As the individual pigs reached a weight of 200 pounds they were removed at weekly intervals and taken to the university meat laboratory for slaughtering and processing. The usual carcass measurements were made, plus specific gravity and a chemical analysis of the soft tissue of the right side of the carcass produced in the first trial.

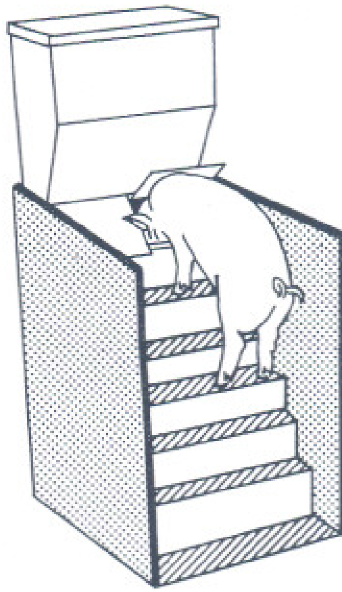

Figure 1. With this platform feeder pigs could eat whenever they wanted to, but to do so had to climb and stand in an inclining position on a ramp.

A milo-soy type ration containing 16 percent protein was fed throughout the trial. The usual change to a 14 percent protein ration as the pigs reached 120 pounds was not followed because of the difficulties involved in getting the changes made at the proper time. The ration used is shown in table 1.

Table 1: Ration Fed

Ingredients	Percentage	Per Ton
Milo-Western Yellow, No. 1 (Ground)	76.5	1530.0
Soybean Meal (50%)	15 9	318.0
Alfalfa Meal (17% Dehy.)	5.0	100.0
Calcium Carbonate	0.8	16.0
Dicalcium Phosphate	1.0	20.0
Trace Mineral Salt	0.5	10.0
Vitamin—Antibiotic—Trace Mineral Per Mix	0.3	6.0
Total	100 0	2000 0

RESULTS AND DISCUSSION

The results of this test are summarized in table 2. Daily feed consumption was reduced from 6.44 to 5.23 pounds, a reduction of 1.21 pounds or 18.8 percent. This reduction in daily feed intake was accompanied by a significant reduction in rate of gain from 1.87 to 1.58 pounds, a drop of 0.29 pounds daily or 15.5 percent. Previous work has shown

Table 2: Summary of Results

Lot No. Treatment Standing Position Rate of Feeding	I Self-Fed Level Floor Unlimited	II Self-Fed 56 Degrees Limited
Production Data		
Number of Pigs	50	47
Initial Wt. (Lbs.)	66 6	66.3
Final Wt. (Lbs.)	204.5	202.0
Av. Gain (Lbs.)	137.9	135.7
Days on Feed (Lbs.)	75.0	90.5
Av. Daily Gain (Lbs.)	1.87	1.58
Av. Daily Feed (Lbs.)	6 44	5.23
Feed Efficiency (Lbs.)	3.51	3.38
Feed Cost		
Carcass Data		
Chilled Carcass Wt. (Lbs.)	141.4	140.7
Dressing Percentage	69.1	69.6
Specific Gravity of Carcass	1.046	1.051
Loin Area (Sq. In.)	4.01	4.33
Backfat Thickness (In.)	1.42	1.32
Ham Percentage (L.W.)	14.3	15.0
Loin Percentage (L.W.)	12.2	12.4
Ham-Loin Percentage (L.W.)	26.5	27.4
Lean Cut Percentage (L.W.)	40.4	41.8

that a reduction of at least 0.20 pounds per day is required to have a significant influence on carcass composition. Pigs on the lower daily feed intake required 15.42 days longer to reach slaughter weights. The full-fed pigs average about 155 days of age when slaughtered and the restricted group about 170 days.

Feed efficiencies of 3.51 and 3.38 were obtained. This difference of 0.13 pounds or 3.7 percent in favor of the restricted group is not statistically significant. If one figures the complete ration at $2.90 per hundred the feed costs would amount to $10.21 and $9.80 for the full-fed and restricted groups respectively. This difference in feed cost of $0.39 per hundred may be offset against the additional time required and equipment used by the limited fed pigs. On the 136 pounds gain made by each pig this amounts to $0.48 per head or a little over three cents per day for the fifteen additional days required.

The influence of the treatments on the composition of the resulting carcasses is also indicated in table 2. All carcass calculations are based on the weights off feed. Considering full weights on the live hogs and a 24 hour shrink on the carcasses dressing percentages of 69.1 and 69.6 were obtained. These dressing percentages seem low in relation to those obtained after marketing shrinkages are absorbed. On the basis of live weights taken just prior to slaughter, after 14 hours without feed, and hot carcass weights the dressing percentages would have been in excess of 72.0 percent. In either case, the dressing percentage of the limitedfed group slightly exceeded that of the fullfed group.

All of the physical measurements of carcass composition used indicated that the limited-fed pigs were slightly leaner. Differences between the treatments with regard to backfat thickness, loin area, percent ham and percent lean cuts were all statistically significant. Loin percentage did not differ significantly between groups. Under the experimental design used it is not possible to separate the influence of limited feeding with the resulting longer time required to reach slaughter weights and the in fluence of the additional exercise required of the pigs standing in the in clining position.

From the standpoint of backfat thickness, 84 percent of the carcasses from full-fed pigs carried 1.6 inches of backfat or less and would have met this requirement for No. 1 carcasses. Several others were close to the maximum backfat. Ninety-six percent of the limited fed group met these standards. Thus if one were working with hogs on the borderline between No. 1 and No. 2 it appears quite likely that such a scheme as described herein could be used effectively in increasing the percentage of No. 1 carcasses. On discriminating markets this could be worth while.

The improvement in lean cut yields as a percentage of live weight of 1.4 percent might also be given a value. At present market prices each percentage change in lean cut yields is worth about $0.20 per hundred on the live hog. Thus, the limited fed group would actually be worth about $0.28 per hundred or $0.56 more per head than the full-fed group. This value coupled with the $0.48 saving per head in feed cost amounts to $1.04 greater difference between feed cost and market value in favor of the group receiving the lower daily feed intake. With some modification, this scheme could be made to restrict feed intake further if such was desired. Its adaptation to commercial practice would be very simple if market demands require a leaner carcass. One should remember that average market hogs yield about 33 to 34 percent of their live weight in the four lean cuts if processed under conditions of this experiment. The full-fed group yielded 40.4 percent, a full 6.0 percent above the average market hog. Restricted feeding moved this figure up an additional 1.4 percent to a total of 7.4 percent above the average market hog. To make limited feeding practical these differences must be recognized at the market.

The Feasibility of Feeding Lambs During The Summer, and The Effect of Two Concentrate:Roughage Ratios on Certain Live Measurements and Carcass Composition

D. G. Ely and Robert L. Noble

Many Oklahoma lambs born during February and March fail to reach market weight by the middle of June. These lambs are either sold as feeders or carried through the summer and fattened during the fall months. In either system there is an economical loss to the state. With the improvement made in rations in recent years, it was considered desirable to further test the feasibility of feeding lambs in dry-lot during the summer months.

Also, considerable interest has been shown in recent years in the use of high concentrate rations for fattening cattle and lambs. Most feeding trials have indicated satisfactory gain and feed efficiency of lambs to high energy rations; however, very little work has been reported on the effect of ration on carcass composition. This research was initiated to study both the feasibility of feeding lambs during the summer and to study the effect of two concentrate to roughage ratios on the feedlot performance, and carcass characteristics of lambs sired by rams of different breeds.

PROCEDURE

Forty-eight, 4-month-old lambs born of Rambouillet ewes and sired by either Dorset, Hampshire, or Suffolk rams were assigned to the experiment. Twenty-four were Dorset (DxR) and 24 were black-face (H or SxR). Lambs of each breed were randomly allotted into two lots of 12 lambs each, except that twins were separated. Treatments consisted of two concentrate:roughage (C:R) ratios (50:50, 92:8) which were factorially arranged with two breeding groups (Dorset and black-face). Ingredient composition and nutrient analyses of the self-fed rations are given in table 1. The primary differences between the rations were the differ ences in crude fiber and TDN.

All lambs were drenched with phenothiazine and sheared two days prior to the initiation of the experiment. A 24-hour shrunk weight was taken when the lambs were allotted. Live measurements of loin width, leg circumference, rump length, body length, and heart girth circumference were also taken at this time. The lambs were started on feed gradually and by the 6th day were on full feed.

Individual lambs were removed from the experiment when they reached approximately 97-103 pounds non-shrunk weight. At this time, the live measurements were repeated. The animals were shrunk for 24 hours, reweighed, and slaughtered. Following a 48-hour chill period, specific gravities were obtained on each carcass. The carcasses were then ribbed (between 12-13 ribs) and the backfat was measured over the inside edge, the center, and outside edge of the *Longissmus dorsi* (loin-eye) muscle two different times an averaged. Duplicate tracings of the *Longiss mus dorsi* (loin-eye) were averaged.

The carcasses were broken (using standard cutting procedure) into the four lean cuts. The cuts were trimmed to leave not more than 1/4 inch of outside fat. A semi-physical separation of fat and lean was made on each of the four lean cuts as well as the remainder of the carcass. All the separated lean and fat of the carcass was ground twice (separately). Duplicate samples of each were taken for chemical analysis.

RESULTS AND DISCUSSION

The average number of days on feed and the average initial, final, shrunk, and cold carcass weights are given in table 2. Although some

Table 1. Composition of Rations (%)

Breed	Dorset		Black-face	
Ration	Standard[1]	HE	Standard[1]	HE[2]
Ingredient				
Ground milo	45	80	45	80
Ground alfalfa hay	50	8	50	8
Cane molasses	5	5	5	5
Soybean oil meal	--	7	--	7
Nutrient analyses				
Dry matter	88.97	88.44	88.97	88.44
Crude protein	11.70	11.49	11.70	11.49
Crude fiber	15.34	4.54	15.34	4.54
TDN	63.77	75.78	63.77	75.78
Calcium	0.78	0.77	0.78	0.77
Phosphorus	0.25	0.29	0.25	0.29

[1] Standard rations were supplemented with 10 pounds of salt and 2 pounds of Aurofac 10 per ton of feed.
[2] HE rations were supplemented with 10 pounds of salt, 1.5 pounds of Vitamin A (10,000 I.U. per gram), 2 pounds of Aurofac 10, and 30 pounds of calcium carbonate per ton of feed.

Table 2. Average Number of Days on Feed and Average Initial, Final, Shrunk, and Cold Carcass Weights

Breed	Dorset		Black-face	
Ration	Standard	HE	Standard	HE
Measurement				
Days on feed	69.25	61.83	53.83	60.25
Initial wt., lbs.	69.67	72.83	75.08	74.17
Final wt., lbs.	98.50	100.25	102.75	101.17
Shrunk wt., lbs.	89.29	89.58	91.04	90.08
Cold carcass wt., lbs.	47.08	49.81	47.45	48.41

variation existed between lots when the initial and final weights were taken, average total gain during the feeding period were quite similar, ranging from 27 to 28.83 pounds.

SUMMER FEEDING

Both rations produced very satisfactory gains (.47 to .50 pound per day). This is in agreement with previous summer feeding trials (see M.P. 67) at the Ft. Reno Station. It would appear that lamb can be fed quite satisfactorily through the summer months.

THE EFFECT OF RATION

There was no significant difference in the average daily gain due to ration. No digestive disturbances or death loss occurred with either ration, thus indicating the feasibility of self-feeding rations varying considerably in energy (TDN) content (63-76%).

The percentage of the carcass as trimmed loin was significantly greater from the standard fed lambs than those fed the high energy ration. There was a trend for the lambs fed the standard ration to have more loin eye area, less backfat thickness, less total fat, and a greater percentage of lean per cwt. of carcass, and a lower dressing percentage than the lambs fed the high-energy ration. (Table 3) These differences would indicate—even with the average daily gain essentially the same—that the composition of the carcass is effected by ration even during a relatively short feeding period (approx. 70 days).

THE EFFECT OF BREED (SIRE)

The Dorset-sired lambs were fatter as indicated by both average backfat thickness and percentage fat in carcass. This would be expected as Dorsets mature at lighter weights than the black-faced breeds.

The black-faced sired lambs had significantly more trimmed leg and a slightly larger percentage lean in the carcass than the Dorset-sired lambs.

CORRELATIONS

Correlations indicated that the percentage of trimmed loin and leg typified carcass composition to a higher degree than any other measure studied.

Table 3. Average For Selected Live Animal and Carcass Measurements.

Breed	Dorset		Black-face	
Ration	Standard	HE	Standard	HE
Measurement				
Av. Daily Gain, Lbs.	0.46	0.47	5.54	0.47
Loin Width Inc.*, In.	0.82	0.68	0.76	0.60
Leg Cir. Inc.*, In.	0.74	0.45	0.45	0.47
Rump Length Inc.*, In.	2.13	1.79	2.14	2.00
Body Length Inc.*, In.[3]	2.65	1.84	2.92	3.00
Hg. Cir. Inc.*, In.	4.35	4.23	4.05	4.13
Dressing Percent[6]	52.73	55.59	52.13	53.77
Specific Gravity[3]	1.0463	1.0335	1.0426	1.0384
LEA[1]/cwt. Carcass, Sq. In.	4.28	4.18	4.43	4.36
BF[2]/cwt. Carcass In.	0.66	0.76	0.63	0.67
Percent Trmd. Leg[4]	22.62	21.70	23.60	23.49
Percent Trmd. Loin[5]	6.77	6.45	7.07	6.46
Percent Trmd. Rack	5.56	5.61	5.61	5.48
Percent Trmd. Shoulder	20.75	21.05	20.97	21.48
Yield Trmd. Lean Cuts (Live Wt. Basis)[5]	29.34	30.35	29.83	30.56
Percent Lean In Carcass	52.39	50.98	53.10	52.44
Percent Fat In Carcass[3]	29.84	32.47	28.29	29.54
Percent Bone In Carcass[4,5]	14.54	13.41	15.81	14.84

*Increase of, during feeding period
[1] Loin-eye area
[2] Backfat
[3] Significant difference ($P < .05$) between breeds
[4] Significant difference ($P < .01$) between breeds
[5] Significant difference ($P < .05$) between rations
[6] Significant difference ($P < .01$) between rations

Trace Minerals In Beef Cattle Feeding In Oklahoma

Allen D. Tillman

INTRODUCTION

Many localized areas in the United States have been found to be unsatisfactory for the raising of beef cattle because of severe endemic disorders. By close study of such disorders, which result primarily from trace mineral deficiencies in the indigenous forage, new areas are being found each year. Such acute deficiency symptoms are important, but it must be emphasized that the greatest loss in beef production results from the subclinical deficiencies. In such cases no definite symptoms appear.

Rather, the metabolism rate of the animal slows down in compliance with the level of the limiting nutrient. This results in slower growth, less resistance to infection, less resistance to parasites, less milk production, and lowered efficiency.

As techniques for detecting subnormal performance associated with a limiting nutrient are improved, it is predicted that new areas showing suboptimum trace mineral levels will be discovered at an increasing rate. This is true in Oklahoma where improvements in sanitation accompanied by the judicious use of drugs have reduced the incidence of infectious diseases and parasite damage, and selection and performance testing has increased the genetic potential for fast growth to a level never before found in this animal. Biological bottlenecks, such as trace mineral deficiencies, which limit growth and performance, become apparent much sooner under improved conditions which place greater stress on animals. When one considers the cost-price squeeze that the Oklahoma beef producer now faces, it becomes apparent that even more stress will in the future be placed upon this animal in an attempt to make him gain faster and more efficiently in terms of both feed and money.

The purpose of this paper is to discuss the importance of trace minerals in the production of beef cattle. For convenience, the paper will be divided into three sections: (1) identification and metabolic function of trace elements; (2) listing of the quantitative requirements; and (3) a discussion of the possible need for each trace mineral in Oklahoma.

ESSENTIAL TRACE MINERALS

The proof of essentiality of a trace mineral rests upon the effects of variations in dietary levels upon growth rate, structural changes, and their functioning in enzymes associated with the general well-being of the animal. Under these conditions, the following minerals are *definitely* dietary essentials for cattle. *Iron, cobalt, copper, iodine, manganese* and *zinc*. Molybdenum and selenium are of doubtful importance, thus will receive only brief consideration.

GENERAL FUNCTIONS AND DEFICIENCY SYMPTOMS

Iron. Iron functions in many enzyme systems in the body and it is well known that nutritional anemia results from an iron-deficient diet. Nutritional anemia can occur at anytime during the life span; however, it is most likely to develop during the suckling period when milk, which is a very poor source of iron, is the major or only component in the diet. The young calf, on essentially a milk diet shows the following sequence of symptoms: (a) feed refusal (b) scouring (c) paleness of buccul mucous membranes and of the conjunctiva, (d) reluctance to move (e) high pulse rate with slow return to normal after forced exercise and (f) progressive loss of appetite. A steady fall is found in the hemoglobin level from about 13% to as low as 4%.

Some field trials in Scotland show that a mild anemia exists in calves 2-3 months of age and that iron-dextran administration will prevent or alleviate the condition. The practical significance of this discovery is in doubt at the moment and the whole area awaits results of similar trials conducted under Oklahoma conditions. In this connection, it is of great interest to note that Indiana workers found that the injection of 300 mg. of a iron-dextran mixture into lambs at 1 and again at 10 days of age resulted in increased gains and reduced mortality.

Copper. Where the vegetation supplies 5 ppm or less copper, adult cattle suffer from "falling disease," which is characterized by (a) loss of weight, (b) diarrhea, (c) anemia, and (d) sudden death caused by heart failure; the weight of the heart is often doubled. Infertility in cows is quite frequent. Calves from copper-deficient cows show (a) poor growth, (b) fading of hair color, (c) a stilted gait resulting from either poor muscular development or failure of bone deposition in the matrix of copper-deficient calves.

There is a reduction in the synthesis of phospholipids or in animals when copper is deficient and the failure to form phospholipids at the normal rate is a possible explanation of the demyelination of the myelin sheath noted in copper-deficient calves and lambs, resulting in an outward condition called "swayback."

A deficiency of copper in sheep results in a marked decrease in wool growth; copper-deficient wool has more sulfhydryl and less disulfide groups than normal. The bleaching of the haircoat probably represents a failure in melanin formation, a process requiring the enzyme, tyrosinase.

Copper requirements and copper deficiency symptoms around the world are influenced by dietary levels of phosphorus, molybdenum, sulfates, and zinc. For example, a high level of molybdenum will result in a copper deficiency if the level of inorganic sulfates is sufficient. In this case, the animals will respond to additional dietary copper. The toxicity of excess molybdenum is less if low levels of inorganic sulfates are present. An excess of zinc results in an anemia which also can be alleviated by additional copper. An interpretation of the experimental data would indicate that in forages containing excess molybdenum, the requirements for copper, sulfur, and phosphorous are increased. There are some indications in Oklahoma studies that the copper level of forages might be lower in plants which contain high levels of manganese and iron, a characteristic of plants grown on the more acid soils found in the southeastern part of the state.

Cobalt. Cattle utilize cobalt for the ruminal synthesis of vitamin B_{12}, thus the symptoms of a cobalt deficiency in the ruminant animal are essentially those of a vitamin B_{12} deficiency in the non-ruminant. Cattle grazing indigenous forages containing less than 0.07 ppm become (a) listless, (b) lose appetite, (c) lose weight, (d) become weak, (e) become anemic, and (f) finally die. *The lowering of the vitamin B_{12} content in the blood is the only specific symptom.* The only certain diagnosis of a cobalt deficiency rests upon the response of the animal to the feeding of cobalt. The response is rapid. Appetite improves within a week or less and the animals begin to gain in weight and general appearance within several weeks. Australian workers have described a new procedure for supplying small amounts of cobalt to cattle and sheep; a cobalt oxide pellet is placed in the esophagus and, after the animal swallows, is trapped in the reticulum. The pellet releases a small amount of cobalt continually over a fairly long period of time. Ruminal bacteria utilize this source of cobalt to synthesize vitamin B_{12}, which is utilized by the animal.

Apparently ruminants require a high level of vitamin B_{12} because it is required for the utilization of propionic acid, one of the major end products of microbial breakdown of dietary carbohydrates in the rumen.

Cobalt levels in plants reflect levels of that element in the soil. This element apparently has no important role in plant nutrition, but is necessary for an active microbial population in the soil. The variety of soils which are deficient in cobalt is too great to make definite associations but rain-leached hills low in organic matter is an example of a inadequate soil, which will produce a plant deficient in this elemnet.

Iodine. The mature bovine contains no more than 0.00004% iodine, more than one-half of which is found in the thyroid gland. Iodine functions as a part of thyroxine, a hormone concerned with the regulation of the metabolic rate. A deficiency of iodine results in an enlargement of the thyroid gland, a condition called goiter. Goiter results because of compensatory hypertrophy of the thyroid gland, i.e., an enlargement of the thyroid gland in an effort to supply more thyroxine. The condition is much more prevalent in the young born of mothers deficient in the element.

Iodine deficiency is an area problem and fortunately Oklahoma is not located in an area in which the soil, water and forages are deficient in this element.

Manganese: Manganese deficiency symptoms in the bovine include (a) poor growth (b) poor body development, (c) leg deformities (shorter and thicker bones), (d) poor fertility (e) frequent abortion and (f) a dull, dry haircoat. The element is an activator of a number of enzymes, which perform important functions in the body. It has been found, in particular, that cattle receiving manganese-deficient diets have lower bone phosphatase activity than normal animals, thereby offering a possible explanation as to why the bones fail to grow in length. Other enzymes which are more active in the presence of manganese are phosphoglucomutase, intestinal peptidases, cholinesterase, cozymase, isocitric dehydrogenase, the carboxylases, arginase and adenosine triphosphatase. Small wonder that numerous deficiency symptoms are found when the diet contains a suboptimum level of this element.

Fortunately, most forages in the world contain higher levels of manganese than is required by the bovine. In fact, some contain levels that are too high. Forages containing an average of 734 ppm of manganese have caused a drop in the magnesium level in the blood and lactation tetany in studies conducted in England. In Oklahoma studies the addition of 250 or 500 ppm of manganese to the diets of beef cows over a period of several years had no pronouned effect upon reproductive and lactation performance. In fact, work with other animal species indicate that if the ration is balanced as regards other minerals, animals can tolerte high levels of manganese.

Zinc: Since natural feeds contain 30 ppm or more of zinc, studies of absolute deficiencies of this nutrient have hitherto been limited to the rat. Then a conditional deficiency of zinc has been found widespread in pigs reared under commercial conditions. High levels of dietary calcium combined with the relative low availability of zinc found in natural feedstuffs of vegetable origin seem to be the conditioning factors causing a deficiency of zinc.

Georgia workers, using a purified diet, produced a zinc deficiency in calves. The outward symptoms appeared about 8 weeks after the animals were placed on the low-zinc diet and were as follows: (a) slightly red and inflamed nose and mouth (b) mild swelling above the rear feet in front of the fetlock, (c) loss of hair on the rear legs and rest of the body (d) breaks in the skin around the hoofs (e) rough and scaly skin especially on the rear legs (f) and a dull, listless appearance. Similar lesions have been noted in beef and dairy cattle kept under natural conditions; cattle grazing the Berbice savannahs have many of the above parakeratotic lesions which cover over 40% of the body. Response to zinc given orally (2 gm./week) or by subcutaneous injection (1 gm./week) was rapid; new growth of hair appeared within one week and the animals appeared normal within three weeks. The unsupplemented control animals in the meantime became steadily worse.

In Finland, the writer saw a number of dairy cows which exhibited the above symptoms. These cows (a) produced less milk, (b) made less efficient use of their feed, (c) required more services for conception and (d) had more abortions than animals not having these abnormalities. Zinc supplementation gave a prompt alleviation of the parakeratotic lesions and later disappearance of the other conditions.

Zinc functions in the metaloenzymes. For example it functions in carbonic anhydrase, an enzyme concerned with the formation of carbonic acid. It, as a part of pancreatic carboxypeptidase, functions in protein digestion. There is also evidence that it is found in glutamic dehydrogenase as well as in lactic dehydrogenase. Red blood cells contain relatively high levels as do some sexual secretions. Males show irreversible atrophy of the testicular epithelium if kept on zinc-deficient diets.

Molyebdnum: is required in xanthine oxidase, an enzyme concerned with purine metabolism. Oklahoma workers have found that rations containing 0.10 ppm of molybdenum met the requirements of ruminants unless nitrates were used as nitrogen sources. As molybdenum is required for the reduction of nitrates to nitrites, a higher level is probably required when ruminant diets contain nitrates.

Forages containing high levels of molybdenum are toxic. The unhealthy pastures contain 20 to 100 ppm of molybdenum causing severe scouring, a condition called "teart" in England and other affected areas. As pointed out previously, there is an interaction between molybdenum, inorganic sulfates and copper. If the first two are high, molybdenum toxicity can be overcome by adding copper to the diet.

Fortunately, there appear to be no large areas in Oklahoma in which toxic levels of molybdenum are present.

Selenium: Interest has shifted from the toxic aspects of selenium in animals kept in some areas of the United States to its possible essential role in nutrition. Several groups of workers have found that selenium, given orally or subcutaneously to lambs, prevents "stiff lambs disease" and muscular dystrophy in calves. It appears that selenium, when given to the dam prior to partuirition, affords some protection against muscular dystrophy. It is also just as effective as is vitamin E in the cure or prevention of muscular dystrophy in the young calf.

The physiological function of selenium is not known at the present time.

QUANTITATIVE REQUIREMENTS FOR TRACE MINERALS BY BEEF CATTLE

The quantitative requirements of beef cattle for the trace minerals are shown in table 1.

ARE TRACE MINERALS NEEDED BY BEEF CATTLE IN OKLAHOMA?

There is no simple answer to this question, thus let us consider conditions which do or might lead to a deficiency of one or more trace minerals in beef cattle diets; however, should the experimental evidence definitely indicate a need for trace minerals, such information will be given along with a definite recommendation as regards whether these should be provided in the diet.

For further consideration of the problem the state is divided into east and west sections, using Highway 81 as the division line. The land

Table 1. Requirement of Cattle and Sheep for the Trace Minerals.

	Cobalt, p.p.m.	Copper, p.p.m.	Iron p.p.m.	Iodine mcgm.	Manganese p.p.m.	Zinc p.p.m.
Beef cattle	0.07	5-10	80-150	200-400	15-30	30
Dairy cattle	0.07	5-10	80-150	200-400	15-30	30
Sheep	0.07	5-10	80-150	200-400	15-30	30

to the west of the line tends to be more alkaline in nature. Such soils are generally lower in available iron and manganese but contain higher levels of phosphorus, copper and molybdenum than the more acid soils. Thus, it becomes apparent that the cows grazing plant indigenous to the west may show a greater liklihood of iron or manganese deficiency than for the other trace elements. If the more alkaline soils, whether they be in the east or west, contain high levels of calcium, there is a possibility that zinc absorption by plants is poor. Thus ranchers running cattle on the limestone soils must be aware of the possibilities of zinc deficiency symptoms, which have been described.

East of the division line, the soils tend to be more acid in nature. These soils may contain higher levels of available iron and manganese, but lower levels of phosphorus and molybdenum than those from the more alkaline soils in the west. There are some indications that the forages which contain high levels of iron and manganese have lower levels of copper. Whether the combination of adverse factors would serve to make copper a limiting nutrient is of conjecture but is not beyond the realm of possibility.

Incomplete analyses of some feeds available to Oklahoma livestock producers are shown in table 2. Such analyses are difficult and expensive to obtain, thus our information concerning the effect of trace minerals of soils upon their contents in forages is very limited. As a result, the third factor, i.e., the effect of the trace mineral analysis of the plants upon animal performance is not very well documented unless severe deficiency symptoms are encountered. The important interrelationship of trace minerals of the soil, their subsequent uptake by plants and their effect upon the productive performance of Oklahoma beef cattle must be studied in carefully controlled experiments. From results of such studies, specific recommendations could be made. Advances in the technology of trace mineral analyses of soils, plants and certain animal fluids now place such a study in the realm of possibility. Until such a study is made and the results made available, only certain general statements can be made and many of these are conjectures.

Table 2. Mineral Composition of Some Feeds

Mineral	N	Ca	P	Mg	K	S	Mn	Co	Cu	Fe	Zn
Level	%	%	%	%	%	%	ppm	ppm	ppm	ppm	ppm
Feeds											
Corn	1.44	0.02	0.28	0.11	0.30	0.04	5.5	0.23	4.2	20	20.0
Milo	1.60	0.03	0.28	0.13	0.35	0.05	13.2	0.30	16.0	40	21.0
Barley	1.92	0.06	0.40	0.13	0.60	0.15	17.6		11.7	80	31.0
Urea	42.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	00.0	00	00.0
Cottonseed meal	6.71	0.20	1.10	0.52	1.48	0.40	22.9	0.27	18.5	160	31.0
Soybean meal	7.20	0.27	0.63	0.25	1.77	0.33	32.3	0.21	18.0	130	26.6
Corn and Urea (6:1)	7.23	0.02	0.24	0.09	0.26	0.03	4.7	0.20	3.6	17	17.0

As pointed out previously, cobalt apparently has no function in plants; however, it is of interest to note that cobalt level in plants decreases as the leaf to stem ratio decreases; most of the cobalt is found in the leaves. From meager results, it appears that the eastern section of Oklahoma offers the best possibilities for obtaining cobalt deficiency symptoms. Forages from leached soils, which have low fertility, are probably the most susceptible.

When cottonseed meal or cake was the protein supplement for range cattle during the winter season, trace mineral supplements in many Oklahoma studies have not improved the performance of beef cattle. A few years ago the author, however, feeding in drylot identical twin Angus steers a ration of weathered range forage, which was clipped in the winter from the Lake Carl Blackwell Range Area, plus one and one-half pounds of cottonseed meal daily, found that a trace mineral mixture containing cobalt, copper, iodine, iron, manganese, and zinc did not greatly affect gains. There were striking differences, however, in the general appearance of the animals. Those receiving trace minerals had a glossy haircoat showing neither dryness nor dandruff in their hair while the control animals exhibited a dull haircoat that appeared quite dry and contained much dandruff. Kansas workers conducted a similar experiment in which cattle were fed a ration of prairie hay plus cottonseed meal, with and without trace minerals, and obtained the same results as regards gains and condition of the haircoat.

If such conditions were duplicated in the field, a need for trace minerals could be shown in a practical feeding trial. In many of the early trace mineral studies conducted by Oklahoma Researchers, steamed bone meal was included in the control ration as a source of phosphorus. As bone meal is also an excellent source of trace minerals, there were not valid tests; however, results of more recent tests in which dicalcium phosphate was used as a mineral source indicate that trace minerals also did not improve the performance of cattle consuming native grass plus cottonseed meal or cake. Even though these practical field results indicate that trace minerals are not needed when cottonseed meal is used to supplement native range grasses during the winter season, the author feels that it is risky to omit trace minerals from the added feeds or salt during the winter season. These minerals are not expensive to feed and do provide a measure of protection should all conditions of soil, climate and stress factors on the animal be favorable for causing a trace mineral deficiency.

With the present emphasis, particularly in the more humid section of the state, upon improved pastures by the use of different grasses and fertilization programs, coupled with the greater stress upon a better animal for faster growth, there are greater possibilities for a trace mineral to become an item limiting growth or other productive functions. Trace minerals in the feed could result in faster and more efficient gains. They could also cause animals to be better able to resist parasites and infection, resulting in less death losses.

When urea plus corn or milo replaces some or all of the oil meals, the resulting mixture contains a lesser quantity of minerals than do the oil meals. A mixture containing 6 lb. of corn or milo plus 1 lb. of urea is equivalent in nitrogen (N) to 7 lbs. of soybean meal, thus it becomes of interest to consider the mineral composition of the mixture as compared to the oil meals. This has been done in table II and it will be noted that the mixture contains less of all minerals, in many cases less than one third as much. As urea is pure chemical compound, containing no minerals, the figures in this table permit other comparisons. The results of a series of Oklahoma feeding trials, in which urea replaced some of the oil meals in protein supplements, show that the addition of trace minerals consistently improved the performance of beef cattle. Trace minerals, therefore, must be provided in the diet if urea is included in winter protein supplements which are fed to Oklahoma beef cattle.

In recent years, barley has been used in "all barley ration" for fattening cattle. Oklahoma studies have shown that a mixture of trace minerals when added to such rations has consistently improved gains and the efficiency of feed utilization. Also, Kansas studies show that trace minerals have consistently improved the performance of cattle fed fattening rations containing corn.

The results of most feeding trials indicate that the milo grains provide a sufficient supply of trace minerals when this grain is the major grain in fattening rations. In such trials, the oil meals have been the protein source. When urea replaces the oil meals and milo from irrigated soils is fed, the possibilities of showing mineral deficiencies are increased. Further research of this nature should be conducted, especially since there are indications that milo or corn grains produced on alkaline soil could be deficient in zinc.

SUMMARY

The trace elements known to be essential for the bovine are cobalt, copper, iodine, iron, manganese and zinc. Molybdenum and selenium may be present in toxic amounts but the importance of this is unknown. The functions as well as outward deficiency symptoms are discussed for each trace mineral. Also quantitative requirements are listed for each.

In discussing the possible need for trace minerals by Oklahoma beef cattle, the author, using Highway 81 as a reference line, divided the state into east and west sections. The soils in the west tend toward alkalinity, thereby tending to be lower in manganese and iron than those in the east. If the alkalinity be caused by high levels of calcium, there is a possibility of a zinc deficiency; it being emphasized that limestone soils in either section could produce plants deficient in zinc. Soils east of the reference line tend toward an acid condition, thus have high levels of iron and managanese, with some evidence of lower copper levels. Cobalt doesn't seem to be a critical element, but forages from the leached hills in east seem most likely to be deficient in this element.

Feeding trials with cows grazing the dry winter forage supplemented with natural protein indicate no advantage in adding trace minerals. In more critical trials, cottonseed meal did not greatly affect gains but greatly improved the general appearance of the animals; the cattle receiving trace minerals had glossy haircoats in comparison to a dull, dry haircoat in the control cattle.

When urea is substituted for some of the oil meals in protein supplements for winter feeding, trace minerals must be added.

Fattening rations containing high levels of corn or barley are improved by additions of the trace minerals. Milo apparently contains higher levels of the trace minerals than corn or barley; however, changes in production procedures are affecting the mineral composition of the milo grains, and there is some evidence that those produced on alkaline soils are deficient in zinc.

Relationship of Some Growth Factors With Carcass Composition in Milk Fat Wether Lambs

A. W. Munson, L. E. Walters and J. V. Whiteman

This study was designed to determine the relationship between excellence in the carcass and the pattern of growth and development of the lamb from birth to market weight. Breed and type of rearing were of particular interest with respect to their association with carcass composition.

Figure 1, drawn from classical works, illustrates the increase in weight of fat, lean and bone in the lamb carcass. It can be seen from the figure that bone growth is rather constant while the increase in the other two components, fat and lean, varies with the age of the lamb. During early life, muscle growth is relatively faster than fat deposition. However, during some period, probably between the tenth and fifteenth weeks, the growth rate of lean begins to decrease and the rate of deposition of fat increases. Restriction of feed intake during early life should reduce lean development during the period prior to the onset of heavy fat deposition. Will an increased lean growth rate follow such restriction or will the gain be the result of the fat deposition that is more normal at this age? Twin lambs, while nursing a ewe, have the naturally occuring environmental effect of restricted diet when compared to single lambs.

If the foregoing reasoning is correct, a comparison of the carcasses of single reared vs twin reared lambs should indicate whether early growth restriction will have a permanent influence on carcass composition.

Prior to weaning, much of a lamb's genetic potential for gaining ability is masked by the milk production of the dam. After weaning, on the other hand, the growth of lambs on an adequate ration is more influenced by their genes for growth. In Figure 1, period A refers to the period in growth at which the lamb starts rapid deposition of fat relative to the growth of lean. The time at which lean growth decreases and fat deposition increases varies between breeds and between animals within breeds. In general, breeds that have a smaller mature size are referred to as earlier maturing because this time occurs earlier in life and at lighter weights than breeds that have a larger mature size. If all lambs are slaughtered at a given weight (such as 100 pounds), lambs that matured at light weights will have had the opportunity to deposit more fat than those that matured at later times and heavier weights. The Dorset breed is earlier maturing than either the Hampshire or Suffolk breeds and therefore, it would be expected that the Dorset crossbred lambs would be somewhat fatter than Hampshire or Suffolk crossbreeds if all lambs were slaughtered at the same weights.

This preliminary report presents the results that have been obtained thus far in answer to the following questions:

1. Is there a difference in the carcass composition of single as compared to twin reared lambs?

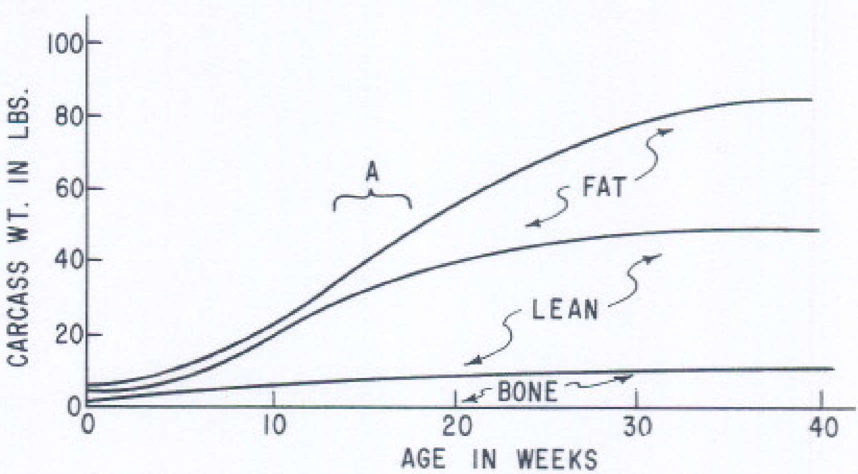

Figure 1—Schematic Diagram of Classical Work Showing Carcass Composition of Lamb by Age.

2. What, if any, are the differences in the carcass composition of crossbred lambs due to breed of sire when comparing early maturing (Dorset) rams with later maturing (Hampshire and Suffolk) rams?

PROCEDURE

The lambs used in this study were from the experimental flock at the Ft. Reno Livestock Research Station. All lambs were out of Dorset X Western crossbred ewes or Western[1] ewes. Half of the sires were Dorset (whiteface) while the other half were Hampshire or Suffolk (blackface) rams. An equal number of single and twin reared lambs was obtained and studied from each sire.

The lambs were born between October 10th and November 25th, 1962. Ten days to 2 weeks after birth, the lambs were placed on wheat pasture with their dams. The lambs had access to a creep containing a mixture of about 32 percent ground alfalfa hay, 63 percent grain sorghum and 5 percent molasses. The lambs were weaned when they weighed a minimum of 46 pounds and were at least 66 days of age.

Biweekly weights were taken on alternate Mondays until the lambs approached 95 pounds and then they were weighed weekly. On the first Monday that the lambs reached a minimum full weight of 100 pounds they were taken off feed and hauled to Stillwater immediately. The lambs were sheared during the evening and were slaughtered the following morning after being off feed approximately 18 hours. The weight of the lambs just before slaughter was recorded as shrunk live weight. After chilling for 48 hours the carcasses were weighed and cut into closely trimmed wholesale cuts (external fat removed). The percent trimmed wholesale cuts was the combined weights of the closely trimmed shoulder, rack, loin and leg expressed as a percent of shrunk live weight.

To determine loin eye area and fat cover at the 12th rib the carcass was ribbed between the 12th and 13th ribs. Tracings were made of the cross section of the *longissimus dorsi* (loin eye muscle) and the areas of these tracings were measured using a compensating polar planimeter. The areas were recorded in square inches. An average of 3 measurements of the fat over the *longissimus dorsi* was used as the fat cover at the 12th rib.

The entire carcass was boned out and the boneless portion ground twice in preparation for chemical analysis. Grinding was first done through a 3/16 inch plate and then through a 1/8 inch plate. After grinding, the ground lamb was mixed and 8 random samples were drawn. The 8 samples were then combined into 2 composite samples of 4 subsamples each for use in chemical determination of percent of fat (ether extract). The weight of the bone in the carcass was recorded and ex-

[1] These ewes were of predominantly Rambouillet breeding.

pressed as a percent of the chilled carcass weight. Percent lean in the carcass was determined by difference, i.e., 100 percent minus percent fat —and percent bone equals percent lean.

RESULTS AND DISCUSSION

Table 1 presents a summary of the growth data of the lambs and Figure 2 illustrates the growth pattern from birth to slaughter. Single lambs were about 1.5 pounds heavier at birth than twins and increased their advantage to 10 pounds or more at 70 days of age. Twins and singles grew at approximately the same rate after 70 days, but twin reared lambs required 23 days more to reach slaughter weight. Table 1 indicates that blackface and whiteface lambs grew at about the same rate before 70 days when the maternal environment was nearly the same for both types of lambs. However, when the lambs were allowed to grow on their own ability, after about 70 days of age, later maturing blackface lambs gained faster than whiteface lambs by about 0.1 pounds per day and therefore reached slaughter weight 23 days before the whiteface lambs.

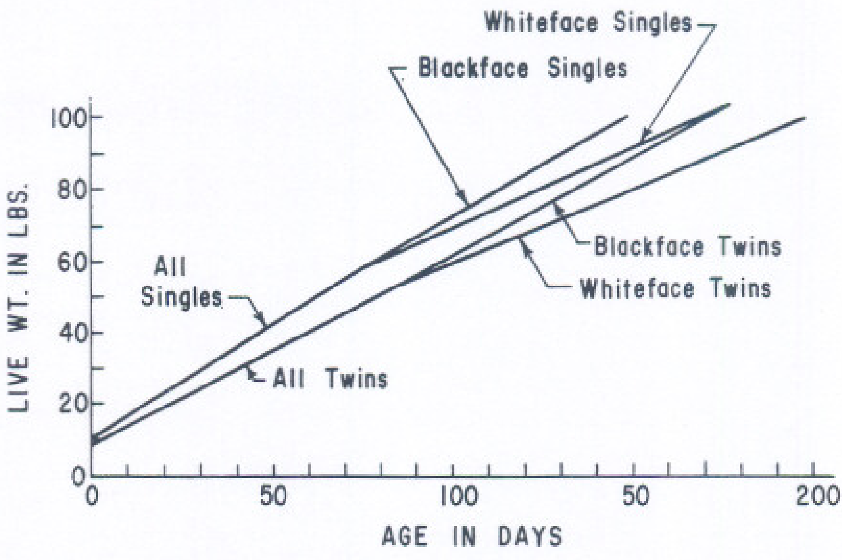

Figure 2.—Growth Pattern of Lambs from Birth to Slaughter Illustrating the Effects of Single vs. Twin Rearing and Early Maturity vs. Late Maturity.

Table 1.—Effect of Breed and Type of Rearing on Various Measures of Growth.

	Blackface		Whiteface	
	Singles	Twins	Singles	Twins
Number of lambs	15.	15.	15.	15.
Birth Weight, lb.	10.6	9.1	10.5	8.7
Adjusted 70 day weight, lb.	58.2	47.5	56.1	46.2
Slaughter weight, lb.	101.7	101.6	101.1	100.8
Age at slaughter, days	144.8	168.1	167.6	194.4
Carcass wt. (chilled), lb.	49.2	48.7	49.8	50.5
Average daily gain birth to slaughter, lb.	.70	.61	.60	.52
Average daily gain 70 days to slaughter, lb.	.59	.57	.49	.45

The carcass data in Table 2 indicate that neither the single-twins nor the time of maturity effects were large. The average carcass grade in each group was choice and the carcasses measured about 0.25 inches of fat cover at the 12th rib. Loin eye area averaged approximately 2.23 square inches. In addition, it should be noted that the percent closely trimmed wholesale cuts was nearly the same for all groups.

Table 3 presents a comparison of the carcass data for blackface and whiteface lambs. Percent of fat in the carcass indicated that whiteface lambs were fatter than blackface lambs, 29 percent and 25.6, respectively. Differences in fat cover at the 12th rib were small.

The percent trimmed wholesale cuts and loin eye area were studied as measures of carcass leanness. Percent trimmed wholesale cuts was slightly higher for whiteface lambs which by most standards would indicate they were leaner than the blackface lamb. This apparent discrepency, however, may be explained on the basis of dressing percent and

Table 2.—Means of Carcass Data for Single and Twin Lambs of Blackface and Whiteface Breeding.

	Blackface		Whiteface	
	Singles	Twins	Singles	Twins
Slaughter grade	Choice	Choice	Choice	Choice
Loin eye area, sq. in.	2.17	2.25	2.26	2.25
Fat cover at 12th rib, in.	.22	.25	.24	.27
% trimmed wholesale cuts	37.6	37.4	38.1	37.9
% lean in the carcass	57.5	57.1	55.5	54.3
% fat in the carcass	25.1	26.1	27.9	30.0
% bone in the carcass	17.4	16.8	16.6	15.7
Dressing %	55.0	55.0	56.0	57.5

Table 3.—Average Loin Eye Area, Fat Cover over 12th Rib, Percent Wholesale Cuts and Composition of Blackface and Whiteface Lamb Carcasses.

	Blackface	Whiteface
Slaughter grade	Choice	Choice
Loin eye area, sq. in.	2 21	2.26
Fat cover at 12th rib, in.	.24	.26
% trimmed wholesale cuts	37.5	38.0
% lean in the carcass	57.3	54.9
% fat in the carcass	25.6	29.0
% bone in the carcass	17.1	16.1
Dressing %	55.0	56.8

distribution of fat. It is well known that dressing percentages increase with an increase in total fat in the carcass. Increased fat in the carcass may occur as external or internal fat (i.e., fat between muscle systems and within muscle systems) and under the procedures of this study, no attempt was made to prepare wholesale cuts of comparable internal fat content. This would suggest that the value of percent trimmed wholesale cuts as a measure of carcass leanness is questionable where internal fat content is not standardized. The loin eye area of the whiteface lambs was slightly larger than the blackface. Blackface lamb carcasses were found to contain 1 percent more bone in the carcass than whiteface lambs. There was 2.4 percent more lean in the blackface carcasses as determined by chemical analysis.

A comparison of carcass data from single and twin reared lambs is shown in Table 4. The faster growing single lambs had 26.5 percent fat in the carcass as compared to 28.1 percent for the slower growing twin lambs. Also, single lambs had slightly less fat cover at the 12th rib than twins.

Table 4.—Average Loin Eye Area, Fat Cover over 12th Rib, Percent Wholesale Cuts and Composition of Single and Twin Lamb Carcasses.

	Singles	Twins
Slaughter grade	Choice	Choice
Loin eye area, sq. in.	2.22	2.25
Fat cover at 12th rib, in.	.23	.26
% trimmed wholesale cuts	37.9	37.6
% lean in the carctss	56.5	55.7
% fat in the carcass	26.5	28.1
% bone in the carcass	17.0	16.2
Dressing %	55.5	56.2

The loin eye area of the slower gaining twin lambs was only slightly larger than that of the single lambs; however, single lambs yielded a slightly higher percent of trimmed wholesale cuts. The carcasses of the single lambs contained 0.8 percent more bone and 0.8 percent more lean than twin reared lambs. Dressing percentages were similar for the two groups with a slight advantage for twins. There was no difference in average carcass grade between the two groups.

From these data it would appear that rate of growth during early life in lambs results in relatively small differences in carcass composition with a slight advantage of more lean and less fat for the singles.

SUMMARY

Sixty crossbred milk fat wether lambs were used in this trial to study some relationships between growth factors and carcass composition. The lambs were out of Dorset X Western and Western ewes and sired by Dorset, Hampshire and Suffolk rams, and thus, afforded an opportunity for studying the influence of different growth rates on carcass composition.

The results indicate that the earlier maturing, slower gaining whiteface lambs produced fatter carcasses than the later maturing blackface lambs. The whiteface carcasses were fatter than blackface carcasses by an average of 3.4 percent. Blackface carcasses had 1 percent more bone and 2.4 percent more lean than whiteface carcasses. In addition, the whiteface lambs required a longer feeding period (by 23 days) to reach the slaughter weight of 100 pounds.

Differences in measures of carcass composition between twins and singles were not as great as between blackface and whiteface lambs. Twin reared lamb carcasses contained on the average, 1.6 percent more fat, 0.8 percent less lean and 0.8 percent less bone than singles.

Creep-Feeding Fall Calves

J. E. McCroskey, W. D. Campbell, and A. B. Nelson

The economic feasibility of creep-feeding fall calves has been the subject of a great deal of consideration in the past few years. A four-year study (Oklahoma. Agr. Exp. Sta. MP-55:72) of creep-feeding fall calves has shown that creep-fed calves gained more rapidly than non-creep-fed calves, but the increased weight gain did not off-set the cost of the creep-ration.

Results of a recent two-year study (Okla. Agr. Exp. Sta. MP-67) comparing a grain mixture and alfalfa hay fed in loose or pelleted forms for different lengths of time showed that feeding the grain mixture in loose form or alfalfa hay either long or pelleted until spring resulted in greater gains and more profit than when no creep-ration was fed.

It is believed by some that mixtures of grains and complex mixtures are no more effective as creep-rations than single grains. The study reported here was conducted to compare single grains and a simple grain mixture with a complex mixture as creep-rations for fall calves.

PROCEDURE

On December 20, 1962, one-hundred and twenty grade Hereford cows with calves were divided into six equal groups on the basis of sex of calf. The cows received 2½ pounds of pelleted cottonseed meal per head daily until April 15, 1963. In addition, a mineral mixture was provided free-choice to all lots.

Creep-feeding was started January 21, 1963, and continued until weaning on June 26, 1963. Treatments were as follows: Lot 1 — no creep-feed; Lot 2—regular grain mixture composed of 55 percent steam rolled milo, 30 percent whole oats, 10 percent cottonseed meal and 5 percent cane molasses; Lot 3—steam rolled milo plus 5 percent cane molasses; Lot 4—steam rolled barley plus 5 percent cane molasses; Lot 5—steam rolled oats plus 5 percent cane molasses; Lot 6—a complex mixture containing 15 percent steam rolled yellow corn, 24 percent steam rolled milo, 15 percent steam rolled barley, 15 percent steam rolled oats, 5 percent wheat bran, 5 percent dehydrated alfalfa meal, 6 percent soybean meal, 6 percent cottonseed meal, 4 percent cane molasses, 4 percent animal fat, 0.5 percent trace mineral salt, 0.5 percent dicalcium phosphate plus one pound of Aurofac 40 and 4.54 million units of vitamin A per ton.

RESULTS

All creep-fed lots gained more rapidly than the control lot but the additional gain was small for all lots except the lot receiving the complex mixture (see table 1). The calves on the complex mixture ate more feed, gained more weight and were more efficient in converting feed to gain than calves fed the other creep-rations. Although the complex mixture cost more per ton, gains were produced more economically on it than the other rations.

Creep-feed consumption, rate of gain, and cost of additional gain were almost identical for the lots receiving rolled oats and the regular mixture. Although rolled barley appeared to be less palatable than the other rations, the cost of additional gain was less on barley than on the other single grains or the regular mixture, due apparently to more efficient feed conversion. Rate of gain was lowest and cost of additional gain was highest on the rolled milo ration.

Table 1. Crop-Feeding Fall Calves, 1963

Lot Number Creep-Feed	1 None	2 Regular[1] Mixture	3 Steam rolled[2] Milo	4 Steam rolled[2] Barley	5 Steam rolled[2] Oats	6 Complex[3] Mixture
Number of calves	20	20	18[4]	19[4]	18[4]	19[4]
Av. wt. per calf, lbs.						
Initial (1-21-63)	147	142	147	145	155	148
Final (6-26-63)	371	394	382	389	409	482
Total gain, lbs.						
(1-21-63 to 6-26-63)	224	252	235	244	254	334
Gain above control, lbs.	--	28	11	20	30	110
Creep-feed/calf, lbs.	--	341	302	205	342	384
Creep-feed cost ($)						
Per ton	--	59.20	52.00	57.00	64.40	68.00
Per calf	--	10.09	7.85	5.84	11.01	13.05
Cost/cwt. additional						
gain ($)	--	36.44	69.58	28.50	36.13	11.87
Value of total gain ($)[5]	67.20	75.60	70.50	73.20	76.20	100.20
Value of gain minus						
creep-feed cost ($)	67.20	65.51	62.65	67.36	65.19	87.15

[1] The regular mixture contained 55 percent steam rolled milo, 30 percent whole oats, 10 percent cottonseed meal, 5 percent cane molasses.

[2] These rations also contained 5 percent cane molasses.

[3] The complex mixture contained 15 percent steam rolled yellow corn, 24 percent steam rolled milo, 15 percent steam rolled barley, 15 percent steam rolled oats, 5 percent wheat bran, 5 percent dehydrated alfalfa meal, 6 percent soybean oil meal, 6 percent cottonseed meal, 4 percent cane molasses, 4 percent animal fat, 0.5 percent trace mineral salt, 0.5 percent dicalcium phosphate, 1 lb. per ton of Aurofac 40, and 4.54 million units of vitamin A per ton.

[4] Calf death losses occurred in these lots.

[5] Value based on a selling price of $30 per cwt. of calves.

These data are the results of only one trial and more trials need to be conducted before any definite conclusions can be made. However, results of this trial suggest that although weaning weights can be improved, it is not profitable to feed steam rolled milo, steam rolled barley or steam rolled oats alone as creep-rations for fall calves. Furthermore, a regular mixture of grains and cottonseed meal was no more profitable than a creep-ration of steam rolled oats.

SUMMARY

A one-year study comparing steam rolled milo, steam rolled barley and steam rolled oats as single grains with a regular grain mixture and a complex creep-ration showed that only the complex mixture was profitable as a creep-ration for fall-born calves. The single grains and the regular grain mixture increased calf weaning weights from 11 to 30 pounds per calf while the complex ration increased weaning weights 110 pounds per calf. Calves fed the complex mixture ate more feed and made more efficient gains than calves fed the single grains or the regular mixture. The regular mixture of grains proved no more effective as a creep-ration than steam rolled oats.

Comparisons of Medicated vs. Non-Medicated Growing Rations for Pigs*

J. A. Whatley, Jr., D. F. Stephens and David Rule

Antibiotics have been used extensively to fortify swine rations because a generally beneficial response, particularly in growth rate, has been demonstrated. Recently a medicated premix, Aureo S-P250, has been made available on the market. As fed, this premix adds considerably higher amounts of aureomycin and penicillin to the ration than has commonly been used before. It also contains sulfamethazine which has not previously been used in feeds on a continuous basis.

The disease level in the Ft. Reno breeding project herd is probably fairly typical of that in many herds in the country. Rhinitus has been a chronic problem in the herd. Abscesses have been a problem in certain seasons. Periodically scours in baby pigs has also been a problem. These have been the more important disease problems in the herd. However, death losses have not been serious, and under the feeding and management conditions in the herd the performance of most pigs has been reasonably satisfactory. There have been a small percentage of runt pigs in each pig crop, and many of these runts and a few other pigs have shown outward symptoms of Rhinitus.

PROCEDURE

Eighty weanling crossbred pigs from the Ft. Reno herd were used to test the value of adding Aureo S-P250 to the growing ration fed from 56 days of age to a weight of 75 to 80 lbs. Forty of the heavier pigs averaging about 38 lbs. were used in Trials I and II. Each trial contained 2 lots of 10 pigs each. One lot of each trial was randomly assigned to receive the medicated Aureo S-P250 in the growing ration and the other lot was the control which received the non-medicated Ft. Reno growing pig ration (see table I). Forty of the smaller pigs averaging about 25 lbs. were used in Trials III and IV with one randomly assigned lot in each trial receiving Aureo S-P250 added to the ration and one lot receiving no Aureo S-P250. The 4 trials gave 4 replications of the test. When the pigs in each lot reached an average weight of 75-80 lbs. the feed was changed from the growing ration to the finishing ration (Table 1). All lots received the same finishing ration.

The pigs in each lot were weighed off individually as they reached weights over 200 lbs. On March 18 after the feeding test had continued for 154 days the few remaining pigs that had not reached 200 lbs. were weighed and removed from the test.

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*This test was conducted at the Ft. Reno Experiment Station in a cooperative project between the Oklahoma Agricultural Experiment Station and the Regional Swine Breeding Laboratory, Agricultural Research Service, U. S. Department of Agriculture.

Table 1.—Medicated and non-medicated rations fed in this experiment.

Ingredient	Growing Rations		Finishing Ration
	Med.*	Non-med.	Non-med.
Ground Milo	35.91	36.00	40.00
Ground wheat	35.91	36.00	40.00
Molasses	4.99	5.00	5.00
Soybean meal (44%)	14.96	15.00	10.00
Dehy. alfalfa meal	4.99	5.00	2.50
Dicalcium phosphate	1.25	1.25	1.00
Calcium carbonate	1.00	1.00	0.75
Salt	0.50	0.50	0.50
Antibiotic, trace mineral, and vitamin premix.	0.25	0.25	0.25
Aurea SP250	0.25	...	
Total	100.01	100.0	100.0
Cost of feed per cwt. of ration**	$3.03	$2.60	$2.46

*5 lbs. of aureo SP250 was added per ton of the medicated growing ration. This added 100 gms. of aureomicin, 100 gms. of sulfamethazine, and 50 gms. of procaine penicillin per ton of feed.

**In the feed prices listed elsewhere in this bulletin, feed wheat was arbitrarily priced at $2.00 per ton above milo. Ten cents per hundred lbs. of grain were charged for grinding and 15 cents per hundred lbs. of ration were charged for mixing. The commercial antibiotic, trace mineral and vitamin premix included in all rations cost 37 cents per lb. and the Aureo SP250 in the medicated growing ration cost $1.74 per lb.

RESULTS

The first weights were taken 29 days after the start of the experiment and the results are shown in Table 2. Pigs on the medicated ration averaged 0.39 lbs. per day faster gain the first 29 days than those on the control ration (1.45 vs 1.06 lbs. per day). This difference was highly significant statistically. In observing the different trials it was noted that the difference between the two rations was larger (0.43 lbs. per day) for the light weight pigs in Trials III and IV than for the heavier pigs (0.33 lbs. per day) in Trials I and II. However, the statistical analysis did not reveal a significant interaction of this kind.

In Trials I and II all lots were changed to the same non-medicated finishing ration after 29 days on test. The lots in Trials III and IV had not attained 75 lbs. average weight at the end of 29 days on test and the feed change in these lots was delayed until the 75 lbs. average weight per lot was reached.

The results for the entire feeding test are shown for each trial in Table 3. A summary for all trials is shown at the bottom of Table 3. Over the entire feeding period pigs that received the medicated growing ration the first month after weaning gained 0.20 lbs. per day faster than the controls (1.60 vs 1.40 lbs. per day). The difference was highly significant statistically. Pigs receiving the medicated growing ration also required 18 lbs. (351 vs 369 lbs.) less feed per hundred lbs. gain. There

Table 2.—Average daily gains of medicated and control pigs the first 29 days on test.

Trial	Lot	Ration	No. Pigs	Av. In. wt., lbs.	Av. wt. after 29 days, lbs.	Av. daily gain 1st 29 days, lbs.
	1	Medicated	10	38.2	84.7	1.60
I	2	Control	10	39.1	76.2	1.28
		Difference		−0.9	8.5	0.32
	3	Medicated	10	39.7	85.5	1.58
II	4	Control	10	36.1	72.6	1.24
		Difference		3.6	12.9	0.34
	5	Medicated	10	26.6	63.5	1.27
III	6	Control	10	25.8	52.4	0.92
		Difference		0.8	11.1	0.35
	7	Medicated	10	24.5	63.0	1.33
IV	8	Control	10	24.7	48.4	0.82
		Difference		−0.2	14.6	0.51
		Medicated	40	32.2	74.2	1.45
All		Control	40	31.4	62.4	1.06
		Difference		0.8	11.8	0.39

was little difference in the cost of gain, and only a slight saving in feed cost per hundred lbs. gain (9 cents) for pigs receiving the more expensive medicated growing ration.

It should be emphasized that Aureo S-P250 was not fed to any pigs until after they were 8 weeks old and placed on this experiment. Earlier feeding of this medicated premix in the creep ration might have given a greater growth stimulus over the growing-finishing period, but this was not tested in this experiment.

SUMMARY

A significant growth stimulus was obtained when Aureo S-P250 premix was added to a growing ration for the first 4 to 6 weeks after weaning. The growth response was most evident when the Aureo S-P250 was being fed in the growing ration, but there was a carryover effect through the finishing period. A small improvement in efficiency of gain was noted which resulted in slightly cheaper gains even though the medicated growing ration cost 43 cents per hundred lbs. more than the control ration.

Table 3.—Average daily gains, feed conversions, and feed costs for medicated and control pigs over the entire feeding period.

Trial	Lot	Ration	No. pigs	Av. In. Wt., lbs.	Av. Fin. Wt. lbs.	Av. daily gain, lbs.	Lbs. feed per 100 lbs. gain	Feed cost per 100 lbs. gain, $
	1	Medicated	10	38.2	207.6	1.73	338	9.31
I	2	Control	10	39.1	205.3	1.58	408	10.78
		Difference		—0.9	2.3	0.15	—70	—1.47
	3	Medicated	9*	39.7	202.4	1.69	349	9.59
II	4	Control	10	36.1	201.9	1.42	350	9.25
		Difference		3.6	0.5	0.27	—1	0.34
	5	Medicated	10**	26.6	195.1	1.41	385	10.69
III	6	Control	10	25.8	198.7	1.29	369	9.76
		Difference		0.8	—3.6	0.12	16	0.93
	7	Medicated	10	24.5	207.7	1.59	333	9.13
IV	8	Control	9***	24.7	198.0	1.30	350	9.29
		Difference		—0.2	9.7	0.29	—17	—0.16
		Medicated	39	32.2	203.2	1.60	351	9.68
All		Control	39	31.4	201.0	1.40	369	9.77
		Difference		0.8	2.2	0.20	—18	—0.09

*One pig died.

**Two pigs were removed because of broken legs before they completed the test, but they were still counted in the test.

***One gilt in this lot was removed February 13 and not counted in the test. She had an extremely bad case of Rhinitus and weighed only 65 lbs. at the time of removal—120 days after the beginning of the test. One other gilt in this lot gained only 0.99 lbs. per day. She lost weight the last 2 weeks she was on test, but she was included in the results.

Improving the Utilization of Milo for Fattening Calves: Value of Fine Grinding and Supplemental Vitamin A[1]

Robert Totusek, Dwight Stephens and Lowell Walters

Milo (sorghum grain) is the most abundant feed grain available for fattening cattle in Oklahoma and in the southwest in general. Previous experiments at this station (see Feeders' Day Reports for former years), as well as results reported from other experiments stations, have shown that milo has a lower feeding value than corn. Milo is primarily inferior to corn in terms of feed efficiency, with as much as 10% more feed commonly required per unit of gain. Efforts are being continued to improve the utilization of milo in cattle fattening rations through research at this station.

[1] The vitamin A used in this study was generously provided by Dr. H. A. Bechtel, Dawes Laboratories Inc., 4800 South Richmond, Chicago 32, Illinois.

Previous tests with limited numbers of steers indiacted that the fine grinding of milo improved its efficiency of utilization. Coarse and fine grinds of milo were directly compared in this experiment, with sufficiently adequate numbers to justify rather definite conclusions.

The vitamin A requirements of beef cattle are being re-evaluated today. Since milo is almost devoid of carotene (the precursor of vitamin A), the value of supplemental vitamin A in a milo base ration was determined.

PROCEDURE

Eighty Hereford steer calves with an average weight of 475 lbs. and an average age of approximately 7 months were obtained from Experiment Station herds. They were divided into eight lots, primarily on the basis of sire and weaning weight. The heavier calves (average weight 516 lbs.) were assigned to Lots 1-4, and the lighter calves (average weight 435 lbs.) to Lots 5-8, with the four lots in each of the two replicates comparable in initial age, grade and weight. The feeding trial was conducted at the Ft. Reno Station.

The calves were fed 168 days, from November 15, 1962, to May 2, 1963. Both initial and final weights were obtained on a shrunk basis, with the calves allowed no access to feed and water for a 16 hour period. At the conclusion of the feeding period, the calves were shipped to Oklahoma City for slaughter. Carcass information was obtained after a 48 hour chill.

The ingredient makeup of the basal ration, formulated to contain 12% crude protein, is given in table 1. The average chemical composition of the ration is shown in table 2. Ration treatments consisted of coarse versus fine grinding of the milo grain, and supplemental vitamin A versus no supplemental vitamin A. The experimental design is shown in table 3. It should be noted that it was possible to compare 40 calves fed coarsely ground milo with 40 fed finely ground milo, and 40 fed supplemental vitamin A with 40 which received no supplemental vitamin A.

All rations were self-fed during the entire feeding period. A mineral mixture of equal parts salt and steamed bonemeal was offered free-choice

Table 1: Ingredient Makeup of the Ration

Feed	%
Milo, ground	40.0
Cottonseed meal	12.5
Ground alfalfa hay	10.0
Molasses	7.5
Cottonseed hulls	30.0

Table 2: Average Chemical Composition of Milo and the Complete Ration

	Crude Protein %	Crude Fiber %	Ether Extract %	Ash %	N.F.E. %	Calcium %	Phosphorus %
Milo	10.2	1.3	2.9	1.3	77.7	.02	.18
Complete ration	12.9	17.6	2.9	4.0	54.8	.27	.33

Table 3: Design of the Experiment

Lot	1	2	3	4	5	6	7	8
Milo grind*	Coarse	Coarse	Fine	Fine	Coarse	Coarse	Fine	Fine
Supplemental vitamin A**	0	+	0	+	0	+	0	+

*Coarsely ground milo was processed through a hammer mill with a 1/2 inch screen, finely ground milo with a 1/8 inch screen.

**Vitamin A, when included in the ration, was fed at a level of 1,000 I.U. per lb. of ration.

at all times. Water, heated in winter, was always available, and access to both an open shed and an outside pen was provided for each lot. Aureomycin was fed at an approximate level of 70 mg. per head daily. No hormones were used.

RESULTS

Coarse Vs. Fine Grinding of Milo

Feedlot Performance

Performance information is summarized in table 4. Calves fed coarsely ground milo gained slightly faster than calves fed finely ground milo. However, the difference was small, and more important are the differences in feed data. Even though the calves fed finely ground milo gained almost as rapidly, they consumed 1.8 lb. less feed daily and required 5.2% less feed (48 lbs. per 100 lbs. gain) than the calves fed coarsely ground milo. This supports and extends previous observations at this station. The fact that the ration containing finely ground milo was consumed in smaller quantity than the ration containing coarsely ground milo should not be considered strictly a disadvantage, since rate of gain was not greatly affected. Apparently, energy in the finely ground milo was more efficiently utilized and less feed was required to satisfy the daily energy requirement of the calves than was true of the coarsely ground milo.

Slaughter and Carcass Information

Dressing percentage and carcass data are given in table 5. Averages for dressing percentage, quality grade, ribeye area, and fat covering were almost identical for calves fed the two differently ground milo grains. The reason for the higher yield of trimmed retail cuts from the calves fed finely ground milo is not obvious, and certainly would not be anticipated when the similarity in fatness and apparent muscling is considered.

Table 4: Feedlot Performance of Steer Calves Fed Coarsely vs. Finely Ground Milo (168 Days)

	Milo Grind	
	Coarse	Fine
No. calves started	40	40
No. calves completed test	38*	36*
Av. initial wt., lb.	475**	475**
Av. daily gain, lb.	2.70**	2.65**
Av. daily feed intake, lb.	25.1	23.3
Feed per cwt. gain, lb.	929	881

*Losses were as follows, by treatment:
Coarsley ground milo:
Urinary calculi — 1 calf
Chronic bloat — 1 calf
Finely ground milo:
Urinary calculi — 4 calves

**Initial and final weights were taken after a 16 hour shrink without feed and water.

Table 5: Slaughter and Carcass Information of Steer Calves Fed Coarsely vs. Fine Ground Milo

	Milo Grind	
	Coarse	Fine
Dressing %*	60.8	61.0
Quality grade**	8.8	8.8
Ribeye area, sq. in.***	9.9	9.9
Fat over ribeye, in.†	.72	.68
Trimmed retail cut yield, %††	46.5	48.0

*Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.

**U.S.D.A. quality grade converted to following numerical designations: high prime—15, average prime—14, low prime—13, high choice—12, average choice—11, low choice—10, high good—9, average good—8, low good—7.

***Determined by measurement of tracings of ribeye.

†Average of three measurements determined on tracings of the ribeye.

††Calculated as follows: % of carcass as boneless trimmed retail cuts from the four major wholesale cuts = 51.34 − 5.78 (fat thickness) − .462 (% kidney fat) + .740 (ribeye area) − .0093 (carcass weight).

Supplemental Vitamin A

Feedlot Performance

Gain and feed data are shown in table 6. Calves fed supplemental vitamin A (1,000 I.U./lb. of ration) gained slightly faster, consumed slightly more feed, and were slightly less efficient than calves which did not receive supplemental vitamin A. However, differences were small and probably of little significance. It appears that the carotene furnished by the basal ration, which contained 10% alfalfa, was adequate, along with liver stores of vitamin A, to meet the vitamin A requirements of the calves during the feeding period.

Slaughter and Carcass Information

Differences in dressing percentage, carcass quality grade, ribeye area, and fat covering between treatments were negligible (table 7). There seems to be no logical explanation for the difference in trimmed retail cut yield which was observed.

SUMMARY

Fine grinding of milo resulted in a 5.2% improvement in feed efficiency compared to coarse grinding. Rate of gain was only slightly decreased.

The use of finely ground milo in fattening beef cattle rations should be considered, especially in high roughage rations. However, a finely

Table 6: Feedlot Performance of Steer Calves With and Without Supplemental Vitamin A (168 Days)

	Supplemental Vitamin A	
	0	1,000 I.U./lb. Ration
No. calves started	40	40
No. calves completed test	36*	38*
Av. initial wt., lb.**	475	475
Av. daily gain, lb.**	2.64	2.70
Av. daily feed intake, lb.	23.7	24.7
Feed per cwt. gain, lb.	898	913

*Losses were as follows, by treatment:
No supplemental vitamin A:
Urinary calculi — 3 calves
Chronic bloat — 1 calf
Supplemental vitamin A:
Urinary calculi — 2 calves

**Initial and final weights were taken after a 16 hour shrink without feed and water.

Table 7: Slaughter and Carcass Information of Steer Calves With and Without Supplemental Vitamin A

	Supplemental Vitamin A	
	0	1,000 I.U./lb. Ration
Dressing %*	60.8	61.0
Quality grade**	8.8	8.9
Ribeye area, sq. in.***	10.0	9.9
Fat over ribeye, in.†	.68	.71
Trimmed retail cut yield, %††	48.1	46.4

*Calculated on basis of shrunk Ft. Reno live weight and chilled carcass weight.

**U.S.D.A. quality grade converted to following numerical designations: high prime—15, average prime—14, low prime—13, high choice—12, average choice—11, low choice—10, high good—9, average good—8, low good—7.

***Determined by measurement on tracings of the ribeye.

†Average of three measurements determined on tracings of the ribeye.

††Calculated as follows: % of carcass as boneless trimmed retail cuts from the four major wholesale cuts = 51.34 − 5.78 (fat thickness) − .462 (% kidney fat) + .740 (ribeye area) − .0093 (carcass weight).

ground product may be less desirable in high concentrate rations, and certain management factors may also influence the choice of grind. For example, if neither molasses nor fat is used, a coarsely ground or rolled milo may be most desirable due to the dustiness of finely ground milo.

The addition of supplemental vitamin A (1,000 I.U./lb. of ration) to a ration containing 10% alfalfa and milo as the grain was of little apparent benefit.

Trace Mineral Supplements to "All-Barley" Rations For Fattening Steers

R. Renbarger, L. S. Pope and George Waller

A serious problem to cattle feeders in the Southwest during recent years has been the high cost of roughage in finishing rations. Most feeders now use much more grain than in the past, and drop the roughage to 10-15%, in finishing rations. It has been possible in experiments to reduce the roughage content to zero and depend on steam-rolled grains for the necessary bulk in the diet.

Experiments at several stations over the past 5 years have demonstrated that steamed rolled barley, properly supplemented, can make up the entire ration. Studies at the Ft. Reno station have been designed to determine the mineral deficiencies when all-barley rations are fed.[1] From these studies, it has been shown that an "all-barley" ration is quite efficient for finishing cattle (i.e. less than 7.5 lb. feed per lb. gain) provided care is taken in formulating the supplement. When all, or nearly all, of the roughage is removed from fattening rations, it is obvious that the supplement has to carry the load and supply the nutrients essential for proper growth and fattening.

In the mineral fraction likely to be deficient, our studies show that certain trace minerals are most important. It was observed that when all-barley rations were supplemented with trace minerals, appetite improved and rate of gain was increased. In the trial reported herein, an attempt was made to determine some of the trace minerals responsible for increasing the feed intake and performance of steers on all-barley and soybean meal rations, and to compare the mineral-supplemented diets with those containing dehydrated alfalfa meal and molasses. It seemed possible that these natural feeds might supply nutritional factors above and beyond their trace mineral content which would be worth investigating.

WHY TRACE MINERALS ARE IMPORTANT

Normally, in most rations, natural feeds, such as legume roughages provide enough trace minerals. Trace minerals are known to be closely associated with red blood cell formation, and with various enzyme systems within the body. Some trace minerals serve as component parts of enzymes, while others are known to be activators or catalysts for certain enzymes. This means that the trace mineral must be present in order for the enzymes to be active and perform a vital function within the body. Enzymes have long been recognized as serving many important functions in the metabolism of food nutrients. Each enzyme is designed by nature to control a specific reaction. Since certain trace minerals function as a part of the red blood cells, or in their formation, plus the release of energy from carbohydrates, it is obvious that performance can be greatly affected on rations deficient in any one of the several essential trace minerals. Elsewhere in this Feeders' Day report is a more complete discussion of trace minerals.

If ruminants lack certain trace minerals, such as cobalt, we often observe a depressing effect on appetite and performance. Less bacterial activity may occur in the rumen, resulting in a lower feed intake. Naturally this would lead to a reduction in daily gain. The situation may become especially acute where roughage is withdrawn from the ration, since many grains are poor sources of trace minerals. Few studies have been made of the exact trace mineral needs of steers on all-barley diets.

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[1] See Oklahoma Mis. Pub. MP-67 and MP-70.

PROCEDURE

One hundred, weaner, Hereford steer calves were purchased in October, 1962, from the Schultz Ranch near Shattuck. The calves were branded for individual identification and placed on 50 acres of excellent barley pasture, with an adjacent 100 acres of dead grass and milo stubble. During the 101-day winter grazing period, the calves averaged 0.9 lbs. gain per day. At the end of the grazing period, 64 of the most uniform steers were selected for random allotment to sixteen groups of 4 steers each.

Table 1 shows the four treatments which were used in this study. The design called for four replications, or pens, of steers within each treatment. Differences in the feeding value of two sources of Rogers barley, produced at Ft. Reno vs. that obtained from a local mill and produced in north central Oklahoma, were also compared since two groups within each treatment were fed each of the two barleys.

The steers were placed on full-feed April 1, and were self-fed for 122 days. Cottonseed hulls were added to the rations (50% initially) during the early part of the feeding trial, and withdrawn at weekly intervals until all hulls had been removed from the ration by the end of the fifth week. A supplement based on soybean meal fortified with calcium and vitamin A was fed all lots as small pellets, at the rate of 1.5 lb. per steer daily. Slightly less supplement was fed Lot 4 steers receiving dehydrated alfalfa and molasses.

In addition to initial and final shrunk weights, and weights at 28-day intervals, carcass data were obtained at the completion of the trial. In one group (Lot 4) the calves received 1.0 lb. dehydrated alfalfa meal and approximately 0.6 lb. molasses to see if these natural feeds would further stimulate gains over the trace minerals being studied. The

Table 1. Supplements to Steam-Rolled Barley Rations in Steer Fattening Experiments.

Lot No.*	Supplement
1	Basal**
2	Basal + Iron (Fe), Cobalt (Co) and Zinc (Zn)***
3	Basal + 6 trace elements, Fe, Co, Zn, Copper, Manganese and Iodine***
4	Basal with 1.0 lb. dehydrated alfalfa meal + 0.6 lb. molasses

* Four replications of 4 steers per treatment, with two replications within treatment on barleys from different areas of the state.

** Basal supplement fed at the rate of 1.5 lb. contained soybean meal with 6% calcium carbonate and sufficient vitamin A to supply 27,000 I.U. per steer daily.

*** Trace mineral supplements added at the following levels (mg.): Fe, 1000; Cu, 40; Co, 3; Zn, 300; Mn, 168; and I, 1.

alfalfa meal was pelleted in 3/16 inch cubes and mixed with the rolled barley supplement, and 3% molasses was added to the complete mixture. No additional minerals other than salt, free choice, were available to the cattle.

RESULTS

The average results of the feeding trial are shown in Table 2. The need for trace mineral supplementation when "all-barley" diets are used is clearly indicated.

The mineral supplement fed Lot 2 steers containing iron, cobalt and zinc resulted in the highest average daily gain. A smaller response was obtained with the supplements fed Lots 3 and 4 which supplied 6 different elements, or dehydrated alfalfa meal and molasses. Feed intake data clearly show the "appetizing" effect of the additional trace minerals.

It would appear that there is no advantage in average daily gain from adding any trace minerals beyond zinc, cobalt, and iron. Neither was there any advantage from small amounts of dehydrated alfalfa and molasses vs. these minerals. Thus, there appeared to be no extra stimulatory factor in the natural feeds over the trace minerals they supplied. Bear in mind that all rations were fortified with sufficient calcium and vitamin A.

Feed efficiency favored the rations containing trace minerals or dehydrated alfalfa and molasses. The greatest feed efficiency was obtained in Lot 2, where zinc, cobalt and iron were added. It required only 7.42 pounds of feed to produce a pound of gain on this ration, as compared to 8.04 pounds of feed on the control diet. The addition of less than ½ lb. of trace mineral mixture per steer during the trial in Lot 2 reduced feed per 100 pounds gain and resulted in nearly 70 lb. extra gain for each steer over the basal (Lot 1).

Table 2. Comparison of Three Supplements to All-Barley Rations

Ration	Basal Supplement (Control)	Basal Plus Zinc, Cobalt Iron	Basal Plus All Trace Minerals	Basal Plus Dehy. Alfalfa Molasses
No. steers	16	16	16	16
Av. weights lbs.				
Initial	666	685	677	680
Final	983	1075	1046	1038
Total gain, 122 days	317	390	369	358
Av. daily gain, lb.	2.60	3.19	3.03	2.94
Av. daily feed intake lb.	20.9	23.7	23.6	23.0
Feed required per cwt. gain, lb.	804	742	780	781
Av. carcass grade score*	8.94	9.37	9.62	9.31

*8 = Av. Good, 9 = High Good

In this, as in previous trace mineral studies with barley, it appears that zinc and cobalt may be the two most important trace elements lacking. In other studies, we have failed to show a consistent advantage for the addition of iron.

From the results of 6 trials, it would appear that the trace minerals required by fattening steers on all-barley diets are approximately as shown in Table 3.

Carcass grades were slightly improved by the supplements added to the basal diet. This might be expected, since the lowered feed intake of Lot 1 steers resulted in slower gains. No appreciable difference was noted in response to barley produced in two different locations in Oklahoma, as shown in Table 4, despite some variation in trace mineral content.

At the completion of the trial, samples of rumen fluid were taken by a stomach tube for determination of volatile fatty acid levels. The results, shown in Table 5, exhibit an erratic trend, but in all cases a very narrow acetic: propionic ratio was observed, when compared to other data obtained with higher roughage diets. Note the tendency for a wider ratio where the rations contained dehydrated alfalfa meal and molasses. It is presumed that a narrow ratio is more desirable for fattening cattle, and may be one reason for the good efficiency obtained on all-barley diets.

SUMMARY

All-barley rations supplemented with soybean meal, calcium, and vitamin A were fortified with trace minerals. This resulted in greater daily feed intake, increased average daily gains, more efficient feed conversion, and better grading carcasses. The most favorable response was obtained with a combination of zinc, cobalt and iron. Rations supplemented with dehydrated alfalfa meal and molasses gave slightly lower average daily gains and less daily feed intake than those containing the trace minerals. There appeared to be no advantage for the nutritional factors in dehydrated alfalfa meal or molasses other than trace minerals. Similar results were obtained when two samples of

Table 3. Suggested Trace Mineral Needs of Fattening Yearling Steers

Element	Suggested Requirement
	(Mg./day)
Iron	600
Copper	60
Cobalt	3
Zinc	520
Manganese	140
Iodine	0.6

barley grown in different locations in the state were compared. The need to fortify all-concentrate diets with trace minerals is indicated. Further studies are underway to show which trace elements are most critical.

Table 4. Chemical Composition of Rogers Barley Produced in two Different Areas of Oklahoma and Steer Performance.

Source of Barley	Ft. Reno	North Central Oklahoma
Chemical Composition, %:		
Dry matter	89.8	89.3
Crude protein	10.97	11.47
Ether extract	1.95	1.76
Crude fiber	5.18	4.92
N-free extract	69.13	68.45
Calcium	.06	.07
Phosphorus	.38	.43
Mineral Matter, %:*		
Iron, ppm.	42.8	51.5
Copper, ppm.	4.81	5.45
Cobalt,, ppm.	0.071	0.016
Manganese, ppm.	14.4	10.1
Zinc, ppm.	17.4	31.3
Iodine, ppm.	0.096	0.04
Steer Performance:		
Av. daily gain	2.97	2.91
Av. daily feed intake, lb.	23.0	22.6
Feed required per lb. gain, lb.	7.74	7.77

* As determined spectrographically by a commercial laboratory.

Table 5. Volatile Fatty Acid Patterns in Rumen Samples From Steers Fed Differently Supplemented Barleys. (Mole %)

Supplement	Basal	Basal + Fe Cu, & Co	Basal + All TM	Basal + Dehyd. Alfalfa + Molasses
Acetic				
Ft. Reno*	54.3	55.4	48.8	53.3
N. C. Okla.*	40.0	50.1	42.3	53.7
Propionic				
Ft. Reno	34.5	33.9	43.0	32.9
N. C. Okla.	48.6	41.2	46.6	36.2
Butyric				
Ft. Reno	9.3	8.5	6.9	11.3
N. C. Okla.	12.0	6.8	9.3	8.2
Av. Acetic/Propionic Ratio	1.2:1	1.4:1	1.0:1	1.6:1

* Denotes barley produced at Ft. Reno vs. North Central Oklahoma.

Beef Cattle Selection Studies

R. L. Willham and D. F. Stephens

Selection is the judgement exercised in the choice of individuals allowed to reproduce. Such selection, along with natural selection operating on reproductive capacity, has been responsible for most of the genetic change in livestock. Selection is the only directional force at the disposal of the stockman to change the genetic composition of his herd. Thus, in any breeding program, selection is the primary tool employed.

Although of primary importance, the theoretical study of selection is limited, due to mathematical problems. Genetic progress achieved by selection has long been predicted using the equation that response equals heritability times the selection differential. For single trait selection, this prediction has been surprisingly accurate. But for predicting genetic progress from selection as presently practiced, answers are necessary from actual selection studies involving several economic characters in beef cattle. Selection experiments not only give numerical estimates of genetic change that are of immediate practical use to breeders but they test current selection theory and focus attention on genetic problems that can be incorporated into existing theory.

This study is designed to measure the genetic change that results from selection for increased weight and grade of Hereford and Angus cattle both at weaning and as yearlings. What follows is a brief description of this study and some data on early selections.

PROCEDURE

Table 1 gives the plan of the experiment being conducted at the Ft. Reno Station. Foundation animals comprising the lines are a broad genetic sample of the breeds. Approximately 40 spring dropped calves within each line or herd are produced yearly. The cows and calves summer on native grass pasture. The calves are weaned in late September or early October. The seven month or 210 day weight is calculated as follows: Actual weaning weight minus birth weight divided by actual age in days times 210 plus birth weight. This weight is then adjusted for

Table 1. Plan of Experiment

Line Number	5	6	7	8	9	10
Breed: H = Hereford, A = Angus	H	H	A	A	A	A
Selection:						
Traits: Month of weight and grade	7	12	7	12	12	12
Criteria: I = Individual, P = Progeny	I	I	I	I	P	P
Generation Interval: years	4	4	4	4	6	6
Number Males Selected per year:	2	2	2	2	5	5
Mating System: C = closed, O = open	C	C	C	C	C	O

age of dam and also sex when necessary. Feeder grades (fancy, choice, good, etc.) are put on the calves at weaning. A score of 1 to 15 is used with 11 being average choice.

Immediately after weaning, the bull calves are self-fed in groups a 40% roughage ration for 154 days. The ration fed is made up of the following ingredients:

35 percent ground whole ear corn
20 percent cottonseed hulls
10 percent ground alfalfa hay
10 percent whole oats
10 percent wheat bran
10 percent cottonseed oil meal
5 percent molasses

Twelve month weight of the bulls is as follows: The adjusted weaning weight plus 154 days times the average daily gain in the feedlot. This gives a 364 day weight. Feedlot daily gain is obtained by averaging the 142, 154 and 168 day weights minus the unadjusted weaning weight divided by 154.. All weights are taken after the animals have been off water for 12 hours.

The heifer calves are wintered on dry native grass and winter small grain pasture. They normally will gain from 75 to 125 pounds from fall to spring. They are exposed to the bull when approximately 15 months of age and weigh around 600 pounds. Eighteen month rather than twelve month weights are taken on heifers. Gains during the grazing season permit greater expression of genetic differences at 18 rather than 12 months. Eighteen month weight is the adjusted weaning weight plus 330 days times the average daily gain from weaning to 18 months. This regime gives a 540 day weight for heifers and it allows them to express their subsequent maternal ability without the danger of too high feed levels at an early age.

Both bulls and heifers are graded at the end of their respective tests. A score of 1 to 15 is again used; however, this score is not precisely a slaughter grade because soundness and muscling are of more concern. All calves regardless of line are measured for all characters even though selection in a given line is either for weaning or yearling characters.

As shown in Table 1, one Hereford and one Angus line (5 and 7) are selected for weaning weight and grade at seven months. Selections are made on the performance of the individuals. Weaning weight and grade are the most important traits cow herd owners are dealing with a cow-calf operation since they represent a quality and quantity combination of marketable products. Weaning weight and grade are complex characters in that they are due in part to the genes of the calf and to the genes of the cow for maternal performance. A study of this selection response will be of both practical and theoretical importance. The two lines serve as replication or to make the project more reliable. With such different genetic background, it will not be surprising to find different rates of response in the two lines to selection pressure for these traits. This possibility, even within a species, makes it important to study beef cattle rather than use results from laboratory species.

As indicated in Table 1, one Hereford and one Angus (6 and 8) are selected for yearling weight and grade. These characters are of obvious economic importance. Since weaning weight is 7/12ths of yearling weight, selection pressure will still be directed toward weaning weight. But post-weaning gain and grade are also included. The heritability or the relative amount of genetic variance for yearling weight has been reported as 60%. This indicates that selection for yearling weight should be effective. Verification of this potential for genetic change and the possibility that not only growth rate but maturity differences are involved make it extremely necessary to conduct such controlled selection studies. This empirical evidence is essential in the construction of more comprehensive selection theory and to help answer the critical question of mature size for the pure-bred and commercial beef cattle industry.

As indicated in Table 1, two additional lines are selected on yearling weight and grade. In these lines (9 and 10) selection is based on the progeny test of sires rather than individual performance. Each year, five young bulls are selected on their own performance and then progeny tested on some 25 commercial cows each. In line 10, young bulls can be introduced from the breed while all other lines are closed to outside blood. Selection of bulls will be made by using the average carcass grade and carcass weight per day of age of their steer progeny. Thus, selection will be more precise since it is based on the progeny of the individual and on the carcass weight rather than live weight. This extra precision costs an extra two years in terms of generation interval. Selection progress must be compared on some time interval to be realistic. The reason for having progeny test lines is to develop the procedures for such selection since it may be essential for locating genetic differences in the future.

By comparing the response of weaning weight and grade in the lines selected for yearling weight and grade and also the reverse, estimates can be obtained of the genetic correlations between them. This will answer the industry question of whether a producer can confine his selection to weaning data when his calf crop is ordinarily sold or whether some selection must be placed on weight and grade after a short feeding test. Theoretically these genetic correlations are of interest since they involve the relationship between growth and maternal performance.

METHOD OF SELECTION

The main selection pressure is on the bulls. What little selection can be practiced on the females is done on similar criteria. The selection procedure is that of independent culling levels for weight and grade. Primary consideration is given weight. The heaviest bull is selected provided he is in the upper 25% for grade. Only one bull per year out of approximately twenty is selected on his own phenotype in lines 5 through 8. Table 2 and 3 are constructed to illustrate the procedure of bull selection in the two Hereford lines. The four Angus lines are still in the foundation phase of the experiment.

Table 2 gives the selection chart for weaning weight and grade in line 5 for 1963. The fact that weaning weight and grade are correlated is evidenced in the table. Calf 311 had an adjusted weaning weight of 545 pounds. The difference between his weight and the average of line 5 bulls was 66 pounds which is the selection differential. Thus, if heritability is 30% one would expect the progeny of this bull to average 10 pounds above the herd average. ($\frac{1}{2}$•66•.30 = 10)

Table 3 does not indicate a strong correlation between weight and grade as yearlings. Calf 332 was selected even though calf 301 was heavier by 22 pounds. The restriction that the calf must be in the top

Table 2. Selection chart for weaning weight and grade in Line 5 for 1963.

Weight	Grade 8	9		10		11		12
575 — 550								
549 — 525						311	313	
524 — 500		328	331	336	304			
499 — 475		330	335	322	305			
474 — 450		310		324	312			
449 — 425		317		308				
424 — 400								
399 — 375	306*	301						

* The numbers in the body of the table represent the bulls.

Table 3. Selection chart for yearling weight and grade in Line 6 for 1963.

Weight	Grade 7	8	9		10		11	12
1000 — 975			301	332				
974 — 950	310						304	
949 — 925		326	327	303				336
924 — 900		314		308				324
899 — 875			309	317	305	315		
874 — 850			313					
849 — 825		307		333			312	
824 — 800	318							
799 — 775								
774 — 750								
749 — 725								
724 — 700								
699 — 675			321					
674 — 650								

25% for grade limited the selection for yearling weight in this instance. The yearling weight of calf 332 was 975 pounds being 81 pounds above the average weight of his contemporaries. If heritability of yearling weight is 60% his progeny should average 24 pounds above herd average. ($\frac{1}{2} \cdot 81 \cdot .60 = 24$)

MEASURES OF GENETIC CHANGE

Genetic progress is measured by using each selected sire two years. Each year two sires are mated to a comparable half of the females in each line. The difference between the average performance of progeny by the new sire when compared with the progeny average of the repeat sire constitutes the measure of genetic gain from selection. The comparison of the progeny averages of a sire from the first year to the second year gives the environmental change from one year to the next. Also semen is being frozen from foundation sires used over all lines. This semen will be stored for five years and used in comparison with the sires currently in use for another measurement of genetic change.

SUMMARY

This selection study involving beef cattle is designed to measure the genetic change resulting from selection for increased weaning weight and grade or yearling weight and grade. The experimental procedure is briefly outlined. The method of selection is illustrated using data from the 1963 season.

Effect of High or Low Winter Feed Levels in Alternate Years on Growth and Development of Beef Heifers

L. Smithson, S. A. Ewing, R. E. Renbarger and L. S. Pope

Due to the significance of the cow-calf operation to the agricultural economy of Oklahoma, we must be intensely concerned with proper feeding and management to bring out the inherent producing ability in the beef female. Extensive studies at the Ft. Reno station since 1949 have explored different winter feed levels and systems of feeding to get maximum production, yet reduce supplemental feed costs as much as possible.

From this research a system of "weight control" has been developed which sets a pattern of maximum weight gain or loss the female should sustain during the winter and yet calve successfully in February-March and wean calves of satisfactory weights in October.

Several questions have evolved from these studies. What is the optimum level of winter feeding for replacement heifers until two years of age if they are to be well fed thereafter? Which is most damaging to subsequent performance, a low winter feed level during the first winter as a weaner calf or during the second winter as a bred yearling? Can feed levels be reduced sufficiently during the first and/or second winter, to effect important savings in terms of feed cost.

The results of two trials are now available. The results of the first trial were reported in detail last year.[1] This report covers the results of the second trial and the average effects for both trials on weight changes and reproductive performance of beef females. Obviously, the effects of extremely low levels of winter feed during one or two winters prior to the first calving may show up later in terms of a delayed conception and in lack of uniformity in the calf crop or in poor growth and lactation performance. Little is known about carryover effects resulting from restricted energy intake during the early developmental period of the beef female.

PROCEDURE

In each trial, 75 weaner Hereford heifer calves were selected from the Experiment Station herd and allotted to 5 groups on the basis of age, sire, body weight and productivity of dam. They were placed on three levels of winter feed the first winter as designated in Table 1. This table also gives the number of heifers completing each winter treatment. Unfortunately, due to failure to vaccinate the young heifers in trial 1 for Leptospirosis, a large number of abortions in November resulted in heavy losses of calves from heifers on all treatments. The heifers which had aborted were dropped from the test. This, together with above-normal difficulty at calving, reduced the numbers completing each treatment at 2.5 or 3.5 years of age. Only the heifers in trial 2 were continued into the second breeding season to study carryover effects.

The prescribed levels of winter gain or loss within each treatment were accomplished by varying the amounts of cottonseed meal and ground milo at approximately 2-week intervals during the winter, according to the weight gain or loss of the females. Weaner heifer calves on the Low level (lot 1) were to make no gain from November 1 to mid-April and following summer recovery on good native grass, they were to lose 50-75 lb. during the second winter up to calving, with a further loss of 100 lb. (including loss at calving time) until spring grass was ample.

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[1] Oklahoma Mis. Pub. MP-70, P. 42.

Table 1. Design of Experiment and Number of Heifers Completing Test

Lot No.	1st Winter as calves		2nd Winter as bred yearlings*		3rd Winter as 2 year-olds**
1	Low	—30	Low	—18	Moderate — 12
2	Low	—30	High	—20	Moderate — 13
3	Moderate	—30	Moderate	—21	Moderate — 13
4	High	—30	High	—22	Moderate — 12
5	High	—30	Low	—20	Moderate — 14

* The lower number is due to removal of heifers with Leptospirosis.
** Heifers remaining on test from Trial 2.

Heifers on the Moderate regime (lot 3) were to gain approximately 100 lb. during the first winter as calves, and to maintain weight during the second winter as bred yearlings up to calving, with a loss of less than 50 lb. until spring grass was ample. The high level heifers (lot 4) were to gain one pound per day the first winter and sustain no loss during the entire second winter until spring grass was ample. Except for lot 1 during the early winter dry lot period all heifers were maintained on native grass pastures year-long with supplemental feed as necessary from November to mid-April, and a mineral mix of 2 parts salt and 1 part steamed bone meal, free choice, at all times. To initiate the early weight loss, heifers on the Low level were confined to drylot with wheat straw and no supplement for 4-6 weks each year. This treatment is considered to be similar to poor pasture conditions which may exist during drought conditions or low level feeding that might result from the scarcity of harvested roughage.

The experiment was designed so that some heifers on the Low and High levels as calves could be reversed to the opposite regime the second winter as bred yearlings (lot 2 and 5). Following the first two winters all heifers were maintained on the moderate level. The results obtained in terms of average winter weight loss, summer weight recovery, final body weights, reproductive data and calf birth and weaning weights are shown in tables 2 and 3. The birth and weaning weights of all calves were corrected for sex, but not for age, since an earlier calf was considered advantageous for Moderate or High winter feed levels.

RESULTS

The period between 8 and 13 months of age is critical to the growing and developing beef heifer. Not only must nutritive demands for growth be met but the heifer must reach puberty and start cycling regularly before the start of the breeding season, if she is to calve as a two-year old. As shown in table 2, heifers on the Low level (lots 1 and 2) actually lost 26 to 28 lbs. during the first winter on the average, while those on the

Table 2. Effect of Winter Feed Level for Beef Females on Weight Change and Feed Cost.

Lot No. and Winter Feed Level 1st Winter 2nd Winter	1 Low Low	2 Low High	3 Moderate Moderate	4 High High	5 High Low
Average wt. change, lbs.					
Initial weight	438	436	438	438	438
8 to 18 months of age					
Winter gain or loss	— 26	— 28	97	147	164
Summer gain	355	346	314	277	270
Net yearly change	329	318	411	424	434
19 to 30 months of age					
Winter gain	—193	9	—128	— 67	—230
Summer gain	237	153	187	141	243
Net yearly change	44	162	59	74	13
31 to 43 months of age					
Winter gain	—120	—193	—166	—207	—185
Summer gain	205	242	251	257	263
Net yearly change	85	49	85	50	78
Fall weight 43 mo. of age	991	958	1000	1022	1034
Winter supplement/head (lbs.)					
1st winter					
C.S. meal	92	92	240	289	289
Grd. milo	79	79	384	949	949
2nd winter					
C.S. meal	89	289	211	289	89
Grd. milo	30	823	126	823	30
Av. winter supplemental feed cost/head ($)*	8.52	34.38	25.99	52.17	33.81

* All lots were fed the same amount during the third winter.

High level (lot 4) gained almost 1.0 per day during the winter. Summer gains were inversely related to winter performance which is a rather typical response. Nevertheless after a summer on good grass, at 18 months of age the difference in total yearly gain was more than 100 lb. in favor of the High vs. the Low heifers.

Reversing the level of wintering for lots 2 and 5 resulted in a pattern of weight loss as bred yearlings similar to that observed for lots 1 and 4, which were wintered each year at the same level. Fall body weights at 30 and 43 months of age reflect the previous winter's feeding regime, although the differences are less than might be expected, and are indicative of good summer recovery on pasture. Marked differences in supplemental feed costs can be seen in table 2. However, the differences between savings with respect to feed cost and overall returns as influenced by reproductive efficiency and weaning weight must be considered.

Table 3. Effect of Winter Feed Level on Reproductive Performance.

Lot No. and Winter Feed Level 1st Winter 2nd Winter	1 Low Low	2 Low High	3 Moderate Moderate	4 High High	5 High Low
Calf production data					
Av. calving date					
1st calf	4/3	3/27	3/19	3/12	3/8
2nd calf	4/6	3/5	3/26	3/1	3/24
% calf crop					
1st calf	65	73	70	72	78
2nd calf	73	79	76	62	79
Av. birth weight (lbs.)					
1st calf	65	72	71	72	67
2nd calf	81	77	79	76	75
Av. weaning weight (lbs.)					
1st calf	388	409	408	412	383
2nd calf	444	432	424	425	387
Av. daily gain of calves (lbs.)					
1st calf	1.56	1.62	1.61	1.65	1.50
2nd calf	1.73	1.65	1.71	1.63	1.66
Av. daily milk production (lbs.)					
1st calf	7.62	7.84	7.40	7.33	6.41
2nd calf	10.67	10.70	11.45	8.75	9.72

Data in table 3 show that the first winter at a Low level for heifers of lots 1 and 2 delayed calving date, and in the case of lot 1 resulted in a much lower percentage calf crop. In contrast, the better-fed heifers on the Moderate regime (lot 3) or High levels (lots 4 and 5) during the first winter evidently cycled earlier and calved 2 to 3 weeks before those on the Low level. Raising the level of energy during the second winter (lot 2) however, nullified the effects of a Low plane as a weaner calf. During the second calf crop while under the influence of the Moderate regime, the heifers of lot 2 tended to conceive as early as lots 3 and 4. In contrast the High level heifers that were switched to the Low level the second winter (lot 5) tended to conceive later than heifers in lot 4 but not as late as heifers in lot 1.

The effect of feed level on conception time is highly important and is one of the most significant patterns shown in this study. The first winter's feed level evidently sets the pace at which the heifer matures sexually, and will influence first conception. However, these effects are apparently not permanent in a seasonal calving program, and can be overcome by good feeding following the first winter.

Trends in percentage calf crop are less meaningful because of small numbers and high death loss, for various reasons, at calving. There is some indication of a lowered percentage calf crop and reduced birth weight for the first calf crop out of the Low-Low heifers (lot 1). Again, this was not a permanent effect, once these heifers were advanced to the Moderate regime after weaning their first calves.

Weaning weights of first calves reflected the wintering regime prior to calving (lots 1 and 5 vs. 2 and 4). Average daily milk production indicates that the high level of energy during the first winter resulted in lower milk production values for the first and second lactations. Perhaps the most important observations are that a poor wintering regime for either the first or second winter does not have a permanent effect on milk production or weaning weight and does not affect the second years performance if the heifer goes to a higher level during subsequent winters.

SUMMARY

Two trials were conducted to study the effects of varying the level of winter feed and varying this level from Low to High and vice versa during the first winter as weaner calves or the second winter as bred yearlings on subsequent performance of replacement beef females. In one trial, all the heifers were continued on the Moderate level for the second calf crop.

The results show that the main effect of the first winter at a Low level is to delay the onset of puberty and, as a result, delay conception and average calving date as two-year-olds. Other than this, the effects on growth and later performance appear negligible, providing good pasture and adequate feed levels are provided thereafter. There appears to be no permanent effect of a Low level during one winter as a calf.

Of the two winter periods, low level feeding the second winter as a bred yearling appears to be most damaging. Here the heifer, while still continuing to grow and develop must undergo the strain of calving and early lactation on inadequate feed supplies. The results are to delay re-breeding for the second calf, and a sharp reduction in milk flow. Naturally, this reduces the weaning weight of the calf.

Neither the Low-High or High-Low sequence appears to be as beneficial as an adequate feed level (Moderate) each winter in terms of growth and reproductive performance.

Factors Influencing Feed and Energy Intake of Steers Fed Conventional and High Concentrate Rations

Joe Hughes, S. A. Ewing, L. S. Pope and Eldon Nelson

During recent years, the high cost of energy from roughage relative to that from grain has been a significant item in formulating least-cost rations for finishing cattle in the Southwest. The demand for alfalfa hay in dairy operations, periodic drouth conditions and increased demand for cottonseed hulls have resulted in the commercial feeder paying nearly as much for cottonseed hulls or other processed roughage as for grain sorghum.

Roughages are relatively low in net energy, which is the energy remaining for production after all losses to the body in digestion and metabolism of food nutrients are accounted for. Although roughages often supply significant amounts of protein, minerals and carotene to the diet, these can be replaced by adding balanced supplements to high-grain rations. However, a significant question is how the presence of bulk in the diet influences energy consumption and performance of ruminants.

Numerous experiments have shown that if roughage is removed from the ration and replaced by grain, the fattening steer eats less total feed and actually consumes only slightly more energy. All the factors governing feed intake of ruminants on finishing rations are still obscure, but among the most important are:

1. **Inheritance.** Recent studies show that appetite may be rather highly heritable.

2. **Type of ration.** The physical nature and bulk of the diet tends to influence rate of feed passage from the rumen and as a result may influence appetite.

3. **The caloric content of the diet.** Presumably this is due to the end products of digestion which may, in some way, regulate appetite.

4. **Rumen pH.** The lowered pH of the rumen associated with finishing rations may also influence feed intake.

Among other factors, the environmental temperature to which the finishing steer is exposed has been observed at this station to exert an important influence on daily feed intake.

Further, roughages initiate or lead to a rather high "heat increment" due to the energy released during digestion and metabolism. It seems possible that this heat load could be reduced by the use of high-energy and low roughage rations in the Southwest during the hot summer months.

The factors that influence feed intake in ruminants have been investigated in a series of trials. A part of the initial study was reported in the 1963 Feeder's Day report.[1] The studies were concerned with the effects of the physical make-up of the ration and the source of calories on total feed and energy consumed.

TRIAL 1 (FALL 1962)

In this preliminary trial started in the fall of 1962, five lots of 6 yearling steers were self-fed the different experimental rations to determine the influence of high concentrate rations, fat additions, ration density per unit of volume, and the addition of inert bulk on feed and caloric intake of finishing steers as well as the resulting performance in terms of daily gain.

The rations fed the various lots were:

Lot 1: Conventional finishing ration (65% concentrate).

Lot 2: High-concentrate ration (95% concentrate).

Lot 3: The conventional finishing ration with 5% stabilized animal fat.

Lot 4: The conventional diet plus approximately 16% added fine sand to increase ration density and to simulate the weight per unit of volume of the high concentrate diet.

Lot 5: The high-concentrate diet plus inert bulk supplied by an indigestible polyethylene resin in order to increase the dietary bulk without adding nutrient value.

The steers were self-fed the above rations for a period of 193 days in paved lots bedded with sand to prevent the consumption of other roughage. The average daily feed consumption and daily gain over this period are shown in Table 1 along with daily net energy intake calculated from published values for the feeds used.

The results show a marked reduction in total feed consumed by steers consuming the high concentrate ration (Lot 2), as well as some reduction in caloric intake. When fat was added to the conventional ration (Lot 3), the total feed intake remained almost constant with that observed in Lot 1. However, the caloric intake was increased due to the presence of fat which supplies approximately 2.25 times as much energy per unit of weight as carbohydrate or protein. The addition of a dense, inert material such as fine sand to the ration (Lot 4) at levels providing as high as 5-6 lb. per steer daily resulted in an increase in the total mixture consumed. This suggests that the density of the diet has little effect in depressing appetite. When the inert plastic material was added to the high concentrate diet (Lot 5), greater con-

[1] Oklahoma Agricultural Exp. Station Misc. Pub. MP-70.

Table 1: Composition of Rations Fed, and Average Daily Feed and Energy Intake of Finishing Steers
(Trial 1)

Lot Designation	1	2	3	4	5
Ration Designation	A	B	C	D	E
Ration Composition, %[1]					
Steam Rolled Milo	51.4	83.9	46.4	Same As A Plus 500 Lbs. Sand Added to 1 Ton Feed	Same As B plus 400 Lbs. Inert Bulk Added To 1 Ton Feed[2]
Cottonseed Meal	8.0	5.0	8.0		
Dehyd. Alf. Meal	5.0	5.0	5.0		
Urea	1.5	1.5	1.5		
Molasses	3.0	3.0	3.0		
Stabilized Animal Tallow	--	--	5.0		
Cottonseed Hulls	30.0	--	30.0		
Salt	0.5	0.5	0.5		
Calcium Carbonate	0.5	1.0	0.5		
Av. Daily Feed Intake, Lbs.	28.73	21.46	29.59	33.12	27.94
Ave. Net Energy Intake/da., Therms[3]	17.5	15.5	19.3	16.1	16.8
Ave. Daily Gain, Lbs. (148 Days)	2.50	2.56	3.15	2.90	2.95

[1] All mixtures supplied 30,000 I.U. Vit. A and 3 gm. trace mineral per steer daily.
[2] Polyethylene resin, DuPont, used as filler.
[3] Calculated from Morrison's *Feed and Feeding*, 22nd Ed., Appendix Table 2.

sumption was obtained than on the high concentrate ration fed to Lot 2. Upon slaughter, no abnormalities were noted in the digestive tract.

It appeared that the steers would consume quantities of the different rations that would provide a similar caloric intake, irregardless of the physical density or bulk of the ration. The only exception appeared to be in the case of the fat-containing ration. More total calories were consumed from this ration than from the other rations fed. This suggests that the mechanisms controlling feed intake may be more sensitive to carbohydrates than fat.

TRIAL 2 (SUMMER 1963)

In order to test the influence of increased ration density and added inert bulk to finishing rations during the hot summer months, a trial was started during the summer of 1963. Twenty-seven yearling steers were allotted to nine lots of three steers each and self-fed three experimental rations as shown in Table 2.

The basal diet contained 74% concentrate, and as in Trial 1, the ration fed Lot 2 contained approximately 16% sand. The ration fed Lot 3 contained 13% inert bulk from polyethylene resin. The additions were made to alter the density or level of bulk fed.

Table 2: Composition of Rations Fed and Average Daily Feed And Net Energy Intake of Steers During Summer Months
(Trial 2)

Lot Designation Ration Designation	1 A	2 B	3 C
Ration Composition, %			
Steam Rolled Milo	61.15	Same As A Plus 400 Lbs. Sand Added to 1 Ton Feed	Same As A Plus 300 Lbs. Inert Bulk Added to 1 Ton Feed[2]
Cottonseed Meal	7.00		
Dehyd. Alf. Meal	6.00		
Molasses	3.00		
Urea	1.00		
Cottonseed Hulls	20.00		
Salt	1.00		
Calcium Carbonate	.80		
Vit. A Premix[1]	.03		
Trace Mineral	.02		
Ave. Daily Feed Intake, Lbs.	26.7	31.1	27.1
Ave. Net Energy Intake/ Da., Therms[3]	16.55	16.17	14.63
Ave. Daily Gain, Lbs.	2.65	2.57	2.50

[1] 10,000 I.U. per gram.
[2] Polyethylene resin, DuPont, used as filler.
[3] Calculated from Morrison's *Feeds and Feeding*, 22nd Ed., Appendix Table 2.

The animals were maintained in paved lots bedded with sand during the 110 day feeding period. An open shed provided shade for all lots. In addition to composition of the rations fed, the average daily feed intake, caloric intake and daily gain are shown in Table 2.

The results indicate that under summer conditions, finishing steers can adjust to the increased density of the diet in that more of the sand-containing ration was consumed and thus provided a caloric intake essentially equal to that observed in Lot 1. This same pattern was noted in the previous trial conducted during the winter months.

It is interesting, however, in this preliminary trial that steers of Lot 3, fed the ration containing inert bulk, did not appear to be able to compensate by increasing their feed intake in order to maintain a caloric intake equal to that for the other rations. Possibly, a higher heat increment resulted from the bulkier diet. This would be the expected case when the level of normally fed roughage is increased in the ration and is presumably due to altered end products of digestion. The influence of inert bulk in the diet is presently being studied further.

Large amounts of bulk or roughage during the hot summer months may be disadvantageous to finishing cattle. For summer-type rations, the "all-concentrate" approach may have merit. Such a pattern has been apparent from recent California trials. In the Southwest, cattle feeders may well use two different rations—one containing approximately 20% roughage such as cottonseed hulls for winter feeding, and the other one designed for more efficient summer feeding by eliminating most of the roughage, thus reducing the heat produced by roughage utilization.

TRIAL 3 (WINTER 1963)

To further study the influence of bulk in the ration or the presence of additional fat on the feed and energy intake of steers, a test was designed for the 1963-64 winter study. Five different rations containing varying levels of roughage, fat, or bulk were formulated. The composition of the diets used is shown in Table 3. A brief description of the experimental rations appears below:

A—Basal ration containing 20% cottonseed hulls.
B—High-concentrate ration (95% concentrate).
C—Basal ration with 5% stabilized fat.
D—High-concentrate ration with 5% stabilized fat.
E—High-concentrate ration with 5% stabilized fat plus 13% polyethylene resin to increase the bulk in the diet.

Five lots of 7 yearling Hereford steers each were self-fed the above rations during five 25-day feed intake tests. This design permitted all lots of steers to receive each ration during the trial. The steers were fed for a 7-day preliminary period, and then feed consumption records were maintained during the 25-day test period. About midway through each feeding period, rumen samples were taken from at least 2 steers on each treatment to study ruminal pH and volatile fatty acid levels in the rumen fluid.

Table 3: Composition of Rations Fed to Finishing Steers (Trial 3)

Ration Designation	A	B	C	D	E
Ration Composition, %					
Steam Rolled Milo	60.85	83.95	55.85	78.95	Same As
Cottonseed Meal (41%)	8.00	5.00	8.00	5.00	D Plus
Dehyd. Alf. Meal (17%)	6 00	5.00	6.00	5.00	300 Lbs.
Molasses	3.00	3.00	3.00	3.00	Inert Bulk
Urea	1.00	1.50	1.00	1.50	Added To
Stabilized Animal Tallow	---	---	5.00	5.00	1 Ton Feed[2]
Cottonseed Hulls	20.00	---	20.00	---	
Salt	0.50	0.50	0.50	0.50	
Calcium Carbonate	0.60	1.00	0.60	1.00	
Vit. A Premix[1]	0.03	0.03	0 03	0.03	
Trace Mineral	0.02	0.02	0.02	0.02	

[1] 10,000 I.U. per gram.
[2] Polyethylene resin, DuPont, used as filler.

Preliminary results from three trials (25-day feed intake periods) have been obtained and are shown in Figure 1. The net energy in each ration was calculated from published values.

The results to date indicate the same pattern observed in other studies, with reduced feed and caloric intake on the high-concentrate ration (B) vs. the conventional diet (A). Adding fat to each of these rations (C and D) had little effect on feed intake, however caloric intake was higher in each case. The greater improvement in caloric intake resulted from the addition of fat to the high-concentrate ration. Hence, there may be considerable advantage to the inclusion of fat in finishing rations of this type. In other words, more energy can be crowded into the finishing steer diet when supplied as fat than when made up predominately of the carbohydrate-containing grains. However, there is a limit to the amount of fat that can be used. Most studies show that levels above 6-8% cause a reduction in appetite and effect the digestibility of other constituents in the rations.

A limitation to the experimental design used here is that the long-term effects of such rations cannot be determined. Over a long feeding period, cattle may tire of fat containing diets devoid of roughage and thus nullify the effects obtained over a shorter feeding period.

It is apparent from the data that the addition of inert bulk to the high-concentrate diet containing fat (E), fed during the winter, was compensated for by increased feed intake of the steers. The possibility of maximizing energy intake during the hot summer months by employing an all-concentrate type diet plus added fat will be investigated in further trials.

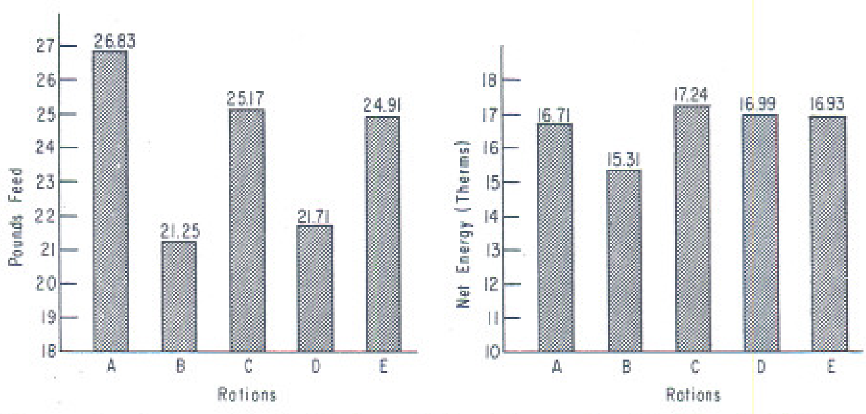

Figure 1. Average Daily Feed and Net Energy Intake Obtained From Three Trials with Steers (Trial 3).

One possibility for the reduced feed intake on high-concentrate diets is that there is a difference in the volatile fatty acids produced by rumen bacteria from each type of ration. To study this, 8 yearling steers were divided into two groups of four steers each and fed a conventional diet containing 30% cottonseed hulls (Ration A) and the ninety-five percent concentrate ration (Ration B). After a preliminary period of 10 days on each ration, rumen samples were taken by stomach-tube. Rumen pH readings were recorded and volatile fatty acid determinations were made by the gas chromatograph procedure. The groups were then reversed with respect to treatment, and further samples were taken for analyses after a 10-day preliminary period. The results of the fatty acid determinations are shown in Table 4. The ratio of acetic to propionic acid in rumen fluid was lower in the case of the high-concentrate ration. Higher levels of propionic acid are often associated with more efficient energy utilization.

SUMMARY

A series of trials, using yearling steers confined in paved lots with sand bedding, was initiated to study the effects of density or bulk and the addition of fat on feed and energy intake. The results demonstrate the ability of finishing cattle to overcome differences in the physical nature of the ration and to equalize their caloric intake. The addition of 5% fat appears to offer promise as a means of increasing the total calories consumed. Results of a summer trial indicate that fattening steers can tolerate greater density of the ration, but not an increase in bulk. This tends to suggest the need for different rations for summer and winter feeding.

Table 4: Volatile Fatty Acid Content of Rumen Fluid From Steers Fed Conventional and High-Concentrate Rations

	m moles VFA/liter				Acetic: Propionic Ratio
	Acetic	Propionic	Butyric	Valeric	
Trial 1					
Ration A[1]	51.52	38.22	8.47	2.36	1.35:1
Ration B[2]	35.02	36.01	5.44	1.27	0.97:1
Trial 2					
Ration A[1]	60.98	30.42	14.47	1.66	2.00:1
Ration B[2]	56.03	58.03	7.39	1.12	0.97:1

[1] Conventional ration containing 30% cottonseed hulls.

[2] 95% concentrate ration.

Fish Flour in Replacement of Dry Buttermilk and Soybean Meal in Starter Rations for Pigs

J. C. Hillier — Ray Washam — Lynn Byram

The source and biological value of the protein in starter rations has an important bearing on the performance of young pigs. Milk or fish protein is ordinarily included in starter rations to supply the required amino acid levels and balance. In this test a fish flour processed by an azeotropic solvent method was substituted for a combination of soybean meal, dry butter milk and DL methionine in a starter ration. The compositions of the two starter rations used are shown in Table 1. The fish meal was used to the extent permitted by its mineral content. Soybean meal and dry buttermilk were used to supply an equal level of protein. DL methionine was added to ration 1 at the rate of 2.6 pounds per ton.

The sows used in this test were all first and second litter, primary and secondary specific pathogen free Yorkshire females. The litters were all sired by Yorkshire boars that were very closely related. Farrowing took place between November 1, 1963, and January 20, 1964. Sows and their litters were moved to six by twenty-four foot pens, a portion of which is covered by an open shed, when they were fourteen days old. The starter rations were placed before the pigs at this time. The sows were self-fed the ration shown in Table 2.

Table 1: Composition of Starter Rations Fed.

Ration[1]	1	2
Milo (Western Yellow-finely ground)	1235.2	1443.8
Soybean meal (50% protein)	463.0	82 0
Fish flour[2]	----	260.0
Buttermilk (Dry 32% protein)	60.0	-----
Whey (Dry 12% protein)	100.0	100.0
Molasses (wet)	100.0	100.0
Dicalcium phosphate	22.0	-----
Calcium carbonate	6.4	-----
Trace mineral salt	10.0	10.0
Vitamin mineral pr-mix	3.4	3.4
Total[3]	2,000.0	2,000.0

[1] Hygromix was added to this base ration at the rate of 5.0 pounds per ton; Aureo S.P. 250 was also added at the rate of 5.0 pounds per ton. Both of these products were supplied by the manufacturers, Eli Lilly and Co., Indianapolis, Indiana, and American Cyanamid, Agriculture Division, Prnceton, N. J.

[2] The fsh flour used was supplied by the Vio Bin Corporation of Monticello, Illinois. Analysis available on this material ndicated that t has 73 to 75% protein, 15-18% ash and 1.5% fat.

[3] Ration 1 is calculated to contain the following quantities of nutrients, protein, 18%; calcium, 0.70%; phosphorus, 0.60%; vitamin A, 1020 I.U.; lysine, 1.08%; methionine, 0.30%; and pantothenic acid, 10.0 Mgs; riboflavin, 3.0 Mgs. per pound. This ration contains four pounds of DL methionine added per ton. Ration 2 has slightly more lysine (1.28%) and methionine (0.35%). No DL methionine as such was added to ration 2.

Table 2: Composition of Sow Ration—Gestation and Lactation

Sow Ration During Gestation and Lactation [1, 2]	Pounds Per Ton
Milo (Western Yellow—finely ground)	1607.7
Soybean meal (50% protein)	208.6
Tankage (60% protein)	50.0
Alfalfa meal (dehydrated 17% protein)	100.0
Dicalcium phosphate	12.4
Calcium carbonate	7.3
Trace mineral salt	10.0
Vitamin B_{12}	2.4
B complex vit. supplement	1.2
Zinc sulfate	0.4
Total	2,000.0

[1] The base ration used was as listed. To this base ration 5.0 pounds of Hygromix was added per ton for the last 30 days of gestation. Aureo S.P. 250 was added at the rate of 5.0 pounds per ton for the last few days of gestation and during lactation. Aureo S.P. 250 contains chloretracycline 20 grams, sulfamethazine 20 grams, and penicillin 10 grams per pound of material. Thus the medication amounts to 100 grams of aureomycin, 100 grams of Sulfamethazine and 50 grams of penicillin per ton of complete sow ration.

[2] The calculated composition of the sow ration during gestation and lactation was as follows: protein 14.0%, calcium 0.6%, phosphorus 0.5%, vitamin A 4,000 I.U., pantothenic acid 7.7 milligrams, riboflavin 2.2 milligrams and B_{12} 33 micrograms per pound.

As the litters reached 42 days of age, the sows were driven out and the pigs continued on the same ration until they were weighed out at 56 days of age.

The results of this trial are summarized in Table 3. It was considered that the pigs on both starter rations performed exceptionally well. Some scouring was observed in the farrowing quarters but no scouring or other digestive disturbance was observed after significant quantities of the starter rations were being consumed. The litters on starter ration 1 averaged 449.2 pounds each at 56 days for an average pig weight of 48.3 pounds. Litters on starter ration 2 averaged 418.6 pounds with an average pig weight of 45.5 pounds. Pigs on ration 1 average 0.86 pounds of weight for each day of age to 56 days. Those on ration 2 average 0.81 pounds. Pigs on ration 1 consumed an average of 46.1 pounds each between the 14th and 56th day. Those on ration 2 consumed 39.1 pounds each or 7.0 pounds less. This amounts to 15.2 percent lower feed consumption. In terms of creep feed consumed per pound of weight of the pigs the figures are 0.95 and 0.86 pounds respectively. Figuring starter ration 1 at $4.50 and ration 2 at $4.73 per cwt the feed cost was $2.07 and $1.85 per pig for rations 1 and 2 respectively.

The sows also performed exceptionally well on the ration used. No sows went off feed or showed signs of lactation fatigue. Perhaps the exceptionally heavy feed consumption of 19.1 and 18.5 pounds per day helped to meet the heavy lactation requirements common for nursing

Summary of Results

Table 3: Starter Rations for Pigs Weaned at 42 Days-Rations Continued to 56 Days

Ration No. / Treatment Variables	1 Buttermilk Methionine	2 Fish Flour
No. of litters	15	13
No. of pigs	139	120
Av. pigs per litter	9.3	9.2
Pig weights		
Birth (lbs.)	2.8	2.7
14 days (lbs.)	8.2	8.3
42 days (lbs.)	30.7	29.4
56 days (lbs.)	48.3	45.5
Pig gains		
Up to 14 days (lbs.)	5.2	5.5
14 to 42 days (lbs.)	22.7	21.6
42 to 56 days (lbs.)	17.5	16.1
Rate of gain—per day		
Up to 14 days (lbs.)	0.37	0.39
14 to 42 days (lbs.)	0.81	0.77
42 to 56 days (lbs.)	1.25	1.15
Feed consumed per pig		
14 to 42 days (lbs.)	14.4	11.9
42 to 56 days (lbs.)	31.7	26.4
14 to 56 days (lbs.)	46.1	39.1
Creep feed per lb. gain (lbs.)	0.95	0.86
Cost of creep feed per pig $	2.07	1.85
Weight changes on sows		
Loss farrowing to 14 days (lbs.)	67.7	73.2
Gain 14 to 42 days (lbs.)	24.9	33.2
Net loss entire farrowing and lactation (lbs.)	44.1	47.5
Feed consumed by sows (lbs.)	637.6	615.9
Sow feed per day (lbs.)	15.2	14.7
Sow feed costs $	19.13	18.48
Feed cost per pig $		
Sows feed after farrowing and Creep fed for pigs	4.13	4.07

sows. The fact that these sows gained 0.89 and 1.19 pounds per day during the twenty-eight days of the nursing period that they were on test is proof that they were in strong condition. They did, however, sustain net losses of 44 and 47 pounds from 110 days of gestation to weaning at 42 days post-farrowing.

Considering the feed cost of the sows and the pigs, each pig at weaning represented a feed cost of $4.13 for those on ration 1 and $4.07 for those on ration 2. To offset this slight difference in feed cost the pigs fed ration 1 were 2.8 pounds heavier. It thus appears that either ration could be used with little choice between them.